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EFFECTS OF VARIOUS PLANTING PRACTICES ON YIELDS,
AND GROWTH AND DEVELOPMENT OF SOYBEANS
(GLYCINE MAX L. MERRILL) IN MICHIGAN

By

David Warren Merck

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ABSTRACT

EFFECTS OF VARIOUS PLANTING PRACTICES ON YIELDS,
AND GROWTH AND DEVELOPMENT OF SOYBEANS
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By

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The effects of various cultural practices on yield, and growth and development of soybeans (Glycine max L. Merrill) were studied at two Michigan locations in 1978 and 1979.

Yields were generally reduced with later planting dates. However, earlier than normal dates for northern locations responded with little if any yield advantage.

Row widths of 25 and 51 cm yielded significantly more than 76 cm widths. However, yield responses to width were somewhat inconclusive since plant densities in each width varied by year.

Of four cultivars tested both years, yield differences were of a much smaller magnitude than those of planting date and row width. Over years and locations 'Hodgson (78)' yielded the most followed by 'Corsoy', 'SRF 200' and 'Evans'. 'Nebsoy,' grown only in 1979, appeared tolerant to late summer drought.

There were several yield interactions. Measurements were recorded for developmental stages, photosynthetically active radiation, agronomic characteristics and yield components.

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INTRODUCTION

During the last few decades the agricultural production of soybeans has risen to a level of primary, world-wide significance. In the state of Michigan, there has been a dramatic increase in cropland planted to soybeans to the 1978 level of 324,000 hectares, an increase of 362 percent since 1960. This rapid rise in production is continuing with the 1979 soybean cropping area estimated in excess of 364,000 hectares in Michigan. At present the soybean crop in the state is second only to that of corn among the grain crops.

This sizeable commitment of cropland resources to the soybean crop highlights the importance of developing methods to maximize yield from these resources. Such a maximization is critical not only for the obvious and basic economic reasons, but also for the more philosophical and moral reason of being a good steward of the resources devoted to production of a primary world food crop.

It is commonly known that the reproductive capacity of a plant, or community of plants, is dependent upon many factors. These factors may be categorized as either micro-factors or macro-factors. Micro-factors having a direct relationship to reproductive capacity would include such metabolic factors as photosynthesis, respiration, nitrogen metabolism, and water relations, and also plant growth and development factors such as vegetative growth, flowering and senescence. On a macro level are factors which may influence the micro-factors just mentioned. In soybean production, macro-factors include the

various standard crop production practices, some of which are characteristically associated with the planting of the crop. Selection of the particular cultivar to be planted is critical, for each cultivar possesses different inherent expressions of the micro-factors. The spatial arrangement of plants in a monocrop community will have profound effects upon the micro-factors through varying intraspecific competition for raw materials. In the row-crop production of soybeans, both row width and overall plant density contribute to the final spatial arrangement. The nature of the growing season will also affect the micro-factors, especially those related to plant growth and development. Planting date directly determines the portion of the growing season utilized by the crop.

Each of the above planting practices not only may have potentially profound effects upon final reproductive yield, but also have the additional advantage of being manipulated without significant investments of time, money (with the possible exception of spatial arrangement factors), and energy resources.

The effects of the various planting practices are not individually independent. There is a composite effect from various combinations of these practices. Also, different combinations of planting practices may produce varying responses under diverse conditions. Hence, a systems approach would be a more realistic way to determine the optimal set of planting practices. Such systems approaches have been utilized in other states in the past, but little information was available for the rather unique environmental conditions of Michigan. This study involved such a systems approach in which combinations of various levels of planting practices were analyzed with two

objectives in view. The first was to obtain preliminary indications of the individual planting practices and overall planting systems which result in maximum economic yield under typical Michigan growing conditions. The second objective was to explore in a preliminary fashion some growth and development factors, especially as they related to the variability in yield resulting from these different combinations of planting practices.

LITERATURE REVIEW

The concept of a systems approach to soybean production has gained increasing acceptability in recent years and has been investigated by several researchers.

One systems approach composed of production practices specifically related to planting has been investigated in Ohio by Ryder and Bierlein (33). Planting practices in this system included plant density, row width, planting date and cultivar. There have been other uses of the systems approach in soybean production including one investigation into a system for production of soybeans on sloping land (45).

In general, delays in planting of soybeans beyond the optimal period for a given location or cultivar, have resulted in reductions in grain yields (16, 19, 33). The later the planting date beyond the optimum period, the larger the yield reduction has been. In northern areas of the U.S., soybeans generally have not responded favorably to extremely early plantings in contrast to corn (16). The early plantings have often resulted in reduced stands, slow early growth and serious weed competition (19). Soybeans appear to be sensitive to the cool soil temperatures present at very early planting dates, and the soil temperature should be at least 10°-12° C before planting begins (23).

Crop yields are known to be related to both the total assimilation and nutrient uptake during the growing season, and also to the way

this material is partitioned between harvestable storage structures and the rest of the plant. When differentiation of the reproductive structures is an alternative to vegetative growth, as is the case with indeterminate soybeans, the timing of the transition to reproductive growth has been reported to be a factor in determining the number of reproductive structures, the competitive ability of these structures in accumulating reserves, and ultimately the overall yield (17).

Planting date is a critical factor in the timing of this transition.

In the northern latitudes, longer photoperiods generally delay flowering of most adapted cultivars (8, 26). Cooler temperatures also delay flowering in an additive fashion with photoperiod. Effects of cool spring temperatures on flowering predominated with plantings early in the season while photoperiod predominated in later plantings according to Major, et al. (26). In a study in the California Imperial Valley, the maturity date was delayed relatively little by successive delays in planting (1). However, in the northern U.S., a three-day delay in planting on the average results in a one-day delay in maturity (16).

Later planting dates tend to result in better emergence (49). In research done at Urbana, Illinois, it was found that on the average, maximum plant height was attained by the first planting date (May 1). However, this same study also concluded that lodging was greater with later planting dates (29). Other Midwest data have indicated that medium planting dates respond with the greatest plant height and that more lodging occurs with early dates (4).

Although in the southern U.S., narrow row widths have given little yield advantage (19, 23), the increased yields from row widths

which are narrower than traditional row widths have been widely documented in the north (5, 6, 7, 16, 21, 22, 23, 30, 33, 36, 39, 44, 46). The optimal row width is less well established and may be dependent upon cultivar, length of the growing season and soil fertility. Some work done in Indiana, Iowa, Ohio and Illinois has indicated that highest yields occurred at 53 cm row widths, and that yield reductions occurred at widths of 36 and 18 cm (19). However, a classic study by Wiggans in New York indicated that, in general, decreasing row width increased yield all the way down to 20 cm widths (46).

Narrower rows tend to have a higher leaf area index (LAI) earlier in the season than do wide rows (18). As a result, natural weed control tends to be more effective in narrow rows due to earlier shading (13, 16). With narrow row widths, there appears to be more water infiltration and less soil loss, but Hartwig and Pendleton reported no width effect on evapotranspiration (16). A critical factor with narrow rows appears to be maintaining a low enough seeding rate to avoid potential lodging problems which might negate the yield advantage (3, 4, 5). Lodging is less of a problem at later planting dates. Narrow row widths have had yield advantages at all planting dates but the percentage increase appears to rise as planting date is delayed (6, 16, 33). In one study, narrow rows also tended to yield better in relation to wide rows during poor growing seasons when plants remained short (33).

The effects of varied plant densities upon soybean yields have usually been negligible except at extremes toward very high or very low (4, 7, 13, 18, 22, 25, 46). In some instances higher densities have resulted in higher yields (16, 33) while in other instances in Iowa

and Minnesota, yields have decreased (39, 44).

High plant densities have been shown to reduce the harvest index of some crops (36). Research with corn has indicated that plant height increased to an optimum density and then decreased at higher densities. Evidently a point was reached where the stimulation of elongation was negated by shading effects, although this point varied by cultivar (9). This response of corn perhaps explains reports of variable responses of soybean plant heights to plant density (18, 25, 44, 47). The general increase in plant height often observed with increased plant densities has been closely related to another density response of increased early lodging (4, 7, 13, 16, 25, 31, 44, 47). Early lodging has been observed to decrease yield, and in Indiana, the R_5 stage was the most critical for yield reductions (43, 48) resulting from early lodging. Other observed responses to increased plant densities have included decreased branching, fewer seeds and pods per plant, decreased seed weight per plant, greater height of the lowest pod-bearing mainstem node, fewer seeds per branch pod, increased LAI, reduced number of days to 95% (daily basis) solar radiation interception from the date of emergence, decreased stem diameter, and increased number of pods per land area (m^2) (7, 13, 18, 22, 25, 36, 37, 44, 47). Individual seed weight was usually little affected by density.

The concept of spatial arrangement of soybean plants is actually a combination of row width and plant density. Theoretically the highest yield should come from equidistant spacings (16). However, the need for mechanical weed control often dictates wider row spacings. It has generally been recommended that narrow row widths should be planted with more plants per land area for maximum yield than wider rows

(16, 19, 23). However, work in central Illinois indicated that a rate of 37.5 viable seeds per m² was near optimal for all three row widths tested and for most cultivars (5). Wiggans (46), on the other hand, in earlier work indicated that the optimal spacing and plant density should be determined for each individual cultivar. Plant density responses provide a tremendous capability for soybean plants to compensate for different densities.

Two major concerns when considering cultivar selection are maturity groups and varying plant morphology. The responses of cultivars with early or late maturities for a given location may be varied. Embryos of early maturing cultivars have been found to be more susceptible to imbibitional chilling injury than have late cultivars. This response may be due to the fact that seeds of early maturity cultivars generally mature during warmer periods of the year and are therefore not hardened to cold (2). Maximum yields have usually been obtained from highly-productive, adapted late-maturing cultivars for a given location (6, 16). Early maturing cultivars have usually been less sensitive to photoperiod than late maturing cultivars (8, 26). Therefore, as planting date has been delayed, the period from planting to flowering has tended to be reduced more for later cultivars than earlier ones. The reverse was true for the flowering to maturity period in California and Illinois (1, 29). Research by Osler and Cartter (29) in Illinois has indicated that early cultivars responded with their greatest yields when planted at a medium planting date (May 15) while late maturing cultivars yielded best when planted early (May 1). Early cultivars also tended to decrease in height more rapidly as planting date was delayed and tended to produce pods at lower plant levels in one study (16).

Early maturing cultivars tended to be more responsive to narrow rows in Illinois, Wisconsin and Minnesota (5, 6, 7). However, at Wisconsin, the later cultivar yielded the most at every row width treatment. Generally, the optimum plant density has been shown to be less for late, tall, large leaf cultivar types than for earlier and shorter types (16).

Considering morphological characteristics, attempts have been made to find common yield components with significant correlations with yield. In one study involving 237 strains, of the five factors of percent of abortive seed, weight of 100 seeds, number of nodes per plant, number of pods per node and number of seeds per pod, only the first two had significant correlations with grain yield (42). In studying the morphology of the above-ground plant portions, an obvious factor is that of penetration of light into the canopy. Wahua and Miller, utilizing various levels of shading, reported significant decreases in yield and number of pods per plant with increased shading (40). Increasing light intensity by use of lights or reflectors at the lower portions of plants caused increased yields, especially of the bottom and middle plant portions. Also increased were numbers of seeds, nodes, pods, branches, pods per node, seeds per pod, rate of apparent photosynthesis and oil content. Protein content and seed size were reduced (21, 38). These results tend to indicate that light levels at the lower canopy level are a limiting factor to yield. In an attempt to determine the contribution of leaves at various plant areas, a defoliation experiment was conducted by Johnston et al. (20). Defoliation of the middle plant leaves caused the greatest yield reduction while that of the top portion was second and of the bottom portion was

last in reducing yield. In related studies in Iowa (14) the highest abortion levels of flowers and pods were found to occur on branches and on lower mainstem nodes.

In an attempt to better utilize the incoming light, various plant morphologies have been tested. In general, thin-line cultivars have tended to do best in narrow rows, while branching, medium to late cultivars have generally proven best if wide rows are used, especially at later planting dates (33). Iowa results have indicated that most light interception occurred at the periphery of soybean canopies, and that many lower leaves in a closed canopy did not receive optimal radiation levels (34). In an attempt to allow more light penetration, narrow leaflet plant types have been designed. However, thus far no consistent yield advantage has been observed for the narrow leaflet cultivars, even when comparison was made with near isogenic lines with broad leaflets (15, 16, 18). This was true even though more light penetrated into the narrow leaflet cultivar canopies, compared to those with broad leaflets.

In addition to providing energy for photosynthesis, other aspects of radiation may influence patterns of growth and development. One possible example is that of a phytochrome regulated branching response, since the relative ratio of far red to red radiation increases rapidly from the top of the canopy down to the soil surface. However, such a response is still somewhat speculative (28).

Canopy morphology also may affect more than just light distribution. The patterns of leaf distribution may also influence air circulation, canopy roughness and hence the efficiency of eddy turbulence. These factors in turn affect CO_2 , H_2O vapor and heat transfer so that

canopy structure may influence the microclimate of plants (24).

Noticeable environmental effects upon soybean plants highlight the need for repetition of experiments across locations and years. Warrington (41) found that a constant day/night temperature cycle of 23°/23° C resulted in significantly higher plant heights and mainstem leaf numbers. Increasing differences in this cycle resulted in higher leaf, stem and root dry weights, and higher specific leaf weights (41). Limited soil moisture has been found to reduce plant height, the size of the assimilating leaf area, and the size and number of potential storage sites for produced dry matter (27). However, the effects of moisture stress have been found to be very dependent on the stage of plant development. A shortage of water during pod-fill has reduced yields more than one during flowering (16). Using a greenhouse technique, it has been possible to a limited degree to identify cultivars which are either drought resistant or susceptible (35). In one analysis at Urbana, Illinois, it was possible to account for 68% of the variation of soybean yields from 1909 to 1957 utilizing precipitation and maximum daily temperature figures for the site (32). These results reinforce the importance of environmental factors.

Growth stage differences, noted earlier in relation to date of planting, may also help explain certain plant yield responses. A Kentucky study has indicated that the length of the effective grain filling period was positively associated with yield (11). In another study, there was no association between yield and the number of days between any two vegetative stages. However, the period from the R_4 to R_7 stages was most highly correlated with growth. Longer periods of pod development (R_2 - R_4) tended to be associated with lower yields (10).

MATERIALS AND METHODS

A field study investigating various systems of planting practices for soybeans was conducted during the 1978 and 1979 growing seasons at two locations each year. The two locations were selected from the two major soybean producing areas in Michigan, the southeastern portion of the lower peninsula and the Saginaw Valley area. The Saginaw Valley location was essentially identical both years while the southeastern location was at two distinctly separate sites during the two growing seasons.

I. 1978 Growing Season

Both locations were planted in a 3 X 3 X 2 X 4 factorially arranged classical split, split plot design with three replications. The 72 treatments consisted of 3 planting dates, 3 row widths, 2 intended plant densities and 4 cultivars. The first split involved planting dates and the second split reflected row width. Equally-spaced planting dates varied by location. Row widths of 24, 51 and 76 cm were planted in 2 intended plant densities of 344,000 (low) and 474,000 (high) plants per hectare. Of the 4 cultivars planted, 3 were selected as commonly-used, well-adapted representatives of 3 different maturity groups. 'Evans' was selected from Group 0, 'Hodgson' from Group I, and 'Corsoy' from Group II. In addition to these 3 cultivars, a Group II narrow-leaf cultivar, 'SRF 200,' was selected. Standard warm germination tests utilizing 200 seeds from each cultivar yielded

the following results: 'Corsoy' -- 90 percent, 'Evans' -- 84 percent, 'Hodgson' -- 90 percent, and 'SRF 200' -- 96 percent. However, the seed amounts planted were not adjusted by these germination test figures.

Planting was accomplished with a 1949 Model G Allis Chalmers tractor specially adapted for planting small plots. The planting adaptation consisted of a ground-driven, belt metering device, a simple two-way divider, and two John Deere rolling disk planter units with depth bands. Depth of planting was slightly varied on differing planting dates due to changing field conditions. Final plot lengths were all 5.0 m. Plot widths were 3.0 m for 76 cm rows (4 rows planted); and 2.5 m for both 51 cm rows (5 rows planted) and 25 cm rows (10 rows planted). An alley of 1.5 m was left between rows of plots. The 76 cm row width plots were planted with the 2 planter units 76 cm apart. The 25 cm row width plots were planted by first planting two 76 cm rows and then shifting the planting vehicle over 25 cm for two additional passes. A total of six passes were made. Only 10 rows instead of 12 were planted because seeds for the outer row were caught and not planted on 2 passes. In planting the 51 cm row width plots, 1 planter unit was removed; and the other was center-spaced and adjusted so that all seed from the divider entered it. By making 2.5 rounds, 5, 51 cm rows resulted. One exception to the previous procedure was that the 51 cm plots for the first planting date at the Saginaw Valley location were hand-planted using a V-belt Planet Junior planter

During the growing season, essentially complete weed control was achieved through the combined use of herbicides, mechanical cultivation,

and hand weeding.

Mechanical harvesting was accomplished with a Hege small plot research combine. In instances where hand harvesting was necessary, the Hege combine was utilized as a stationary threshing unit. All seed harvested was dried in a forced air drier to a 7.2% moisture level and recorded in grams per plot. Subsequently, yields were converted to quintals per hectare on a 13% moisture basis. Yields were statistically analyzed using the standard analysis of variance technique. At the southeastern location, eight plot yield values were estimated using the standard missing plot statistical procedure.

A. Location One

The southeastern location was near Carleton, Michigan. The previous crop was soybeans, and the soil type was a Hoytville clay loam (Mollic Ochraqualf, illitic, mesic) with a zero percent slope. An application of 450 kg/ha of 6-24-24 analysis fertilizer was made in the spring prior to planting. Averages of soil samples taken on August 3 in open areas between plots indicated a pH of 6.7, 158 kg of Bray P_1 extractable P/ha, and 94 kg of K/ha. A pre-plant incorporated herbicide application was made of pendimethalin (1.2 kg/ha) and metribuzin (0.4 kg/ha). Primary tillage was accomplished with two passes of a vibra-shank tillage tool, and a rotary tillage tool was used for secondary tillage. The entire plot area received secondary tillage before the first planting date. The second planting date area received another secondary tillage operation before it was planted, but the third planting date area received no additional secondary tillage due to unavailability of equipment.

Planting dates were May 25 (first date), June 12 (second date - 51 cm plots only due to inclement weather), June 15 (second date - 25 and 76 cm plots), and July 7 (third date). Initial emergence of the first planting date areas was irregular due to dry soil conditions. Rainfall was more than adequate until July 1, and thereafter was severely limited until late August. Greater drought effects were not realized due to the exceptional water-holding capacity of the soil. Some scattered root rot symptoms were observed early in the season but readings were not taken. The 25 and 51 cm plots of the first planting date in the first replication were harvested on September 30. Inclement weather delayed further harvest until October 12 when the remaining plots of the first planting date were harvested. A killing frost the morning of October 8 hastened the maturity of green plants of the third planting date of 'Corsoy' and 'SRF 200.' Plots of the second and third planting dates were hand-harvested, due to the shortness of the plants, on October 21. Harvested portions were 4 m long and two rows wide for 76 and 51 cm rows, and three rows wide and 3 m long for 25 cm rows. All harvest samples were taken from the middle of the plots where there were enclosing border plants during the growing season. Shorter harvested portions for 25 cm rows were used due to unevenness of stand in those plots.

B. Location Two

The Saginaw Valley location was near Chesaning, Michigan. The previous crop was corn, and the soil type was a combination of Parkhill loam (Mollic Haplaquept, mixed, nonacid, mesic) and Macomb sandy loam

(Aquollic Hapludalf, mixed, mesic) with a zero percent slope. An application of 330 kg/ha of 6-24-24 analysis fertilizer was made in the spring prior to planting. Averages of soil samples taken on August 4 in open areas between plots indicated a pH of 7.1, 36 kg of Bray P_1 extractable P/ha, 139 kg of K/ha, and 18 parts per million of 0.1N, HCl extractable Mn. A preemergence herbicide application was made of alachlor (2.2 kg/ha) and linuron (0.8 kg/ha). Some chemical damage did appear on plots of the first two planting dates which was evidently the result of too shallow planting before the preemergence application was made. A chemical rating for the plots of the first two planting dates was made using the following scale: 5 = moderate damage, 3 = light damage, and 1 = no damage (Table A 5). Due to a heavy yellow nutsedge (Cyperus esculentus L.) infestation, 2 applications of bentazon of 1.75 l/ha each were made over the whole plot area, one each on June 22 and July 6. Some bronzing of leaves on plants of the first date in the first replication did occur as the result of too high an herbicide rate during the initial application. Primary tillage was accomplished with a moldboard plow, and a combination of field cultivator and harrow was used for secondary tillage. The entire plot area received secondary tillage before the first planting date. The second and third planting date areas received another secondary tillage operation just prior to planting.

Planting dates were May 8 (first date - 25 and 76 cm plots only due to inclement weather), May 10 (first date - 51 cm plots), May 23 (second date) and June 7 (third date). Due to cool, wet weather conditions, emergence of plants in the first planting date

plots was delayed until May 21. Rainfall was adequate in June, but was somewhat limiting in July and August. Some scattered root rot symptoms were observed early in the season but readings were not taken. In mid-July, apparent mild manganese deficiency symptoms appeared on lower leaves in the first planting date plots in the first replication, second planting date plots in the second replication, and adjacent plots. The plants appeared to grow out of this deficiency. The 'SRF 200' cultivar evidenced a lower level of visual deficiency symptoms than did the other cultivars. On July 28, considerable early lodging was observed in first and second planting date plots, evidently the result of a windstorm. The 'Corsoy' cultivar was observed to be particularly susceptible to lodging at this time, as were all varieties in the 51 and 76 cm rows and the high plant densities. All plots were harvested on October 10, with the harvested row lengths all being 4 m. Harvested portions included two 76 cm rows, three 51 cm rows, and five 25 cm rows from the middle of the plots where there were enclosing border plants during the growing season.

II. 1979 Growing Season

Both locations were planted in a 3 X 3 X 8 factorially arranged classical split plot design with 3 replications. The 72 treatments consisted of 3 planting dates, 3 row widths, and 7 cultivars, with 1 cultivar at 2 intended plant densities. Main plots consisted of all 9 possible combinations of planting date and row width. Equally-spaced planting dates varied by location, and row widths of 25, 51, and 76 cm were planted as in the previous season.

The 4 basic cultivars planted in 1978, 'Corsoy,' 'Evans,' 'Hodgson 78,' and 'SRF 200,' were again used, but each row width - planting date treatment was planted at only one intended plant density. In 1979 'Hodgson 78' was planted instead of 'Hodgson.' In addition to the above four cultivars, 'Beeson,' 'Nebsoy' and 'SRF 250,' all Maturity Group II cultivars were planted at the same intended plant density. 'Nebsoy' was also planted at 1.5 times the standard intended plant density. The standard intended plant densities were based upon the average recommended density for each row width. They were 460,000 plants/ha for 25 cm row widths, 321,570 plants/ha for 51 cm row widths, and 302,630 plants/ha for 76 cm row widths. The within-row spacings were 11.5, 16.4, and 23.0 plants/m of row for 25, 51 and 76 cm row widths, respectively. Actual seed numbers planted were adjusted upward by 10 percent, and again adjusted upward to account for varietal differences in standard warm germination tests. These germination tests, utilizing 200 seeds from each cultivar, yielded the following results: 'Corsoy' - 90 percent, 'Evans' - 90 percent, 'Hodgson 78' - 95 percent, 'SRF 200' - 90 percent, 'Beeson' - 88 percent, 'Nebsoy' - 90 percent, and 'SRF 250' - 94 percent.

Planting was accomplished with the same basic planting unit with minor modifications. Depth of planting was slightly varied on different planting dates due to changing field conditions. The third planting date plots at the southeastern location were planted unusually deep (6.3 - 7.6 cm) due to a dry, sandy seedbed. Emergence was delayed by 2-3 days as a result. Final plot lengths were all 5 m with alleys of 1.5 m left between rows of plots. Plots were 4,

4, and 8 rows wide for 76, 51, and 25 cm rows, respectively. The 76 cm row width plots were planted in the same manner as in 1978. The 51 cm row width plots were planted by 1 round-trip of the planting vehicle with the 2 planter units spaced 51 cm apart and off-center. The 25 cm row width plots were planted using the previously mentioned 51 cm spaced planter units. Due to the off-center arrangement, it was possible to plant all eight 25 cm rows without running the tractor (planter) wheels on previously planted rows.

Essentially complete weed control was again maintained, and the harvesting methods and statistical analysis remained the same as in 1978 except that harvested seed was dried to a 6.6 percent moisture level. At the Saginaw Valley location, 2 plot yield values were estimated using the standard missing plot statistical procedure.

A. Location One

The southeastern location was near Dundee, Michigan. The previous crop was corn and the soil type was a combination of Metamora sandy loam (Udolic Ochraqualf, mixed, mesic) and Brookston silty clay loam (Typic Argiaquoll, mixed, mesic) with a zero percent slope. An application of 224 kg/ha of 3-17-40 analysis fertilizer with 2 percent Mn was made during the previous fall. Soil samples taken before planting indicated a pH of 6.7, 75 kg of Bray P₁ extractable P/ha, and 269 kg of K/ha. A pre-plant incorporated application was made of trifluralin (0.8 kg/ha) and chloramiben (2.2 kg/ha). Primary tillage was accomplished with a mold-board plow, and secondary tillage prior to the first planting date was accomplished with a combination of one disking operation and two spring-tooth harrow -- spike-tooth harrow operations. The second planting date area

received another secondary tillage operation with a small spring-tooth harrow before it was planted, but the third planting date area received no additional secondary tillage due to adequate seedbed condition.

Planting dates were May 15, June 2, and June 19. The month of June was extremely dry, but from early July until early September rainfall was nearly optimal, if not excessive at times. Like June, the month of September was also a very dry month. Early lodging was apparent in the first planting date area by July 25. By August 1, the first planting date area was heavily lodged and the second planting date area was beginning to lodge. A severe storm occurred on August 23 which virtually levelled plants in the first two planting date areas and caused heavy lodging of plants in the third planting date area. Only some of the 'SRF 250' plots in the third planting date area remained standing at an acceptable level. On September 20, the 'Evans' plots in the first planting date area were hand harvested due to the early maturity of these plants in relation to the others. On October 22, all remaining plots were mechanically harvested with the harvested row lengths all being 3.5 m. Harvested areas included two 76 cm rows, two 51 cm rows, and four 25 cm rows from the middle of the plots where there were enclosing border plants during the growing season.

B. Location Two

The Saginaw Valley location was in the same field near Chesaning, Michigan, as was the 1978 study. The exact location was shifted a few feet east of the previous year's site in an attempt to

obtain a more uniform soil type. This effort was successful and the soil type was uniformly Parkhill loam (Mollic Haplaquept, mixed, non-acid, mesic) with a zero percent slope. The previous crop was soybeans. Soil samples taken in the spring indicated a pH of 7.5, 27 kg of Bray P_1 extractable P/ha, 126 kg of K/ha, and 11 parts per million of 0.1N HCl extractable Mn. An application of 450 kg/ha of 16-24-24 analysis fertilizer was subsequently made on May 15. A pre-plant incorporated herbicide application was made of trifluralin (0.7 kg/ha) and chloramiben (2.2 kg/ha). Primary tillage was accomplished with a moldboard plow, and a combination of one vibra-shank operation and two spike-tooth harrow -- cultipacker operations was used for secondary tillage prior to the first planting date. No additional secondary tillage was utilized on subsequent planting date areas due to adequate seedbed conditions.

Planting dates were May 17, May 30, and June 13. The month of June was very dry. Adequate rainfall was received during early July, but rainfall became quite limiting in late July. Dry conditions interrupted only by widely scattered light showers prevailed for the remainder of the growing season. A root rot subsequently identified as phytophthora root rot (Phytophthora megasperma var. sojae) appeared in early July, and especially devastated the 'SRF 250' plots. As a result, the 'SRF 250' cultivar was not included in the final statistical analysis. Other cultivars, especially 'Corsoy,' experienced some limited infestation. Readings on all plots based upon the estimated percentage of infected plants were taken (Table A1). In contrast to 1978, very few manganese deficiency symptoms were noted during this growing season. A light frost caused slight damage to the top

leaves of plants of some third planting date plots on September 22. No killing frosts were experienced. Approximately one half of the first planting date plots were harvested on October 2 before rain interrupted harvest. The rest of the first planting date plots and a few second and third planting date plots were harvested on October 15. The harvest was interrupted by equipment failure. On October 25 the remaining plots were harvested. The harvested row lengths were all 4 m. Harvested areas included two 76 cm rows, two 51 cm rows, and four 25 cm rows from the middle of the plots where there were enclosing border plants during the growing season.

III. Morphological Development

Dates when plants in the various treatments achieved certain developmental stages were noted each year. Emergence dates for each planting date were recorded when plants began to appear above the soil surface. In 1978, V_5 , R_1 and R_5 stage dates, as defined by Fehr and Caviness (12), were recorded by date and cultivar, averaged across plant density and row width. Approximate vegetative growth stages at R_1 and R_5 were also recorded. In 1979, R_1 stage dates only were recorded, but were noted for each individual plot. Maturity readings each year were based upon harvest maturity rather than physiological maturity. Harvest maturity was defined as the stage when essentially all pods had turned brown and were dry enough to permit thorough threshing. Due to wet weather throughout September and into October during the 1978 season, maturity readings, again recorded by date and cultivar, and averaged across plant density and row width, reflected dates when the plants were actually ready to harvest. Due to interspersed showers, the relationships of the various treatment maturity readings

were somewhat distorted. In 1979, essentially no rainfall interrupted maturity until early October. Maturities, again recorded for each plot, which occurred later than this time were projected to dates when they would have occurred if rain had not interrupted the normal drying process. Therefore, relationships between treatments were more precise. All plots were actually ready for harvest by October 15 except for the third planting date, 'Beeson' plots.

Final estimated plant density figures for each plot were obtained soon after emergence from two 1.83 m samples taken, 1 each, from a pair of interior rows planted during the same trip by the planting vehicle where applicable. Selection of these particular rows allowed for seed divider fluctuations. Sample areas from the selected rows were representative areas in the plots and were essentially directly across from one another.

Final lodging readings, using a scale of 1 = totally erect to 5 = lying prostrate, were gathered on each plot prior to harvest. Early lodging readings were taken in similar fashion on first and second planting date plots at the Dundee location on August 1, 1979.

Average final plant height for each plot was measured at the Carleton location in 1978 and both locations in 1979 by sighting across the plot portions to be harvested with an upright measuring stick. Final plant height measures for each plot at the Chesaning location in 1978 were obtained by averaging measurements taken from yield component plant samples to be described later.

IV. Yield Components

Seed size was estimated by randomly selecting and weighing a 100 seed lot from each plot for each location and year except for the

1978 Carleton study where no seed size information was obtained. For the 1978 Chesaning study, 100 seed lots were randomly selected from seed obtained from yield component plant samples to be described later. For both 1979 studies, 100 seed lots were randomly obtained from the seed harvested for basic yield measurements.

During both the 1978 and 1979 growing seasons, mature plant samples were obtained from each plot at the Chesaning location, except for the 'SRF 250' plots in 1979, and were broken down into basic components of yield. Plant numbers and regular spacings for each plant density and row width treatment, reflecting estimated overall average final plant density, were used to construct an ideal, regularly-spaced sampling ruler. The sampling ruler was used to select a one-third meter sample from a row to be harvested in each plot. Samples were selected which most nearly conformed to the ideal plant number and spacing on the sampling ruler (Tables 1 and 2). After drying, data from whole plants were collected from the above samples for the number and height (cm) of the lowest podded node, number of mainstem nodes and pods, number of branch nodes and pods, branch numbers, and seed yield (gm), in addition to components mentioned earlier. In 1979, an additional procedure was added for the 'Hodgson 78,' 'SRF 200,' and 'Beeson' plot samples. Sample plants were divided into thirds by counting mainstem nodes and dividing by three. The bottom third and then the middle third received any extra nodes above the greatest figure divisible by three. The same components mentioned above were measured for each plant third and then whole plant averages were obtained by combining the figures for the thirds. These basic component figures were then used to derive other component figures.

Table 1. Ideal, components of yield sample plant numbers and spacings (cm) for the 1978 Chesaning location by row width (cm) and plant density.

<u>Row Width</u>	<u>Plant Density</u>			
	<u>Low</u>		<u>High</u>	
	<u>Number</u>	<u>Spacing</u>	<u>Number</u>	<u>Spacing</u>
25 10	3	11.38	4	8.61
51 20	5	5.66	7	4.29
76 30	8	3.78	10	2.87

Table 2. Plant numbers and spacings (cm) for ideal, components of yield samples from the 1979 Chesaning location by row width (cm) and plant density.

<u>Row Width</u>	<u>Plant Density</u>			
	<u>Regular</u>		<u>1.5 Regular</u>	
	<u>Number</u>	<u>Spacing</u>	<u>Number</u>	<u>Spacing</u>
25	4	8.42	5	5.61
51	5	5.90	7	3.93
76	7	4.21	10	2.80

In 1979, photosynthetically active radiation (PAR) was measured for each plot at the Chesaning location. Full sunlight readings at mid-canopy and ground levels were taken at three representative sample sites per plot in the areas to be harvested. A hand-held light meter (Lambda Instruments, Model LI-185) and a one meter long, line quantum sensor (Lambda Instruments, Model LI-191S) were used to obtain PAR readings. A cover was utilized to reduce the sensor length to 76 cm when measuring 76 cm rows in order to insure readings over whole row widths, since the sensor was inserted perpendicularly to the rows. The readings obtained were converted to percentages of direct sunlight

based upon readings in full sunlight over bare soil, obtained for each eight-plot sequence. For all readings obtained, the sensor was held as nearly level horizontally as possible. Readings were taken between 11:45 AM and 2:25 PM EDT over all 3 replications. Plots in the first planting date were measured on August 15 at approximately the R_5 growth stage, using 'SRF 200' as the reference cultivar. The second and third planting date plots were measured on August 30 and 31. Plants in the second planting date plots were several days past the R_5 growth stage and the third planting date plots were one or two days past the R_5 growth stage, again using the 'SRF 200' cultivar for reference. When the second planting date plot readings were obtained, the 'Evans' cultivar had already begun to exhibit leaf-turn which probably resulted in some increase in the percentage of direct sunlight figures.

In an attempt to identify reasons for cultivar differences in PAR measurements, limited leaf area determinations were made on August 30 and 31 utilizing border-row plant samples obtained in the same manner as were yield component plant samples, described earlier. Although less satisfactory, border rows were utilized to avoid, as much as possible, disruption of the canopy of plot areas to be harvested for yield measurements. Determinations were derived from all the first planting date plots of 'Corsoy,' 'Hodgson 78,' 'SRF 200,' and 'Nebsoy' (regular plant density) cultivars. Since advanced maturity made determinations of leaf area for 'Evans' in the first planting impossible, determinations were also obtained for second planting date plots of 'Evans' and 'SRF 200' cultivars with 'SRF 200' plots included for approximate comparison. Cumulative

leaf area readings were obtained for all leaves of one representative sample plant using a leaf area meter (Lambda Instruments, Model LI-300). These leaves were then weighed as were the leaves from the remaining sample plants, and average leaf area figures per plant were calculated on a direct proportion basis. Average per-plant leaf area figures were then multiplied by the number of plants per squared meter, obtained from the ideal figures used in sampling in order to derive a leaf area index (LAI).

RESULTS AND DISCUSSION

I. Grain Yields

A. 1978

The average soybean yield at the Chesaning location was 25.51 ql/ha, or 24.9% greater than the 20.43 ql/ha yield at the Carleton location (Table 3). Some of this difference may be explained by the drought conditions experienced at the Carleton location, although rainfall was also subnormal during much of the growing season at the Chesaning location. Rainfall data were not recorded at the actual locations, but rainfall records were available for nearby sites. The later planting dates coupled with later dry soil conditions at the Carleton location also apparently contributed to the yield reduction.

It should be mentioned that the third replication at the Chesaning location was clearly divided into two different soil types, Parkhill loam and Macomb sandy loam, which did respond differently. The more droughty Macomb sandy loam did respond with lower yield levels. Although all three replications are included in the results and discussion, it should be remembered that this unplanned source of variability did exist.

The main effects of planting date, row width and cultivar all significantly (0.01, 0.001, 0.001, respectively) affected yields at the Carleton location, while only row width and cultivar significantly

Table 3. Effects of planting date, row width, and cultivar on soybean yields (ql/ha) at both 1978 locations averaged over all other factors.

<u>Treatments</u>	<u>Location</u>		<u>$\bar{x}$</u>
	<u>Carleton</u>	<u>Chesaning</u>	
<u>Planting Date</u>			
1st	23.57	26.32	24.95
2nd	20.88	26.04	23.46
3rd	16.83	24.16	20.50
LSD 0.05	3.11	n.s.	1.70
<u>Row Width (cm)</u>			
16" 25	22.52	26.66	24.59
20" 51	21.60	26.35	23.98
30" 76	17.15	23.50	20.33
LSD 0.05	2.33	1.16	1.23
<u>Cultivar</u>			
Corsoy	20.67	26.02	23.35
Evans	18.69	23.86	21.28
Hodgson	21.66	25.41	23.54
SRF 200	20.68	26.74	23.71
LSD 0.05	1.05	0.80	0.65

(0.001, 0.001, respectively) affected yield at the Chesaning location. When locations were combined in 1978, yields were also affected by planting date, row width and cultivar at significant levels (0.001, 0.001, 0.001, respectively). Plant density main effects were not significant in any instance although low density yields tended to be slightly greater than those at high density. Unless otherwise indicated, all future treatment effects and interactions discussed may be considered to be at least significant at the five percent level.

Planting date effects were much more pronounced at the Carleton location than at the Chesaning location (Table 3). At the Carleton location, first date yields were 12.9% greater than those of the second date (not significant), and second date yields were 24.1% greater than third date yields. The first date yields were also 40.0% greater than the third date yields, indicating profound effects of delayed planting date upon yield at this location. The yield reduction between dates 2 and 3 was 4.05 q1/ha, or 50.6% larger than the yield reduction of 2.69 q1/ha between dates 1 and 2. Although not significant, Chesaning location yield responses to the different planting dates followed a similar, though lesser, trend of greater yield reductions with further delays in planting.

The much smaller response to planting date at the Chesaning location may be attributed to several factors. The first planting date at the more northerly Chesaning location was May 8, or 17 days before the first planting date at the Carleton location. An earlier planting date normally results in colder soil temperatures. This negative temperature effect was indicated by the 13 day period for

emergence of the first planting date at the Chesaning location, as compared to a 5 day period for emergence of the first planting date at the Carleton location. This delayed emergence, coupled with more unfavorable growing conditions after emergence, helps to explain the lack of advantage of the first planting date over the second. Another factor explaining the lesser response to planting date at the Chesaning location is that of interval between planting dates. The intervals between the first and second, and second and third planting dates were 21 and 23 days, respectively, at the Carleton location while at the Chesaning location they were only 15 and 15 days, respectively. These longer intervals, coupled with a later first planting date at the Carleton location, caused the second and third planting dates to occur relatively much later in the growing season. The resulting marked reduction in growing season length, shorter daylengths, and greater exposure to late season dry periods at critical growth stages would all provide explanation for the larger planting date effects on yield which resulted at the Carleton location.

The effect of row width upon yield is also presented in Table 3 which shows a trend of increasing yield reduction with increasing row width. Yield differences between 25 and 51 cm row widths were not significant for either location or for the combined averages. As with planting date, yield response to row width was much greater at the Carleton location than at the Chesaning location. Yields from 25 cm row widths were 4.3% greater than those from 51 cm row widths, and yields from 51 cm row widths were 25.9% greater than those from 76 cm widths at the Carleton location with 25 cm row widths producing 31.3% higher yields than 76 cm row widths. However,

at the Chesaning location plants in 25 cm rows produced only 1.2% higher yields than those in 51 cm rows, and plants in 51 cm rows produced only 12.1% higher yields than those in 76 cm rows, with plants in 25 cm rows producing only 13.4% higher yields than those in 76 cm rows. However, it should be noted that the row width x location interaction was not significant.

The similarity of the degree of row width response to that of planting date between the two locations suggests the possibility that the row width effects on yield are related to those of planting date. The row width x planting date interaction was indeed significant for the Chesaning location and the combined averages, but not significant for the Carleton location (Tables 4 and 5). At the Chesaning location, the first planting date evidenced a much greater response to row width than did the second date. The third planting date resulted in a much greater response to 51 cm row widths over 76 cm row widths than did the second date. However, the 25 cm row width response was surprisingly less than the 51 cm row width response for the third date. It should be noted that differences between the 25 and 51 cm row widths were not significant for all dates, and that the difference between 51 and 76 cm row widths was also not significant for the second date.

The row width within planting date response for the Carleton location, although not significant, was very similar to that of the Chesaning location with a much greater row width response at the first and third planting dates than at the second date. This similar response was surprising if row width responses were indeed related to planting date, since the first planting date at the Carleton

Table 4. Soybean yields (ql/ha) at the 1978 Chesaning location as influenced by planting date and row width, averaged over cultivar and plant density.

Row Width (cm)	Planting Date			Differences		
	<u>5/8</u>	<u>5/23</u>	<u>6/7</u>	<u>5/8 > 5/23</u>	<u>5/23 > 6/7</u>	<u>5/8 > 6/7</u>
25	28.66	26.72	24.61	7.26	8.57	16.46
51	27.13	26.21	25.71	3.51	1.94	5.52
76	23.18	25.18	22.15	-7.94	13.68	4.65
<u>% Differences</u>						
25 > 51	5.64	1.95	-4.28			
51 > 76	17.04	4.09	16.07			
25 > 76	23.64	6.12	11.11			
LSD 0.05 - Row width within planting date - 2.01						
Same or different row width across planting date - 3.12						

Table 5. The effect of planting date and row width upon 1978 soybean yields (ql/ha) averaged over location, plant density, and cultivar.

Row Width (cm)	Planting Date			% Differences		
	1st	2nd	3rd	1st > 2nd	2nd > 3rd	1st > 3rd
25	27.43	23.95	22.39	14.53	6.97	22.51
51	26.29	23.91	21.73	9.95	10.03	20.98
76	21.11	22.52	17.36	-6.26	29.72	21.60
% Differences						
25 > 51	4.34	.17	3.04			
51 > 76	24.54	6.17	25.17			
25 > 76	29.94	6.35	28.97			
LSD 0.05 - Row width within planting date - 2.13 Same or different row width across planting date - 2.43						

location came after the second planting date at the Chesaning location, and the second and third Carleton planting dates were much later than the third Chesaning planting date. The row width within planting date response for the combined locations was therefore understandably significant since the individual location responses were similar. However, it would seem that such a combined response has little meaning since the planting dates at the two locations were so different.

The planting date within row width response, derived from the same significant Chesaning row width x planting date interaction, was also of interest. There was a much greater decline in yield experienced with later planting dates at the 25 cm row width, than at the 51 cm width. At the 76 cm row width, the first planting date surprisingly responded with a lower yield than that from the second planting date, but the third planting date experienced a fairly large yield reduction in comparison to the second date. The only significant planting date within row width comparison was that between the first and third planting dates at the 25 cm row width. Although not significant, the planting date within row width response at the Carleton location furnished some additional notes of interest. There, the response to planting date was greater for the 51 than for the 25 cm row widths. Also of interest was the fact that at the 76 cm row width, the first planting date yield was again slightly lower than that of the second date, and the third planting date yield was extremely low.

Although the row width x planting date interaction was not significant at the Carleton location, the three-way interaction between row width, planting date and plant density was significant

(Table 6), suggesting that at least at this location, plant density was also a factor which should be considered when dealing with row width and planting date. At both densities, the 25 cm row width response was much greater between the first and second planting dates than between the second and third dates. The 76 cm row width response was the reverse, revealing a much greater response between the second and third dates than between the first and second. However, at the 51 cm row width, the low density response was much greater between the second and third dates than between the first and second, while the high density response was the reverse. This would seem to suggest that the response to planting dates occurs earlier for narrow row widths and later for wide row widths. Or, possibly from the opposite perspective, due to more equidistant spatial arrangement and resulting light reception benefits, narrow rows evidenced less yield reduction at later planting dates while wide rows evidenced more yield reduction. It would also seem to suggest that negative planting date responses occur earlier at wider row widths if plant density is increased. These relationships were not apparent in the same three-way interaction at the Chesaning location. However, they were apparent in the combined three-way interaction. Neither of these last two interactions was significant. The difference in the two location responses was supported by a significant location x planting date x row width x plant density interaction. The widely differing planting dates at the two locations probably explain this response.

Row width responses within plant density and planting date from the significant Carleton three-way interaction were similar to those observed in the simple row width x planting date interaction. The only

Table 6. Influence of planting date, row width, and plant density upon 1978 soybean yields (ql/ha), averaged over all cultivars, at the Carleton location.

Plant Density (plants/ha)	Row Width (cm)	Planting Date			$\bar{x}$	% Differences		
		5/25	6/15	7/7		5/25 > 6/15	6/15 > 7/7	5/25 > 7/7
344,000 (Low)	25	28.00	21.09	19.45	22.84	32.76	8.43	43.96
	51	24.69	22.48	17.68	21.61	9.83	27.15	39.65
	76	18.86	20.61	12.24	17.23	-8.49	68.38	54.08
	$\bar{x}$	23.85	21.39	16.46		11.50	29.95	44.90
474,000 (High)	25	24.41	21.28	20.90	22.20	14.71	1.82	16.79
	51	26.24	20.72	17.81	21.59	26.64	16.34	47.33
	76	19.21	19.11	12.88	17.07	0.52	48.37	49.15
	$\bar{x}$	23.29	20.37	17.20		14.33	18.43	35.41
Low <u>% Differences</u>								
		25 > 51	13.41					
		51 > 76	30.91	10.01				
		25 > 76	48.46	44.44				
High <u>% Differences</u>								
		25 > 51	-6.97	17.35				
		51 > 76	36.60	38.28				
		25 > 76	27.07	62.27				
% Differences								
Low > High		25	14.71	-6.94				
		51	-5.91	-0.73				
		76	-1.82	-4.97				

LSD_{0.05} - Plant density within planting date and row width - 3.45
 Row width within planting date and plant density - 8.66
 Planting date within row width and plant density - 9.51

items of special interest were the occurrence of a lower yield at 25 cm row widths than at 51 cm row widths for the low density, second planting date and the high density, first planting date treatments.

No definite trends could be observed for plant density responses within row width and planting date at the Carleton location (Table 6). However, it is worthy of note that, while overall averages for low density were higher than those for high density, six of the nine applicable comparisons indicated superior yield responses from the high density. This superior high density response was true for all three row widths at the third planting date. A comparison with the same Chesaning three-way interaction (not significant) suggests that the higher plant density indeed had a clear advantage with the third planting date, while plants in the lower plant density generally performed better with the first two dates.

The above observation is further supported by the significant planting date x plant density interaction for the combined means as shown in Table 7. The low density out-yielded the high density with both the first and second planting dates, but the reverse was true for the third planting date. Or, if this interaction is viewed from a planting date within plant density perspective, the low density responded negatively to later planting dates in a more pronounced manner than did the high density. Although the importance of planting date comparisons when combining means for both locations would be somewhat questionable due to different planting dates at the two locations, it does seem that a definite trend was occurring.

'Evans,' as expected for a Group 0 cultivar, was significantly lower yielding than the other three cultivars at both locations and

Table 7. The effect of planting date and plant density upon 1978 soybean yields (ql/ha) averaged over row width, cultivar and location.

Planting Date	Plant Density (plants/ha)		% Difference
	344,000 (Low)	474,000 (High)	Low > High
1st	25.39	24.50	3.63
2nd	23.73	23.19	2.33
3rd	20.21	20.77	-2.70
<u>% Differences</u>			
1st > 2nd	7.00	5.65	
2nd > 3rd	17.42	11.65	
1st > 3rd	25.63	17.96	
LSD 0.05 = Plant density within planting date - .80			
Same or different density across date - 1.79			

in the combined response as shown in Table 3. The average response for 'Corsoy' was always slightly, although not significantly, lower than the 'SRF 200' yield response. At the Chesaning location, 'Hodgson,' as expected for a Group I cultivar, responded at a level between that of the Group 0 'Evans' and the Group II 'Corsoy' and 'SRF 200' cultivars. 'Hodgson's' response was significantly lower than that of the 'SRF 200' cultivar. However, at the Carleton location, the Group I 'Hodgson' cultivar responded at a higher level than did the Group II cultivars. This unexpected result might possibly be attributed to greater drought resistance, superior inherent yield potential, or the arrival of rainfall during the critical growth periods in a manner favoring the 'Hodgson' cultivar. This varying response by location is supported by a significant location by cultivar interaction. Combined means in Table 3 indicated that 'SRF 200' had the highest yield response, followed in order by 'Hodgson,' 'Corsoy,' and 'Evans.' It should be

noted that the differences between yield means for the 'Hodgson,' 'Corsoy' and 'SRF 200' cultivars at the Carleton location and for the combined locations were all not significant.

The occurrence of significant planting date x cultivar interactions for the individual location means (Tables 8 and 9) and for the means combined over locations (Table 10) indicates that cultivar plays an important role in response of plants to different planting dates. In all instances, the 'SRF 200' cultivar responded with the greatest percentage overall yield reduction from later dates of planting. It also experienced the greatest percentage yield reduction from the first to second dates, and from the second to third dates in all instances except at the Carleton location where 'Evans' responded with a larger percentage yield reduction from the first to second dates. All cultivars except 'Evans,' in all instances, responded with fairly large overall planting date responses, with much larger yield reductions between the second and third dates, than between the first and second dates. This uniform response in all but 'Evans' may possibly be attributed to the restriction of a shortened growing season upon medium to full season cultivars, combined with dry conditions later in the growing season when late plantings had more of the critical growth stages yet to complete. At the Carleton location, the Group I 'Hodgson' cultivar responded with a much smaller percentage overall yield reduction relative to the two Group II cultivars, as would normally be expected of a shorter season cultivar. This response may in part explain why 'Hodgson' yields were greater than those of 'Corsoy' and 'SRF 200' at the Carleton location. However, at the Chesaning location the percentage overall yield reduction for

Table 8. Soybean yields (ql/ha) at the 1978 Carleton location as influenced by planting date and cultivar, averaged over row width and plant density.

<u>Cultivar</u>	<u>Planting Date</u>			<u>% Differences</u>		
	<u>5/25</u>	<u>6/15</u>	<u>7/7</u>	<u>5/25 > 6/15</u>	<u>6/15 > 7/7</u>	<u>5/25 > 7/7</u>
Corsoy	23.62	21.58	16.81	9.45	28.38	40.51
Evans	21.86	17.94	16.28	21.85	10.20	34.28
Hodgson	23.98	22.38	18.61	7.15	20.26	28.86
SRF 200	24.80	21.63	15.60	17.20	38.65	58.97

LSD_{0.05} - Cultivar within planting date - 1.82
 Same or different cultivars across planting date - 3.45

Table 9. Soybean yields (ql/ha) at the 1978 Chesaning location as influenced by planting date and cultivar, averaged over row width and plant density.

Cultivar	Planting Date			% Differences		
	5/8	5/23	6/7	5/8 > 5/23	5/23 > 6/7	5/8 > 6/7
Corsoy	26.95	26.76	24.34	0.71	9.94	10.72
Evans	23.43	23.99	24.15	-2.33	-0.66	-2.98
Hodgson	26.57	25.97	23.69	2.31	9.62	12.16
SRF 200	28.35	27.42	24.44	3.39	12.19	16.00
LSD _{0.05} - Cultivar within planting date - 1.38						
Same or different cultivar across planting date - 2.90						

Table 10. The influence of planting date and cultivar upon 1978 soybean yields (ql/ha) averaged over location, row width, and plant density.

<u>Cultivar</u>	<u>Planting Date</u>			<u>% Differences</u>		
	<u>1st</u>	<u>2nd</u>	<u>3rd</u>	<u>1st > 2nd</u>	<u>2nd > 3rd</u>	<u>1st > 3rd</u>
Corsoy	25.28	24.17	20.58	4.59	17.44	22.84
Evans	22.64	20.97	20.22	7.96	3.71	11.97
Hodgson	25.27	24.17	21.15	4.55	14.28	19.48
SRF 200	26.57	24.53	20.02	8.32	22.53	32.72
LSD _{0.05} - Cultivar within planting date - 1.13						
Same or different cultivar across planting date - 1.96						

the 'Hodgson' cultivar was much nearer that of the 'SRF 200' cultivar, and was in fact greater than that of the 'Corsoy' cultivar. This change in the relative response of 'Hodgson' from the Carleton to the Chesaning location may, in part, be attributed to the fact that growing season length was a less critical factor at the Chesaning location where planting dates were much earlier, and more closely spaced. These planting date effects were evidenced by the much smaller percentage overall yield reductions at the later Chesaning planting dates compared to those at the Carleton location. Other factors such as rainfall during critical growth periods, timing of which varies by cultivar, may aid in explaining the unusual 'Hodgson' response.

The response of the early 'Evans' cultivar to planting date varied even more widely by location. At Chesaning, yields of the 'Evans' cultivar surprisingly increased slightly at later planting dates with a greater percentage increase between the first and second dates than between the second and third. None of the planting date comparisons for Evans was significant, yet reasons for the reversed trend are not readily obvious. Since 'Evans' is a very short season cultivar, and since all the planting dates at Chesaning were relatively early, the length of growing season for even the last planting date should not have been a factor in yield response. It may also have been true that, due to the short growing season of 'Evans,' late season dry conditions did not occur until after a large portion of the critical growth periods had passed. One possible explanation for the reversed response is that the first planting dates occurred too early in the season, and premature flower induction resulted with

concurrent restriction of vegetative growth. This premature flower induction of course would have been the result of the too early presence of inducing short daylengths for the early planting date plants. This was apparently not the case with 'Evans' for flowering occurred on July 1, just one day prior to flowering of the Group I 'Hodgson' cultivar and three days prior to flowering of the Group II, 'SRF 200' cultivar. The July 1 flowering date was also several days past the longest daylength day in the year. Another possible explanation for the reversed trend is that 'Evans' was less cold tolerant than the other cultivars, but there is no direct evidence supporting this possibility. Rather than being less cold tolerant, it may also have been true that more of the 'Evans' vegetative growth period occurred during the periods of colder temperatures which resulted in smaller plant size. The plausibility of any of the above explanations is somewhat supported by the fact that at the more southerly Carleton location, with relatively much later planting dates and therefore comparatively warmer conditions at those dates, the yield of the 'Evans' cultivar responded with a more normal decrease at later planting dates. Unexplained is the reason for the much greater percentage yield reduction between the first and second dates, than that between the second and third dates at the Carleton location for 'Evans.' This is the reverse of the response trend of the other cultivars, and perhaps again may be explained by critical rains received at different relative growth periods of the cultivars. It should be noted that the location x planting date x cultivar interaction was not significant. However, the location x planting date

x row width x cultivar interaction was significant, and will be discussed later.

The row width x cultivar interaction at the Chesaning location was also significant although just barely (Table 11). All cultivars responded with uniform percentage yield increases at row widths of 51 over 76 cm. However, the early maturing cultivars, 'Evans' and 'Hodgson,' actually yielded more at the 51 cm row width than at the 25 cm row width. This response of these early cultivars may, in part, be related to the earlier observation that the narrow row widths responded with much greater yield reductions between the first and second planting dates, than between the second and third. The Group II cultivars, 'Corsoy' and 'SRF 200' both responded with higher yields at the 25 cm row width than at the 51 cm width. 'SRF 200,' the narrow leaf cultivar, showed the greatest response to 25 over 51 cm widths, and therefore showed the greatest percentage overall increase in yield from narrow rows. This response at Chesaning would seem to indicate a greater advantage to a narrow leaf morphology at narrow rows due to greater light penetration. However, at the Carleton location, where this cultivar x row width interaction was strongly not significant, an almost opposite response was evident, with the 'SRF 200' cultivar evidencing the least yield increase at 25 over 51 cm row widths. This opposite response may suggest that, given the drier conditions at the Carleton location, environmental effects at least partly masked the assumed light use efficiency advantages of narrower row widths.

Of note is the lack of a significant location x cultivar x row width interaction. However, as noted before, the location x planting

Table 11. The effects of row width and cultivar upon 1978 soybean yields (ql/ha) averaged over plant density and planting date, at the Chesaning location.

Cultivar	Row Width (cm)			% Differences		
	25	51	76	25 > 51	51 > 76	25 > 76
Corsoy	27.33	26.74	23.99	2.21	11.46	13.92
Evans	24.46	24.91	22.21	-1.81	12.16	10.13
Hodgson	25.87	26.64	23.72	-2.89	12.31	9.06
SRF 200	28.99	27.12	24.11	6.90	12.48	20.24
LSD _{0.05} - Cultivar within row width - 1.38						
Same or different cultivar across row width - 1.66						

date x row width x cultivar interaction was barely significant. This interaction provides several observations of interest. At the Chesaning location, the second planting date uniformly had much lower percentage response to row width across all cultivars than did the other two dates. The Carleton location also evidenced the same trend across all cultivars. At the Chesaning location, the first and third planting dates responded in fairly similar fashion uniformly across cultivars, while at the Carleton location, the third planting date evidenced a much higher percentage response to row width than the first date, in a fairly uniform fashion across all cultivars. At the Chesaning location, both the 'Corsoy' and 'SRF 200' cultivars evidenced decreased response between 25 and 51 cm row widths at the later planting dates. In fact, the 51 cm row widths yielded more than the 25 cm row widths at the third planting date for these two cultivars. Surprisingly, the reverse trend was evident for these two cultivars at the Carleton location with the greatest response of 25 over 51 cm row widths at the third planting date. The 'Evans' and 'Hodgson' cultivars responded to row width at a much higher level at the Carleton location than they did at the Chesaning location, in a fairly uniform manner across all planting dates.

Both locations, in fairly uniform fashion, evidenced much higher yield reductions for the narrower row widths than for the 76 cm row widths between the first and second planting dates. In fact, the 76 cm

row width showed yield increases at the second date over the first date in a uniform fashion across all cultivars. However, there were marked location differences in the row width response between the second and third planting dates as might be expected, since planting dates varied so greatly between locations. At the Carleton location, the 76 cm row width showed a much greater response than did the narrower row widths for the third over the second planting date for all cultivars. Response to the third over the second planting date at the Chesaning location was much more varied, with 51 cm row widths surprisingly evidencing less response than did either the 25 or 76 cm row widths for the 'Corsoy' and 'SRF 200' cultivars. The 'Evans' and 'Hodgson' cultivars responded in the above comparison in a manner similar to that of all the cultivars at the Carleton location, although to a lesser degree.

Another interaction involving cultivars, which was barely significant, was the plant density x cultivar interaction at the Chesaning location (Table 12). The early maturing cultivars, 'Evans' and 'Hodgson,' responded with slightly higher yields at the high, rather than the low plant density. This result was not surprising since shorter season cultivars tend to be smaller plants when mature. The 'Corsoy' and 'SRF 200' cultivars had higher yields at the low, rather than the high plant density, which would be expected for a long season cultivar. Only the difference between the low and high density yields for the 'SRF 200' cultivar was significant. Surprisingly, at the Carleton location where the cultivar x plant density interaction was not significant, the 'Evans' and 'SRF 200' cultivars were reversed in their response to plant density, compared to that occurring at the

Table 12. Plant density and cultivar effects upon 1978 soybean yields (q1/ha) averaged over row width and planting date, at the Chesaning location.

<u>Cultivar</u>	<u>Plant Density (plants/ha)</u>		<u>% Difference</u>
	<u>344,000 (Low)</u>	<u>474,000 (High)</u>	
Corsoy	26.24	25.80	1.71
Evans	23.54	24.17	-2.61
Hodgson	25.36	25.46	-0.39
SRF 200	27.50	25.98	5.85
LSD _{0.05} - 1.13			

Chesaning location. The location x cultivar x plant density interaction was significant in support of this result. It is possible that these responses might reflect varying cultivar response to the drought at the Carleton location.

B. 1979

Table 13 shows that the average soybean yield at the Dundee location was 37.14 ql/ha, or 46.8 percent greater than the 25.30 ql/ha yield at the Chesaning location. This marked difference in yield may be attributed to the drier conditions experienced at the Chesaning location and to the near optimal rainfall received during much of the growing season at the Dundee location. Although rainfall data were not recorded at the actual locations, rainfall records were available for nearby sites. In comparison with 1978 Chesaning average yields, the 1979 Chesaning average yields were only 0.8 percent lower. The average yields at the southeastern locations, although from different locations each year, switched from a level much lower than that at the Chesaning location in 1978 to a level much higher in 1979 (Tables 3 and 13).

The main effects of planting date, row width and cultivar all significantly affected yields at both the Dundee (0.001, 0.001, 0.001, respectively) and Chesaning (0.001, 0.05, 0.001, respectively) locations; and also for the combined 1979 yield means (0.001, 0.001, 0.001, respectively). All future treatment effects and interactions referenced without comment upon their significance may be assumed to be at least significant at the five percent level.

Table 13. Effects of planting date, row width and cultivar on soybean yields (ql/ha) at both 1979 locations averaged over all other factors.

<u>Treatments</u>	<u>Location</u>		$\bar{x}$ <u>(Without SRF 250)</u>
	<u>Dundee</u> <u>(With SRF 200)</u>	<u>Chesaning</u> <u>(Without SRF 250)</u>	
<u>Planting Date</u>			
1st	40.89	26.71	34.00
2nd	37.58	27.15	32.53
3rd	32.94	22.03	27.38
LSD _{0.05}	2.03	1.81	1.38
<u>Row Widths (cm)</u>			
25	38.67	24.50	31.67
51	38.93	26.85	33.10
76	33.82	24.54	29.14
LSD _{0.05}	2.03	1.81	1.38
<u>Cultivar*</u>			
Corsoy	40.87 a	24.70 b	32.79 a
Evans	36.90 c,d	25.37 a,b	31.13 b
Hodgson 78	39.83 a,b	25.54 a,b	32.68 a
SRF 200	38.26 b,c	24.59 b	31.42 b
Beeson	34.11 e	23.45	28.78
Nebsoy (Regular Density)	35.98 d	27.30	31.64 b
Nebsoy (1.5 Density)	35.22 d,e	26.13 a	30.67 b
SRF 250	35.94 d	---	---
LSD _{0.05}	1.70	1.08	1.03

*Means within column followed by the same letters are not significantly different at the 0.05 level of probability by LSD.

Overall planting date effects were slightly more pronounced at the Dundee location than at the Chesaning location, as indicated in Table 13. At the Dundee location, first planting date yields were 8.8% higher than those of the second date, and second date yields were 14.1% higher than those of the third date. The first date yields were also 24.1% higher than those of the third date. Yield reduction between the second and third dates was 4.64 ql/ha or 40.2% larger than the yield reduction of 3.31 ql/ha between the first two dates.

First planting date yields at the Chesaning location were surprisingly 1.6% less than those of the second date (not significant) and as would more normally be expected, second planting date yields were 23.2% higher than those of the third planting date. The first date yields were also 21.2% higher than those of the third date. The yield difference between the first and second dates was only .44 ql/ha, and the yield reduction between the second and third dates was 5.12 ql/ha. The absence of a negative planting date response between the first two planting dates at the Chesaning location correlates with the small 1978 negative response (compare Tables 3 and 13). It is interesting to note that yield reduction between the second and third dates at the Chesaning location (23.2%) nearly equalled that between the first and third dates at the Dundee location (24.1%).

Comparison of planting date effects between locations was more meaningful in 1979 than in 1978, because actual planting dates were more nearly parallel. Planting date intervals at the Dundee location were slightly longer than those at the Chesaning location. The Dundee first, second and third planting dates were two days earlier, and three and six days later, respectively, than those at the Chesaning location. The slightly longer planting date intervals at the

Dundee location aid in explaining the slightly larger overall planting date effects there, compared to the Chesaning location. The planting date x location interaction was significant.

Before discussing the row width main effects upon yield, a basic change in the 1979 experimental design must be noted. Instead of maintaining two uniform intended plant densities across all row widths, as was done in 1978, a single intended plant density reflected the standard recommended seeding rate for each row width. Therefore, each row width was planted with its own unique intended plant density. Another change in the 1979 procedure was the adjustment of the actual seed rates planted upward from the intended plant densities by adding an additional 10 percent to all rates, and then by adjusting to 100 percent viable seed using the standard warm germination test results. This resulted in actual seeding rates which were considerably larger than the intended plant densities.

A comparison of the actual seeding rates in 1978 and 1979 reveals the following differences. In 1978, the uniform, actually seeded plant densities were 344,000 (Low) and 474,000 (High) plants/ha. In 1979, 25 cm row width actual seeding rates in plants/ha were 533,000 for 'Hodgson 78'; 575,000 for 'Beeson'; 538,000 for 'SRF 250'; and 562,000 for 'Corsoy,' 'Evans,' 'SRF 200,' and 'Nebsoy' (Regular Density). These actual seeding rates for 25 cm row widths were on the average 17.4% higher than the high actual seeding rate in 1978. Actual seeding rates in plants/ha for the 51 cm row widths were 373,000 for 'Hodgson 78'; 403,000 for 'Beeson'; 377,000 for 'SRF 250'; and 394,000 for 'Corsoy,' 'Evans,' 'SRF 200,' and 'Nebsoy' (Regular Density). These actual seeding rates for 51 cm row widths

were on the average 13.3% higher than the 1978 low actual seeding rate, and 17.8% less than the high actual seeding rate in 1978. And 1979 actual seeding rates in plants/ha for the 76 cm row widths were 350,000 for 'Hodgson 78'; 378,000 for 'Beeson'; 354,000 for 'SRF 250'; and 370,000 for 'Corsoy,' 'Evans,' 'SRF 200,' and 'Nebsoy' (Regular Density). These actual seeding rates for 76 cm row widths were on the average 6.4% higher than the 1978 low actual seeding rate, and 22.8% less than the 1978 high actual seeding rate.

The 1978 high actual seeding rate was 37.8% higher than the low actual seeding rate. However, the 1979 actual seeding rate in 25 cm rows was 42.7 and 52.0% higher than the actual seeding rates for 51 and 76 cm rows, respectively. The above comparisons, coupled with the fact that 'Nebsoy' was also planted at an actual seeding rate 1.5 times greater than the rates given above in 1979, reveal that plant density variations of greater magnitude than those in 1978 were an inherent part of the row width treatment, even though plant density was not a separate factor in the factorial design. Any analysis of row width response in 1979 must therefore take this variation in plant density into consideration, and direct comparison of 1978 and 1979 row width responses would be of somewhat lessened significance due to the design differences between years. Reference to significant 1978 plant density interactions may, however, provide some assistance in evaluating 1979 row width response.

In 1979, plants in 51 cm rows outyielded those in 76 cm rows at both locations. Yields for 25 cm rows were less than those for 51 cm rows, although significantly so only at Chesaning (Table 13). At the Chesaning location, the 51 cm row width response was 9.4 and 9.6% greater than that of the 76 and 25 cm widths, respectively. In fact, the 25 cm row width yield was slightly lower than that of the 76 cm row width. At the Dundee

location, the 51 cm row width response was 15.1 and 0.7% greater than that of the 76 and 25 cm widths, respectively. The combined averages showed a 51 cm row width response which was significantly 13.6 and 4.5% greater than that of the 76 and 25 cm widths, respectively. The much larger intended plant density at the 25 cm row width over the other two row widths is a possible explanation of its lower yield compared to the 51 cm width. It would appear that plant densities at the 25 cm row width were higher than the optimal level, especially at the drier Chesaning location.

Some comparison with the 1978 row width response can be made by separating out the response of the four cultivars grown in 1978 from the 1979 data. The separate 1979 average row width response of 'Corsoy,' 'Evans,' 'Hodgson 78,' and 'SRF 200' at the Dundee location was 41.48, 40.99, and 34.72 q1/ha at the 25, 51, and 76 cm row widths, respectively. Although the 25 cm width response was only 0.5% greater than that of the 51 cm width, it was greater rather than less than that of the 51 cm width. This trend, similar to that in 1978, would be expected at the Dundee location where rainfall was optimal for most of the growing season. This slightly smaller response to 25 over 51 cm row widths in 1979 could possibly be explained by increased lodging from the higher plant density. However, the separate 1979 row width response for the same four cultivars at the Chesaning location was 36.87, 39.28 and 35.60 q1/ha at the 25, 51 and 76 cm row widths, respectively. Although the 25 cm row width response was not less than that of the 76 cm row width, as it was when all cultivars were included; yet the 51 cm row width response was still 6.5% greater than that of the 25 cm row width. This relative 25 cm row width response, so different from that in 1978, would again appear to be the result of a higher plant density in the drier Chesaning environment. This suggested climatic factor is supported by a significant

location x row width interaction. It is also of interest that percentage yield increases for the 51 over 76 cm row widths at both locations were somewhat higher when the above four cultivars were separated, and were at levels more nearly approximating those in 1978.

Although, in contrast to 1978, no planting date x row width interactions were significant in 1979, the location x planting date x row width interaction was significant. This interaction including location contrasts with 1978 results when the locations responded similarly in the planting date by row width interaction. Some observations from this three-way interaction are as follows. At both locations, yields at the 25 cm row width were lower than those at the 51 cm width for two of the three planting dates. However, at the Chesaning location, a positive 25 over 51 cm width response occurred for the second date, while at the Carleton location it occurred for the first date. These varying positive responses may have been the result of rainfall at different critical times during the growing season of the applicable planting dates which negated the high plant density effect upon 25 cm row width yields. Of interest is the fact that 25 cm row width yields were lower than those for 51 cm rows for the third planting date at the Chesaning location in both 1978 and 1979. This would seem to suggest that perhaps 25 cm row widths do not have an advantage over 51 cm widths for the later planting dates used at the more northerly Chesaning location.

Only for the first planting date was the percentage yield increase of 51 over 76 cm row widths greater at the Chesaning location than at the Dundee site. Surprisingly, the second planting date at Dundee and the first date at Chesaning responded with the greatest percentage yield increase for 51 over 76 cm rows. In the previous

year at the Carleton location this response was smallest at the second planting date. Perhaps climatic conditions plus the varying planting dates would help explain this reversal. The 51 over 76 cm width percentage yield response at Chesaning was the least at the second planting date as it was in 1978. However, the same response at the third planting date was not nearly as large in 1978 which may have been due to the dry conditions in the very last portion of the growing season.

Except for the 25 cm row width at the Dundee location, there was a greater percentage yield reduction for date three over date two, than for date two over date one at each row width. First date yields were actually lower than those of the second date for the 25 and 76 cm row widths at the Chesaning location, and for the 51 cm width at the Dundee location. The above Dundee response for 51 cm rows is very difficult to explain in contrast to the positive 25 and 76 cm row width responses. The dramatic yield increase from first to second planting dates for the 25 cm row width at the Chesaning location may possibly be the result of June dry weather effects upon the higher 25 cm plant density. The even more dramatic yield reduction from the second to third planting date at the 25 cm row width may again have been a response of higher plant density to late season dry weather. The increased yield from the first to second planting date for the 76 cm row width at the Chesaning location is also difficult to explain, but it is of interest that the same response occurred in 1978 at both locations. This similarity in response over years would seem to indicate some significant disadvantage of 76 cm row widths at early planting dates.

There are a few further observations about the significant location x row width x planting date interaction regarding the percentage increase in yields at the well-watered Dundee location over the dry Chesaning location for the nine row width - planting date combination means. There appeared to be a general trend of greater percentage response of 25 over 51 and 76 cm row widths. This response would be expected since 25 cm row widths were at higher plant densities and thus more susceptible to the dry conditions at the Chesaning location. However, the 25 cm row width response for the second planting date was much less than that of the other dates, apparently due to more optimal moisture levels for the second planting date at the Chesaning location.

The location x cultivar interaction was significant for obvious reasons. The cultivar main effects were nearly reversed at the two 1979 locations (Table 13) which would seem to indicate different inherent genetic capabilities to adapt to the divergent environments at those locations. Also, it is possible that critical rainfall at different relative portions of the growing period could be responsible for some of this effect.

The 'Beeson' cultivar yields were significantly lower than all others except for those of the 'Nebsoy' (1.5 Density) at the Dundee location. This response may have been due to the fact that 'Beeson' has a very long growing season and the month of September was dry. This possible explanation is supported by the fact that the 'SRF 250' cultivar, which has a growing season approximately as long as that of 'Beeson,' yielded sixth out of eight cultivars at the Dundee location. Of interest is the fact that the four highest yielding cultivars at

the moist Dundee location were the same as the four cultivars grown in 1978, with 'Corsoy' first, 'Hodgson 78' second, 'SRF 200' third, and 'Evans' fourth. The significantly lower yield of the 'SRF 200' cultivar when compared to 'Corsoy' is difficult to explain. The 'SRF 200' cultivar also yielded at a lower level than did 'Corsoy' at the drier Chesaning location (difference not significant), but both surprisingly ranked much lower overall at sixth and fifth places, respectively, out of seven cultivars. The yield decreases of these two cultivars at the Chesaning location in relation to the other cultivars may in part be explained by lower relative genetic ability to perform under drought conditions, and also perhaps by dry periods during critical stages of their growth. 'Evans' and 'Hodgson 78' were consistent performers over locations with 'Evans' ranking fourth at both sites, and 'Hodgson 78' ranked second and third at the Dundee and Chesaning locations, respectively. This consistent performance of these two shorter growing season cultivars may be due in part to the fact that the late season dry periods did not affect them as adversely as they did longer season cultivars. The strong performance of the 'Hodgson' cultivar especially may be also attributed to inherent genetic capability to resist drought conditions, as supported by its strong performance at the dry, 1978 Carleton location. The reversed relative response of the 'Nebsoy' cultivar at the two intended plant densities also suggests inherent genetic ability to resist drought conditions, especially in the light of the fact that it is a Group II cultivar as were 'Corsoy' and 'SRF 200,' and yet performed in an opposite manner. At the moist Dundee location, 'Nebsoy' (Regular Density) and 'Nebsoy' (1.5 Density) were ranked fifth and seventh, respectively, out of eight cultivars while at the drier Chesaning location, they were ranked first and second,

respectively, out of seven cultivars. This reversed response might also suggest inherent lack of capability to maximize yield under optimal moisture conditions.

Due to the variant response between locations, the meaningfulness of the combined cultivar means is somewhat questionable (Table 13). 'Corsoy' had the highest overall yield in 1979 followed closely by 'Hodgson 78' (difference not significant). These two cultivars had significantly higher combined yields than all other cultivars, and only the lowest yielding 'Beeson' varied significantly in yield among the remaining cultivars.

The planting date x cultivar interaction was significant at both locations (Tables 14 and 15), but the combined interaction was not significant, suggesting differences in response between locations. However, the location x planting date x cultivar interaction was also not significant. Significant comparisons were much more prevalent at the moist Dundee location than at the Chesaning location where lower moisture levels evidently masked much of the interaction response. At the Chesaning location, the only significant cultivar within planting date comparisons were found in the first date, with the exception of the comparisons of 'Evans,' 'Nebsoy' (Regular Density) and 'Nebsoy' (1.5 Density) with 'Beeson' in the second planting date. This response would seem to suggest that the inherent potential yield differences between cultivars are most fully expressed when they are planted earlier, and have the longest portion of the growing season in which to produce their yield. Although significant differences were not so restricted, this same trend was noted at the 1979 Dundee location, and also at the 1978 Chesaning location. Strangely, this trend was not

Table 14. Planting date and cultivar effects on 1979 soybean yields (ql/ha) averaged over row width and plant density at the Dundee location.

<u>Cultivar</u>	<u>Planting Date</u>			<u>% Differences</u>		
	<u>5/15</u>	<u>6/2</u>	<u>6/19</u>	<u>5/15 > 6/2</u>	<u>6/2 > 6/19</u>	<u>5/15 > 6/19</u>
Corsoy	45.70	40.88	36.03	11.79	13.46	26.84
Evans	41.29	37.83	31.58	9.15	19.79	30.75
Hodgson 78	44.06	42.30	33.13	4.16	27.68	32.99
SRF 200	42.79	37.18	34.80	15.09	6.84	22.96
Beeson	37.75	33.82	30.76	11.62	9.95	22.72
Nebsoy (Regular Density)	39.29	36.39	32.27	7.97	12.77	21.75
Nebsoy (1.5 Density)	38.14	36.97	30.55	3.16	21.01	24.84
SRF 250	38.09	35.30	34.43	7.90	2.53	10.63

LSD_{0.05} - Cultivar within planting date - 1.87
 Same or different cultivar across planting date - 2.50

Table 15. Soybean yields (ql/ha) at the 1979 Chesaning location as influenced by planting date and cultivar (SRF 250 excluded), averaged over row width and plant density.

Cultivar	Planting Date			% Differences		
	5/17	5/30	6/13	5/17 > 5/30	5/30 > 6/13	5/17 > 6/13
Corsoy	26.38	27.01	20.71	-2.33	30.42	27.38
Evans	25.20	28.05	22.85	-10.16	22.76	10.28
Hodgson 78	27.52	27.12	21.97	1.47	23.44	25.26
SRF 200	26.21	26.51	21.06	-1.13	25.88	24.45
Beeson	24.31	24.82	21.22	-2.05	16.97	14.56
Nebsoy (Regular Density)	30.31	28.60	22.98	5.98	24.46	31.90
Nebsoy (1.5 Density)	27.05	27.96	23.38	-3.25	19.59	15.70

LSD_{0.05} - Cultivar within planting date - 2.95
Same or different cultivar across planting date - 3.42

evident at the 1978 Carleton location, perhaps because the extremely dry weather there masked effects of an extended growing season resulting from earlier planting dates.

Also of interest at the Chesaning location is the fact that differences between the first two planting dates within cultivars are all not significant while differences between the last two planting dates within cultivars are all significant. All but two cultivars, 'Hodgson 78' and 'Nebsoy' (Regular Density), had first planting date yields which were lower than those for the second date. Also with the two variant cultivars above, a much higher percentage yield reduction occurred between the second and third dates than between the first and second. These observations would seem to suggest that uniformly for all cultivars tested, little if any advantage resulted from the first planting date over the second at the northern location. This would again seem to strongly imply the influence of climatic factors. This above trend was not uniformly true at the southern Dundee location where 'SRF 200,' 'SRF 250,' and 'Beeson' actually experienced larger percentage yield reductions between the first and second planting dates, than between the second and third. Also, in general, percentage yield differences between the first and second dates, and the second and third dates did not vary as widely for each cultivar at the Dundee location as they did at the Chesaning location.

Of the two cultivars which responded with higher yields at the first planting date than the second at the Chesaning location, 'Nebsoy' (Regular Density) had the highest percentage yield reduction between the first and second dates. In contrast, 'Nebsoy' (1.5 Density) had the second highest percentage yield increase between the first and

second planting dates; and a smaller percentage yield reduction between the second and third dates, than that resulting with 'Nebsoy' (Regular Density). The above contrast between the two 'Nebsoy' plant densities would seem to indicate that the higher population was at a greater disadvantage at the first planting for some unknown reason. It would also seem to indicate that the higher population does not result in as great a yield reduction from later planting dates as does the regular population for this cultivar. This proposed explanation is borne up by the treatment means for the two plant densities in which the 'Nebsoy' (Regular Density) responded with significantly higher yields than 'Nebsoy' (1.5 Density) at the first planting date. At the second planting date the higher plant density yield approached that of the regular density, and at the third planting date the 'Nebsoy' (Regular Density) yield was actually surpassed by that of the higher density, although the difference was not significant.

This observed trend is not totally supported by the applicable means at the Dundee location. In fact, the 'Nebsoy' (1.5 Density) actually experienced a greater yield reduction between the second and third dates than did 'Nebsoy' (Regular Density). However, the above plant density trend at the Chesaning location does correspond with trends observed at both locations in 1978. It may be that the opposing 1979 Dundee location response was indeed the result of the extremely late dry period in September which may have caused much greater yield reductions for third date high plant densities in comparison to the second planting date than those experienced at other locations and years where the dry weather came earlier in the season, during July and August.

A few more observations regarding the cultivar x planting date interactions are as follows. The 'SRF 200' cultivar did not show the consistently higher percentage yield reductions in comparison with the other cultivars at later planting dates as it did so uniformly in 1978. This may have been due to different 1979 climatic conditions. At the Chesaning location, the four cultivars grown in 1978 responded in similar fashion in 1979 between the second and third planting dates. The longer season cultivars 'Corsoy' and 'SRF 200' did experience somewhat higher percentage yield reductions between those dates than did the shorter season, 'Evans' and 'Hodgson 78' cultivars. This trend would, as in 1978, seem to be explained by the restrictions of a shortened growing season upon full season cultivars. However, no such trend was obvious between the first and second planting dates, nor was it true with the late maturing 'Beeson' cultivar which evidenced a much smaller planting date response.

The 1979 Dundee location results also failed to support the above planting date-yield response trend. Of the four cultivars grown in 1978, the early maturing cultivars 'Evans' and 'Hodgson 78' actually had noticeably larger overall percentage yield reductions between the first and third planting dates, and also between the second and third dates, than did the longer season 'Corsoy' and 'SRF 200' cultivars. Also of note is the fact that the shorter season cultivars had much larger percentage yield reductions between the second and third planting dates than between the first and second. All of the Group II cultivars responded in the opposite fashion, except 'Nebsoy' and 'Corsoy.' Although percentage yield reductions were not greater between the first and second dates than between second and third dates for the 'Corsoy'

cultivar, the two values were nearly equal. This unusual Dundee location result may be partly explained by several facts. First, since planting dates were earlier than in 1978 at the southern location and since they were nearly the same as those at the northern Chesaning location, it stands to reason that length of growing season would be less critical at the southern location for the same Group II cultivars, than it would be at the northern location. This, coupled with the fact that dry periods occurred earlier at the northern location, would seem to indicate that, perhaps, climatic factors, especially rainfall, were more responsible for planting date response at the southern location. This would also help explain the exceptions of the 'Corsoy' and 'Nebsoy' cultivars at the Dundee location. One last observation at the Dundee location is that the 'SRF 250' cultivar had a very small relative response to planting date. This may be possibly explained by critical rainfall times, and also perhaps by inherent adaptability to varying growing season lengths.

A final cultivar x planting date interaction observation of interest at the Chesaning location was the response of the 'Evans' cultivar between the first and second planting dates. Between these two dates, yield increased in a noticeable, although not significant manner. This response in part parallels that observed for this cultivar at the 1978 Chesaning location, and may again be the result of less cold tolerance than that possessed by the other cultivars. This explanation is supported by the fact that this reverse response occurred both years at the northern location, and was most apparent between the first and second planting dates.

The cultivar x row width interactions were also significant at the Dundee location, and for the combined locations (Tables 16 and 17). All cultivars in both interactions consistently responded much less, and sometimes negatively, to going from 51 to 25 cm row widths, than from 76 to 51 cm row widths. This, coupled with the fact that the 'Nebsoy' (1.5 Density) cultivar had a markedly greater percentage yield reduction in going from 51 to 25 cm widths than did 'Nebsoy' (Regular Density) or any other cultivar, would strongly support the explanation that the reduced 25 cm row width response was largely due to the effects of the much greater plant density at that row width. Also, since 'Nebsoy' was the only cultivar at the Dundee location responding with a yield decrease at 25 over 51 cm widths, with the exception of a similar although lesser 'Corsoy' response, it would seem that 'Nebsoy' inherently does not respond as favorably to the narrower, 25 cm row widths. Perhaps this is due to the structure of the 'Nebsoy' plants. However, the unique 'Nebsoy' response may also be explained by a greater inherent sensitivity to the higher plant densities present at the 25 cm row width.

Surprisingly, the wide leaf 'Beeson' cultivar responded with the highest percentage yield increase at 25 over 51 cm row widths at the Dundee location. It, however, also responded with the lowest percentage yield increase at 51 over 76 cm widths both at the Dundee location and with the combined locations, with the exception of the 'SRF 250' cultivar at the Dundee location. The latter response would normally be that expected for a wide leaf cultivar, but the first response might possibly be due to inherently greater adaptability to the increased plant competition from the higher densities at the 25 cm width.

Table 16. Soybean yields (ql/ha) at the 1979 Dundee location as influenced by row width and cultivar, averaged over planting date and plant density.

Cultivar	Row Width (cm)			% Differences		
	25	51	76	25 > 51	51 > 76	25 > 76
Corsoy	43.28	43.91	35.42	-1.43	23.97	22.19
Evans	39.37	38.37	32.96	2.61	16.41	19.45
Hodgson 78	42.30	42.24	34.94	0.14	20.89	21.06
SRF 200	39.78	39.42	35.57	0.91	10.82	11.84
Beeson	35.92	34.47	31.94	4.21	7.92	12.46
Nebsoy (Regular Density)	36.83	38.32	32.80	-3.89	16.83	12.29
Nebsoy (1.5 Density)	34.41	38.65	32.59	-10.97	18.59	5.58
SRF 250	37.45	36.07	34.31	3.83	5.13	9.15

LSD_{0.05} - Cultivar within row width - 1.87
 Same or different cultivar across row width - 2.50

Table 17. Row width and cultivar effects upon 1979 soybean yields (q1/ha) averaged over location and planting date.

<u>Cultivar</u>	<u>Row Width (cm)</u>			<u>% Differences</u>		
	<u>25</u>	<u>51</u>	<u>76</u>	<u>25 > 51</u>	<u>51 > 76</u>	<u>25 > 76</u>
Corsoy	34.06	34.85	29.44	-2.27	18.38	15.69
Evans	32.24	32.59	28.57	-1.07	14.07	12.85
Hodgson 78	34.01	34.53	29.50	-1.51	17.05	15.29
SRF 200	31.64	32.83	29.81	-3.62	10.13	6.14
Beeson	29.14	29.83	27.37	-2.31	8.99	6.47
Nebsoy (Regular Density)	31.61	33.50	29.81	-5.64	12.38	6.04
Nebsoy (1.5 Density)	29.00	33.54	29.47	-13.54	13.81	-1.59

LSD_{0.05} - Cultivar within row width - 1.78
 Same or different cultivar across row width - 2.15

The 1978 Chesaning location trend of greater row width responses from longer versus shorter season cultivars was not consistently evident at the 1979 Dundee location. Rather, the Dundee location response was more similar to the 1978 Carleton location cultivar x row width interaction, which was not significant. The long season, 'Corsoy' cultivar did respond with the largest percentage yield increases at the 51 over the 76 cm row widths both at the Dundee location, and with the combined locations. However, a negative response resulted when going from 51 to 25 cm row widths. And surprisingly, the narrow leaf cultivars, 'SRF 200' and 'SRF 250,' had the lowest percentage yield increases for 51 over 76 cm row widths at the Dundee location, with the exception of 'Beeson.' This low row width response for 'SRF 200' was repeated when two locations were combined. This response is especially surprising because it might be expected that a narrow leaf morphology would have an advantage at narrower rows due to better light penetration, as appeared to happen at the 1978 Chesaning location. However, the heavy early lodging at the Dundee location may help explain this lack of advantage for the narrow leaf cultivars.

These explanations might also be partially supported by the cultivar x row width interaction at the Chesaning location which was not significant. Here, early lodging was not so severe and the percentage yield increase of 'SRF 200' at 51 over 76 cm widths was fairly equal to that of the other cultivars. However, a greater percentage yield reduction was experienced by 'SRF 200' in comparison with the other three cultivars also grown in 1978, at 25 over 51 cm row widths. This higher reduction was also evident in the 1979 combined interaction where only 'Nebsoy' had a higher percentage

reduction in yield. One possible explanation for this negative row width response is a greater sensitivity to the higher plant densities at the 25 cm width. However, a similar response relative to the other cultivars was also evident for the strongly not significant interaction at the 1978 Carleton location, where plant density did not vary by row width. Here, as noted before, perhaps the drought conditions produced competition effects similar to those resulting from increased plant density.

The cultivar x row width x location interaction was not significant. Also, the row width x cultivar x planting date x location interaction was not significant in 1979 as it had been in 1978.

In conclusion of this discussion of grain yield response, brief mention should be made of the combined treatment means for the two growing seasons listed in Table 18. Statistical comparison of these means is not possible due to the different experimental designs used each year. However, it is interesting to note that the first planting date uniformly yielded more than the second date, although the percentage yield reduction of 5.3% resulting with the second date was much smaller than that resulting from the second date to the third which was 17.0%. Overall 25 cm row width yields were actually slightly less than those of the 51 cm row widths, which seems to indicate that even when plant densities were uniform across row widths, the significance of increased yields of 25 over 51 cm row widths was negligible. Also apparent was the fact that 51 cm row widths consistently resulted in higher yields than did 76 cm widths, with 51 cm width yields averaging 15.4% higher than those of 76 cm widths.

Table 18. Effects of planting date, row width and cultivar on soybean yields (ql/ha) for both years averaged over locations and all other factors.

<u>Treatments</u>	<u>Year</u>		<u>Overall $\bar{x}$</u>
<u>Planting Date</u>	<u>1978</u>	<u>1979</u>	
1st	24.95	34.00	29.48
2nd	23.46	32.53	28.00
3rd	20.50	27.38	23.94
LSD _{0.05}	1.70	1.38	---
<u>Row Width (cm)</u>			
25	24.59	31.67	28.13
51	23.98	33.10	28.54
76	20.33	29.14	24.74
LSD _{0.05}	1.23	1.38	---
<u>Cultivar</u>			
Corsoy	23.35	32.79	28.07
Evans	21.28	31.13	26.21
Hodgson (78)	23.54	32.68	28.11
SRF 200	23.71	31.42	27.57
Beeson	---	28.78	---
Nebsoy (Regular Density)	---	31.64	---
Nebsoy (1.5 Density)	---	30.67	---
LSD _{0.05}	0.65	1.03	---

Surprisingly, of the four cultivars grown both years, the 'Hodgson (78)' cultivar responded with higher yields than any other, although the difference from the overall 'Corsoy' yield was slight. This response of a shorter season cultivar over longer season cultivars would suggest inherently higher yield potential and/or greater adaptability to the wide range of environmental conditions occurring at the different locations and years. 'SRF 200' yielded at slightly lower levels than 'Corsoy,' and, as would be expected, the shortest season 'Evans' cultivar had noticeably smaller yields. However, the 'Hodgson (78)' yield was only 7.2% higher than that of 'Evans' which would suggest that, on the average, differences between superior cultivars are not as important as other planting practices.

II. GROWTH AND DEVELOPMENT FACTORS

A. Developmental Stages and Periods

1. 1978

No statistical analysis was possible for developmental stages because readings were taken only from representative field plots of each planting date and cultivar treatment combination, rather than from each field plot included in the experiment. Planting date differences for the various developmental stages were reduced as later stages were achieved. For each of the three planting dates all cultivars were planted the same day (Figures 1 and 2). There was a consistent trend of subsequent developmental stages occurring earlier for the maturity Group 0 or I cultivars than for the maturity Group II cultivars. Stages for the Group I 'Hodgson' cultivar normally occurred at the same time or later than those for the Group 0 'Evans.' One interesting exception was the earlier flowering of 'Hodgson' at the third planting date at the Chesaning location (Figure 1). However, subsequent to this, the R_5 and maturity stages followed those of 'Evans.' Another interesting observation at the Carleton location was that the 'Hodgson' maturity date at the second planting date preceded that of 'Corsoy' by only one day. Flowering of the 'SRF 200' cultivar tended to precede that of 'Corsoy,' but the R_5 stage of 'SRF 200' followed that of 'Corsoy.' Maturity of 'Corsoy' followed that of 'SRF 200' with earlier planting dates, but the reverse was true with later dates at Carleton. This would seem to indicate the possibility of greater daylength sensitivity in 'Corsoy' than in 'SRF 200' to decreasing daylength for later planting dates. Also of interest is the fact that, in spite of a relatively longer growing season at later dates for 'SRF 200,' this cultivar experienced the greatest percentage yield reduction with later planting dates.

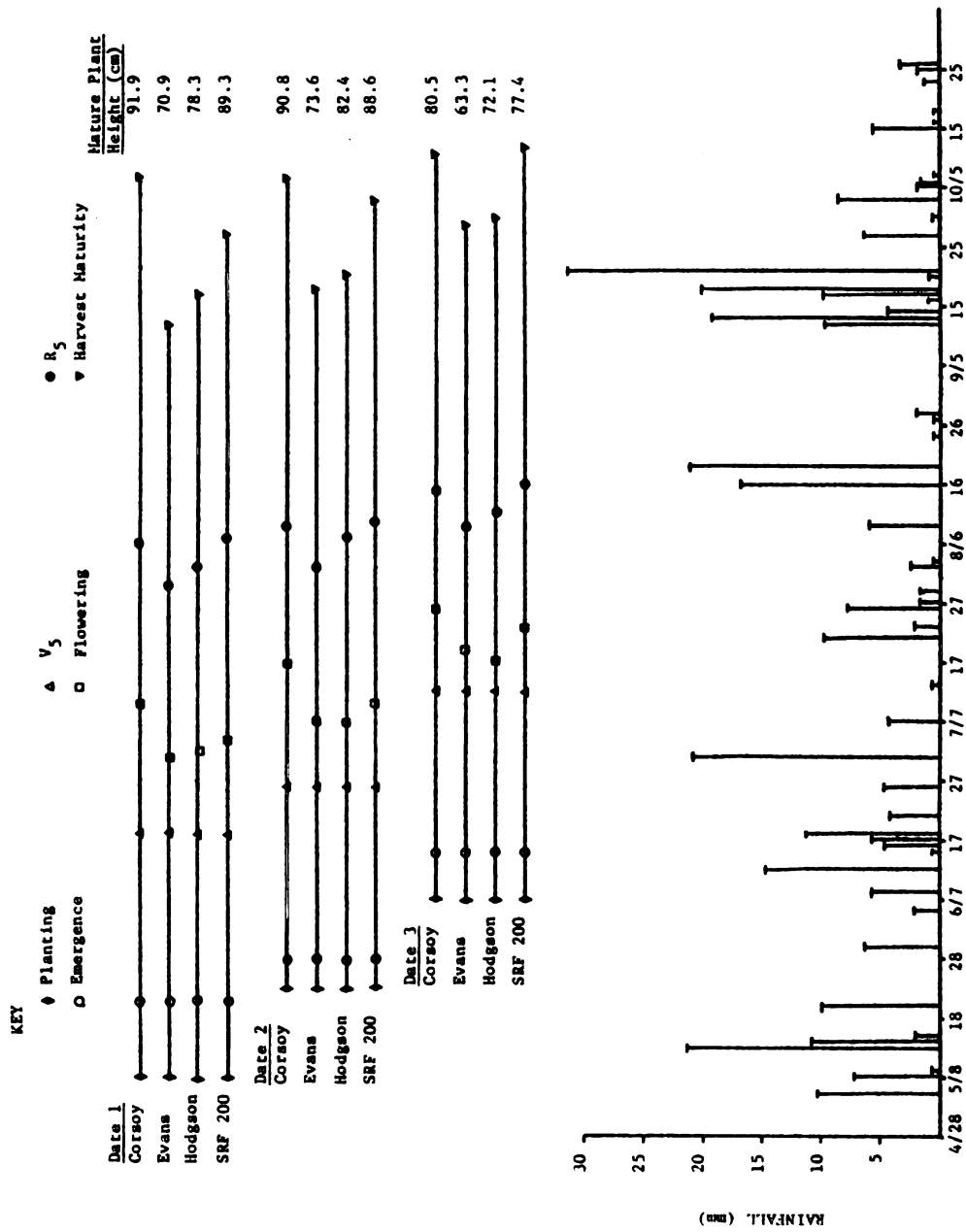


Figure 1. Association of developmental growth stages of four soybean cultivars with planting date and seasonal rainfall data taken near the Channing location in 1978.

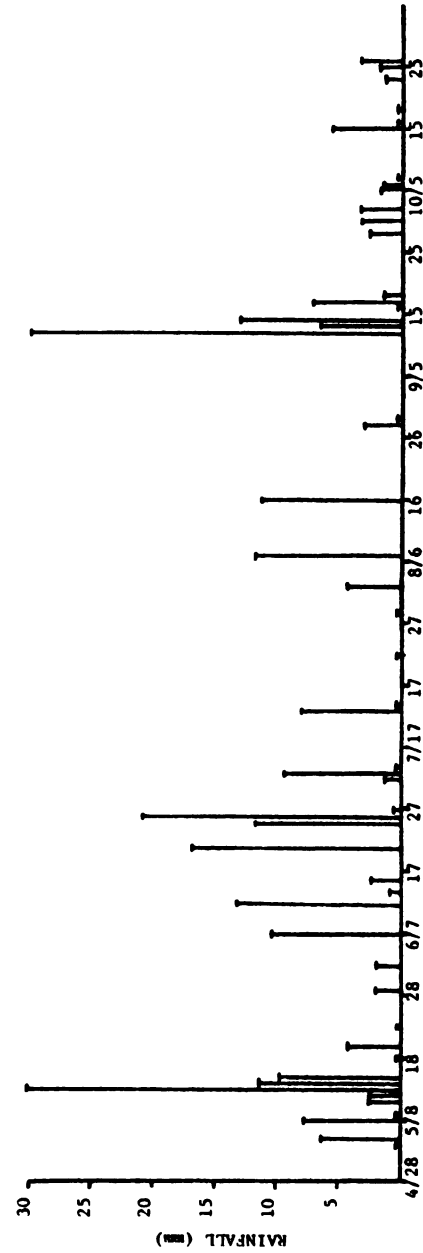
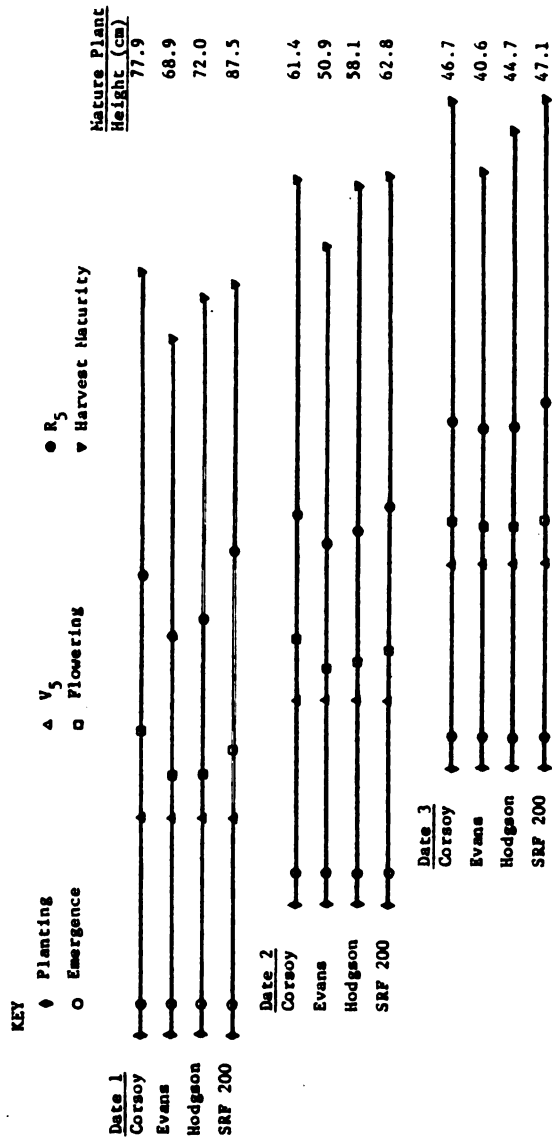


Figure 2. Association of developmental growth stages of four soybean cultivars with planting date and seasonal rainfall data taken near the Carleton location in 1978.

At the Chesaning location where planting date intervals were shorter, the variability of cultivar responses for flowering and R_5 stages remained fairly constant across planting dates, while for maturity, cultivar differences appeared to decrease at later dates. However, at the Carleton location where much larger planting date intervals occurred and where the planting dates were much later, the variability of cultivar responses decreased rapidly at later planting dates for flowering and R_5 stages while it remained fairly constant, if not greater, for maturity at later dates. The above flowering response might be due to the fact that at earlier planting dates, unique cultivar photoperiodic responses were fully expressed as daylength gradually shortened below critical levels for floral initiation; while at the very late planting dates, daylengths were so much shorter than critical levels for all cultivars that when adequate vegetative development had occurred, the cultivars all tended to flower at once.

Figure 1 indicates the major factor that time of emergence was at the Chesaning location. The period between emergence of plants in dates one and two was quite short due to delayed emergence of the first date, while the period between emergence of the second and third dates was quite a bit longer due to a somewhat longer emergence time for seedlings in the third planting date. This, as noted before, aids in explaining the small response between the first and second dates at the Chesaning location. Since planting to emergence periods were so variable, all growing season periods will begin with emergence, rather than planting.

The average growing season lengths (E - M) at the Chesaning location were 125, 122, and 113 days for the first, second and third planting dates, respectively. The E - M periods at the Carleton

location were shorter, due to delayed planting and were 114, 108, and 98 days, respectively. Drought effects were probably also reflected here. One interesting exception was that for 'Hodgson,' the E - M period for the first date at Carleton was only three days less than for the equivalent second date at Chesaning. The E - M period for the second date of 'Hodgson' at Carleton (111 days), planted June 15, was actually four days longer than for the third date at Chesaning planted June 7 (107 days). This surprising response of 'Hodgson' under the droughty conditions at Carleton may help explain its superior yield performance. This correlates well with yields at the two locations (Table 3).

The average period from emergence to V_5 ($E - V_5$) was about 28 days and was fairly constant across planting dates and locations. This would seem to indicate genetic control relatively unaffected by the environment for timing of this vegetative development of the plant. The average decrease in the period from V_5 to flowering ($V_5 - R_1$) was quite marked with later planting dates as would be expected. The $V_5 - R_1$ periods were much shorter at the Carleton than at the Chesaning locations in a manner similar to the E - M periods. This varying $V_5 - R_1$ period response at the two locations might be due, in part, to shorter daylength periods at the southern location, and therefore to earlier inducement of flowering. Also, it must be remembered that planting dates were much later at Carleton. Reduced yields at later planting dates would therefore appear to be partly the result of reduced vegetative growth available to support reproduction although some vegetative growth did continue after flowering.

Cultivars within planting dates maintained a fairly uniform ranking of $V_5 - R_1$ period lengths, with 'Corsoy' having the longest period, followed by 'SRF 200,' 'Hodgson' and 'Evans.' One exception at the Chesaning location was that 'Hodgson's' $V_5 - R_1$ period went from a length greater than that of 'Evans' at date one, to a length less than that of 'Evans' at date three, which for 'Hodgson' was a reduction of 64% from date one to date three. This may help to explain why 'Hodgson's' percentage yield response between the first and third planting dates at the Chesaning location was larger than that of 'Corsoy' and nearly equal to that of 'SRF 200.'

Within the period between flowering and maturity ($R_1 - M$), the R_5 to maturity ($R_5 - M$) period showed relatively little decline, and in fact increased at times with later planting dates. However, the flowering to R_5 ($R_1 - R_5$) period showed a marked reduction with delayed planting. Of special interest is the fact that the length of the $R_5 - M$ period was relatively uniform for both locations where there were radically different planting dates and environmental conditions. This, as with the $E - V_5$ period, would seem to indicate genetic control of the timing of this portion of podfill somewhat independently of environment.

Cultivars maintained a fairly uniform ranking in length of the $R_1 - R_5$ period with that of 'SRF 200' the longest, then 'Hodgson,' 'Evans,' and 'Corsoy,' in descending order. The only exceptions to this ranking were at the Chesaning location, third date where 'Hodgson' exceeded 'SRF 200,' and at the Carleton location, first date where 'Corsoy' exceeded 'Evans.' The small $R_1 - R_5$ period for 'Corsoy'

was balanced by its long $V_5 - R_1$ period. The long $R_1 - R_5$ period for 'SRF 200,' coupled with its second ranking $V_5 - R_1$ period length explains why this cultivar had the longest $E - R_5$ period of the cultivars.

At the Chesaning location, the average $R_5 - M$ period length actually increased with later planting dates (Figure 1). This response may be possibly attributed to late season rains which did not benefit and extend this period for the first date. Also, the cooler, cloudy fall weather probably delayed maturity somewhat for later dates. At the Carleton location (Figure 2), the average $R_5 - M$ period length was longer for the second than for the first planting date, but shorter for the third over second date with the third date length nearly equal to that of the first date. This variable response was, again, perhaps due to late season rains which did not benefit or extend the first date $R_5 - M$ period, coupled with a killing frost which shortened this period for 'Corsoy' and 'SRF 200' in the third date.

Ranking of cultivars within planting dates fluctuated widely for $R_5 - M$ period lengths, especially between locations. Ranking at the Chesaning location was fairly uniform and logical, with 'Corsoy' always having the longest period, 'SRF 200' the second longest, and 'Evans' and 'Hodgson' the shortest, with some switching around of the last two. The long $R_5 - M$ period for 'Corsoy' explains why, although it was earlier than 'SRF 200' in achieving R_5 , it was equal with or later than 'SRF 200' in achieving maturity.

The widely varying cultivar within planting date ranking for the $R_5 - M$ period lengths at the Carleton location were also probably due to critical rainfall at different developmental stages. At the first

planting date, the R_5 - M periods of the earlier maturing cultivars neared or were greater than that of 'Corsoy' in length, and 'SRF 200' lagged behind. By the second date, Group 0 'Evans' was lagging behind while 'Hodgson' still had the longest period length, and 'SRF 200' had tied 'Corsoy' at a length near the 'Hodgson' level. Finally, by the third planting date, a ranking more normally expected was observed with the longer season cultivars having longer lengths than the shorter season cultivars, even though a killing frost cut short this period for the longer season cultivars.

Although statistical analysis of these developmental periods was not possible, correlations between the various periods and yield were computed for the combined locations by assigning the applicable planting date-cultivar treatment combination mean to each plot. The $P - R_5$ correlation was 0.69 (P represents planting date). Other periods with correlations greater than 0.50 were $P - E$, $V_5 - R_1$, $R_1 - R_5$, $P - V_5$, $P - R_1$, $P - M$, $E - R_1$, $E - R_5$, $E - M$, $V_5 - R_5$, $V_5 - M$, and $R_1 - M$.

2. 1979

Flowering and maturity dates were recorded on a per plot basis during this growing season so that full statistical analyses of these stages and the resulting periods were possible. However, V_5 and R_5 stages were not recorded. Again, each of the three planting dates were uniform for all 8 cultivars at each location, although actual planting dates did vary by location, as indicated by Figures 3 and 4.

There was a fairly consistent trend for subsequent developmental stages to occur earlier for the maturity Group 0 or I cultivars than for the Group II cultivars. Of the four cultivars planted in 1978,

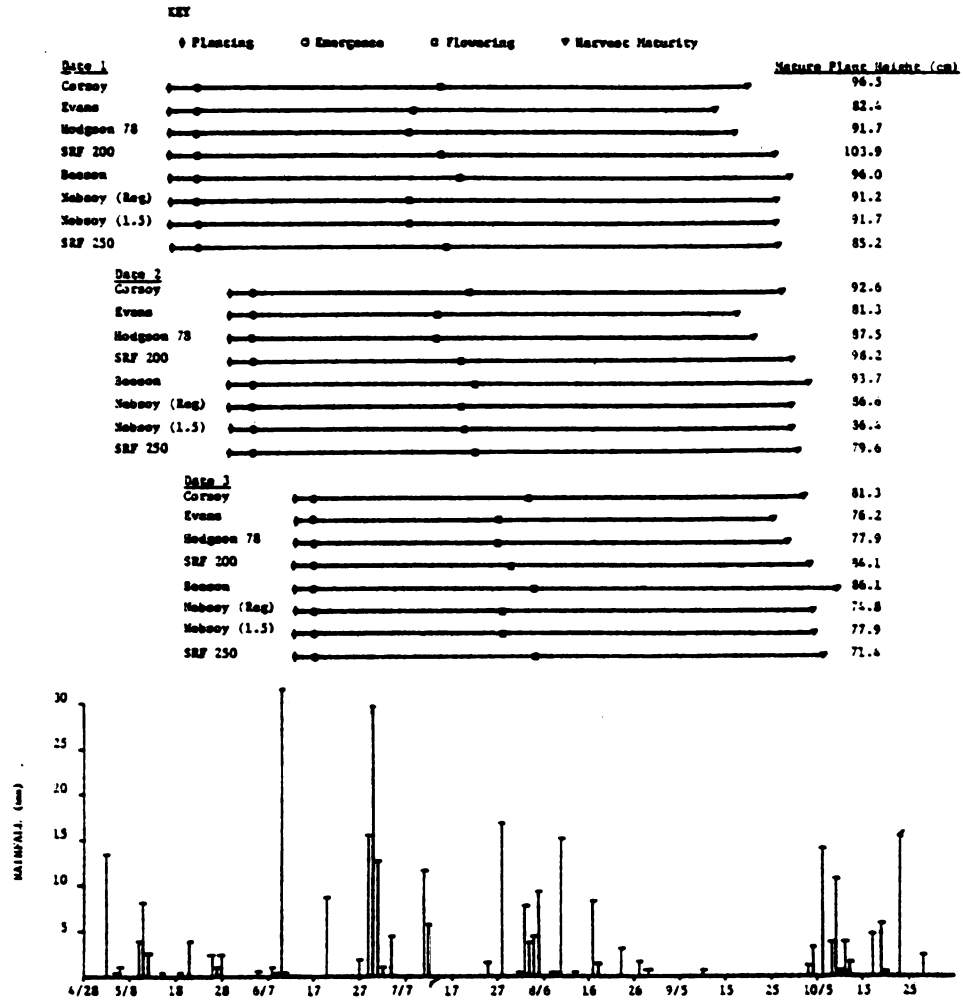
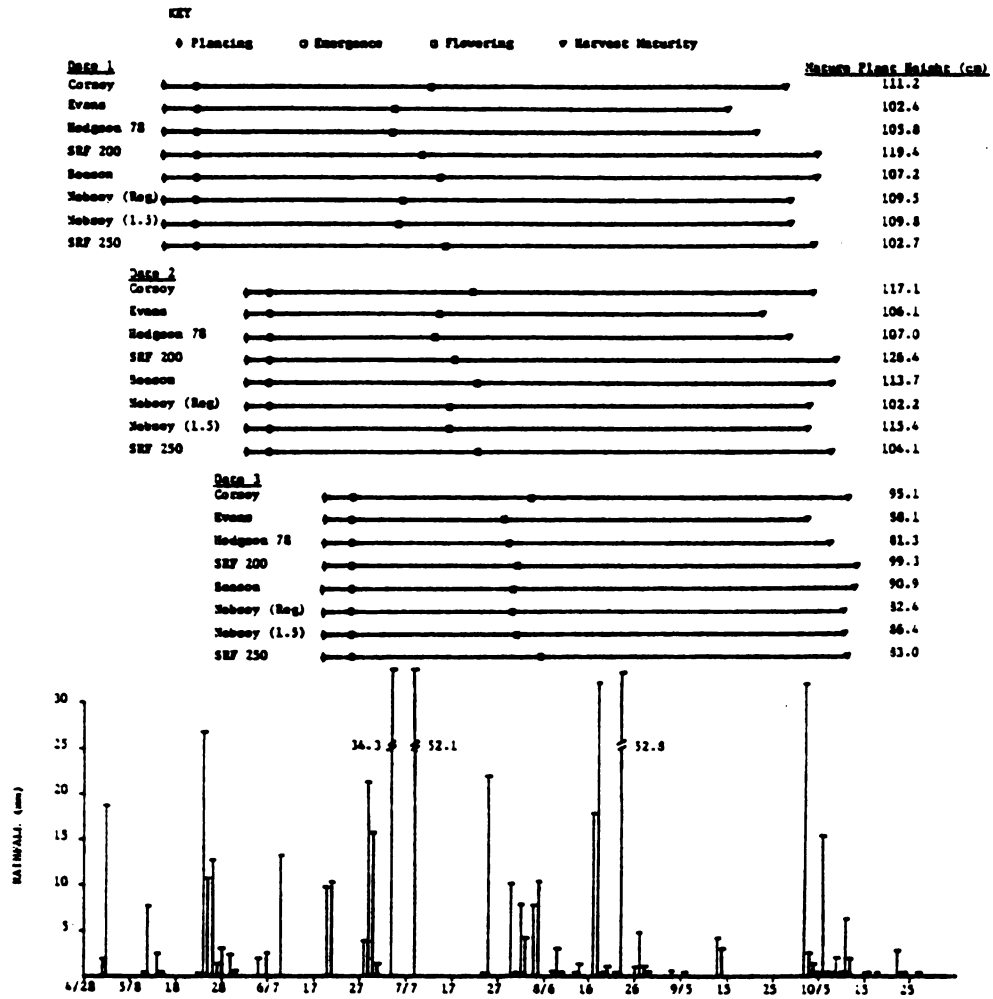


Figure 3. Association of developmental growth stages of eight soybean cultivars with planting date and seasonal rainfall data taken near the Cheanning location in 1979.



Group I 'Hodgson' and Group 0 'Evans' alternated in the timing of flowering, but 'Hodgson' always matured after 'Evans.' 'SRF 200' consistently flowered after the earlier maturing cultivars but before 'Corsoy' as in 1978. However, in 1979, 'SRF 200' consistently matured after 'Corsoy' while in 1978, it matured before 'Corsoy' at earlier planting dates. Even though planting dates were later at Chesaning in 1979, than in 1978, the maturity dates for these two cultivars occurred earlier. It should be noted that yields were reversed in 1979 between these two cultivars which would seem to suggest that, in this case, the longer 'SRF 200' growing season did not give it an advantage in yield, and in fact may have in some way been an indication of detrimental effects.

The added cultivars for 1979, 'Beeson' and 'SRF 250' generally responded in a manner normally expected for late Group II cultivars. Flowering and maturity for these cultivars generally occurred later than for 'SRF 200' and 'Corsoy' although for all three dates at the Chesaning location, 'SRF 200' matured after these two cultivars. Also, for the third planting date at the Chesaning location, both 'SRF 200' and 'Corsoy' flowered after 'Beeson.' One interesting observation regarding the new, 'Nebsoy' cultivar was that it tended to flower much earlier than the other Group II cultivars, sometimes as soon as the early maturing cultivars. In fact, for the first planting date at the Chesaning location, both 'Nebsoy' plant densities actually flowered one day before 'Evans.' This early flowering response of 'Nebsoy' may aid in explaining why its yields were higher than those of the other Group II cultivars at Chesaning,

while the reverse was true at Dundee in 1979. This early flowering response would appear to have been especially beneficial when dry conditions were experienced in the latter half of the growing season as was the case at the Chesaning location. The fact that 'Nebsoy' yields were so high at the Chesaning location coupled with the fact that the early maturing (and flowering) cultivars also responded with high yields would tend to support this benefit of early flowering. 'Nebsoy' did mature at times more nearly approximating maturity dates for the other Group II cultivars. At the Chesaning location, 'Nebsoy' maturity dates tended to fall in between those of the pairs of 'Corsoy' and 'SRF 200,' and of 'Beeson' and 'SRF 250.' At the Carleton location, maturity dates were always earlier than those of the other Group II cultivars with the exception of 'Corsoy' at the first planting date. This response might tend to indicate some reasons for the poor relative yield response here. Perhaps, due to the earlier flowering date, this cultivar was unable to extend its growing season in response to optimal growing conditions as readily as could other Group II cultivars. These facts would seem to indicate that 'Nebsoy' would be better adapted for dry conditions, but is unable to take advantage of optimal growing conditions such as those experienced under irrigation. No apparent difference occurred in flowering and maturity dates between the two plant densities used for 'Nebsoy.'

The planting date x cultivar interactions for flowering and maturity were significant at both locations. At the Chesaning location, the variability of cultivar responses within planting dates

remained fairly constant for both flowering and maturity stages; while at Dundee, variability decreased with later planting dates. This different location response may in part be attributed to slightly later planting dates two and three at the Dundee over the Chesaning location, coupled with slightly shorter daylengths at the southern location.

Surprisingly, flowering and maturity dates were also significantly different for the different row widths at the Chesaning location. Plants in narrower rows flowered later and matured earlier than those in wide rows. However, differences were all less than one day which would appear to indicate little effect upon yield. At the Dundee location, row width differences were not significant for flowering or maturity, but there was a strangely reversed trend of narrower rows maturing later than wide rows. This location difference is difficult to explain since yield responses to row width tended to be more pronounced at the southern location. However, the row width x cultivar interaction in Table 19 was surprisingly significant for maturity at Dundee. 'Evans' responded with later maturity at wider row widths while 'SRF 200,' 'Beeson,' and both 'Nebsoy' densities responded in an opposite manner. The other three cultivars gave mixed responses.

Emergence at Chesaning required less time at the later dates, which probably reflected rising soil temperatures. The same effect was true at the Dundee location, except that emergence was somewhat delayed for the third date by deep planting in dry soil conditions. Due to the variability of the emergence periods, growing season

Table 19. The influence of cultivar and row width on 1979 maturity dates (days after September 1) at the Dundee location, averaged over planting date.

<u>Cultivar</u>	<u>Row Width (cm)</u>			
	<u>25</u>	<u>51</u>	<u>76</u>	<u>$\bar{x}$</u>
Corsoy	33.8	33.6	33.7	33.7
Evans	22.2	22.4	23.4	22.7
Hodgson 78	27.4	29.7	28.4	28.5
SRF 200	38.6	38.4	37.8	38.3
Beeson	37.8	37.8	37.1	37.6
Nebsoy (Regular Density)	34.1	33.2	32.8	33.4
Nebsoy (1.5 Density)	33.9	33.1	33.0	33.3
SRF 250	37.7	36.6	36.7	37.0
$\bar{x}$	33.2	33.1	32.9	

LSD_{0.05} - Cultivar within row width - 1.20
 Same or different cultivar across row width - 1.47

periods will all begin with emergence, rather than planting.

The average growing season lengths (E - M) for the first, second and third planting dates were 128, 117, and 106 days, respectively, at the Dundee location, and 123, 115, and 108 days, respectively at Chesaning. Although the first date at Dundee was before the first planting date at Chesaning, maturity occurred later at Dundee. Also of note is that the second date at Dundee had a slightly longer E - M period than the same date at Chesaning, even though it was planted later. These observations would seem to suggest that the optimal rainfall amounts at Dundee were an overriding factor over shortened daylengths in extending the E - M period length beyond those at Chesaning. However, the third date E - M period was shorter at Dundee than at Chesaning. This probably reflects the fact that emergence of the third date was eight days later at Dundee, and also later in the growing season when planting date effects on yield were more pronounced. The dry period late in the growing season at Dundee may also explain the shorter third date E - M period in relation to that at Chesaning. The longer average E - M periods at the Dundee location in comparison with those at Chesaning were even more pronounced when periods for the four cultivars grown in 1978 were segregated out. First, second, and third planting date periods were 125, 115, and 105 days, respectively, at Dundee, and 119, 111, and 104, respectively, at Chesaning. Here, even the third date E - M period was longer at Dundee. This reversed response of the third date when the four cultivars were segregated was due to the earlier maturity date of 'Nebsoy' in relation to the other Group II cultivars

at Dundee, but not at Chesaning.

Although V_5 stages were not recorded in 1979, since the $E - V_5$ period lengths seemed fairly fixed and independent of location and planting dates in 1978, it might be proper to assume that most of the $E - R_1$ period length trends reflected changes in the $V_5 - R_1$ portion in 1979. Cultivar variations of the $E - R_1$ period within planting dates paralleled flowering dates noted earlier. Even though $E - M$ periods at Dundee were generally longer than at Chesaning, the $E - R_1$ periods were consistently shorter at Dundee than at Chesaning, although not in so pronounced a manner as in 1978. This would again seem to indicate the effects of the shorter daylengths upon flowering at the southern location, especially since planting dates at the two locations corresponded closely.

At the Chesaning location, with one exception, cultivars responded with greatly reduced $E - R_1$ periods at the second over the first date, while for the second and third dates they were nearly identical. This latter response is difficult to explain, since it runs contrary to that which would normally be expected of a photo-periodically regulated response. Flowering of the third date may possibly have been delayed due to the June dry weather, which perhaps would have had greater delaying effect upon the smaller third date plants than the larger ones of the second date. The effect of a limiting "ripeness to flower" period does not seem to be present here since shorter $E - R_1$ periods occurred at the same location in 1978 and at the Dundee location both years. 'Nebsoy' was an interesting exception to the above trend in that its $E - R_1$ periods were

nearly uniform for the first and second dates, and then were noticeably reduced for the third date. This response again may have been due to timing of dry weather periods and to the fact that this Group II cultivar had an unusual flowering response.

At the Dundee location, $E - R_1$ periods again were shortened with later dates, although decreases here were more uniform between the first and second, and second and third planting dates. However, except for 'Beeson,' decreases were greater between the first and second dates, than between the second and third. Of interest is the fact that 'Nebsoy' did not exhibit the opposite response seen at Chesaning. This change probably indicated either different climatological conditions or the effect of the shortened photoperiod at the southern location. One last observation is that the overall decreases in $E - R_1$ period lengths with later planting dates were much larger at the Dundee location than at Chesaning.

The $R_5 - M$ period length was fairly constant over dates and locations in 1978, and therefore it again might be proper to assume that a great deal of the differences in the $R_1 - M$ period lengths were due to changes in the lengths of the $R_1 - R_5$ portions in 1979. $R_1 - M$ periods were consistently much longer at the Dundee location than at Chesaning, in a manner opposite to the lengths of $E - R_1$ periods. This accounts for the longer overall $E - M$ periods at Dundee, and indicates that the increased $E - M$ periods may have been due to increased periods of flowering and podset, and perhaps also of podfill in response to optimal rainfall in the second half of the growing season. As will be seen later, seed size was larger

at Dundee. When seed size was divided into overall plot yields, it also appeared that seed numbers were greater at Dundee.

At both locations, the overall $R_1 - M$ periods decreased less between the first and second dates, than between the second and third, in fairly uniform fashion for all cultivars. This, as would be expected, was the opposite of the trend for the $E - R_1$ period, and probably reflected greater end of the season pressures upon the last planting date maturity. The ranking of cultivars within planting dates at both locations was fairly similar with 'SRF 200' always the longest, 'Evans' the shortest, and the other cultivars closely grouped in between. Of the four cultivars grown in 1978, the ranking was consistently 'SRF 200' the longest, then 'Hodgson 78,' 'Corsoy' and 'Evans' in descending order. Note that 'Corsoy' and 'Evans' switched positions from those indicated in 1978. Although the $R_1 - M$ period was fairly short for 'Corsoy,' its long $E - R_1$ period again balanced out its growing season as in 1978.

Although fewer periods were divided in 1978, it was possible to compute correlations of the $E - M$, $E - R_1$, and $R_1 - M$ periods to yield. The only correlation over 0.50 was that of the $R_1 - M$ period which was 0.62. This correlation would seem to indicate the importance of the total reproductive period to yield.

B. Vegetative Development

1. Percentage Emergence and Initial Stand

A. 1978

In 1978, since seed quantities planted were not adjusted by warm germination tests for each cultivar, the percentage emergence figures were adjusted so that they reflected percentage emergence of viable seed planted, rather than of desired stand. Warm germination tests were evidently fairly accurate for the Chesaning location, as the above adjustment resulted in cultivar differences being not significant.

Emergence percentages were a little higher at the Chesaning than at the Carleton location. This was somewhat surprising since soil temperatures are normally cooler when the Chesaning plots were planted. At both locations and with the combined figures, differences were significant for planting date, row width, and plant density. At the Carleton location, significant differences for cultivar were present along with a significant row width x plant density x cultivar interaction.

At both locations, the percentage emergence of the second date was surprisingly a little lower than that of the first date, especially given that the first date took much longer to emerge at Chesaning. As would more normally be expected, emergence for the third planting date was much higher than that for dates one and two. The location x planting date interaction was not significant.

Surprisingly, at both locations a uniform trend of higher percentage emergence at narrower row widths was observed. Differences

between 25 and 51 cm widths were much greater than those between 51 and 76 cm widths. The row width x location interaction was not significant. However, the row width x planting date x location interaction was significant. Most noticeable in this interaction was the fact that the percentage emergence was lower for the second date than the first for the 25 and 76 cm row widths at the Chesaning location and for the 51 cm width at the Carleton location. Also at the Carleton location, emergence for the second date, 56 cm width was less than that for the second date, 76 cm width.

At both locations, percentage emergence was significantly higher for the low density than for the high.

Although adjustments for warm germination tests were made, a significant cultivar difference occurred at the Carleton location. The significant difference was a much higher percentage emergence for 'Corsoy' than for the other cultivars.

A significant interaction between plant density and cultivar appeared when results were combined for both locations, although this interaction was not significant for the individual locations. The major observation from this interaction was that the high density of 'Corsoy' emerged better than the low density, while the reverse was true for the other cultivars.

One last significant interaction in 1978 was that of row width x plant density x cultivar at the Carleton location, and also with the combined figures for both locations. Most prominent in both the Carleton, and combined location interactions is the observation that the high density of both 'Corsoy' and 'Evans' at the 25 cm row width had a noticeably higher percentage emergence than the low density. The reverse trend was generally true for other cultivars and row widths.

Initial plant stands which represent expanded field samples are indicated in Table 20. The higher stands for the third date in conjunction with the earlier observation that the high density treatment responded with higher yields than the low for all row widths of the third date (including the yet higher stand, 25 cm row widths) further reinforce the observation that higher plant densities were more beneficial to yield at later planting dates. Also of interest is the fact that with the average row width stands, 25 cm rows had stands which were 8.3 and 9.8% greater than those of the 51 and 76 cm widths, respectively. These higher stands at the 25 cm row width may partially explain why 25 cm width yields were not much higher than 51 cm widths, given the dry weather during the growing season. Mainly due to the failure to adjust actual number of seed planted based on the warm germination tests, quite noticeable differences appeared in the initial stands of the various cultivars. Since 'Evans' normally produces a fairly small plant in comparison to the other cultivars, it may well be that by having the lowest plant density, this cultivar was placed at even greater disadvantage than its shorter growing season would normally cause. Also of interest is the fact that 'SRF 200' responded with the highest yields at Chesaning while also having the highest stand there.

The 1978 high plant density treatment was originally intended to have 37.8% more plants per unit area than the low density treatment. However, due to the wide fluctuations in the treatments noted above, much greater variation occurred. An extreme example at the Carleton location was the stands of the third date, high density, 25 cm 'Corsoy' cultivar and of the first date, low density, 76 cm 'Evans' cultivar

Table 20. Effects of planting date, row width, plant density and cultivar on initial plant stand (plants/ha) averaged over all other factors for both locations in 1978 and 1979.

<u>Treatments</u>	<u>1978 Locations</u>			<u>1979 Locations</u>		
	<u>Carleton</u>	<u>Chesaning</u>	<u>$\bar{x}$</u>	<u>Dundee (With SRF 250)</u>	<u>Chesaning (Without) SRF 250)</u>	<u>$\bar{x}$ (Without) SRF 250)</u>
<u>Planting Date</u>						
1st	386,154	400,780	393,467	367,186	417,244	396,221
2nd	384,933	391,486	388,209	423,950	400,416	414,547
3rd	410,946	433,395	422,170	445,768	454,780	450,605
LSD _{0.05}	20,658	20,658	14,607	28,052	25,594	18,557
<u>Row Widths (cm)</u>						
25	417,399	432,050	424,724	535,941	556,961	546,964
51	383,463	401,029	392,246	367,637	373,244	373,458
76	381,171	392,582	386,876	333,327	342,235	340,952
LSD _{0.05}	18,490	18,490	13,074	28,052	25,594	18,557
<u>Plant Density (plants/ha)</u>						
344,000 (Low)	338,946	353,314	346,130	-----	-----	-----
474,000 (High)	449,076	463,793	456,435	-----	-----	-----
LSD _{0.05}	14,409	14,409	10,189	-----	-----	-----
<u>Cultivar</u>						
Corsoy	419,857	417,299	418,578	418,723	407,230	412,977
Evans	358,397	386,370	372,383	384,291	404,162	394,227
Hodgson (78)	385,971	397,399	391,685	384,025	369,402	376,713
SRF 200	411,818	433,146	422,482	380,901	373,320	377,110
Beeson	-----	-----	-----	319,752	354,907	337,329
Nebsoy	-----	-----	-----	426,169	426,173	426,171
(Regular Density)						
Nebsoy	-----	-----	-----	603,522	633,834	618,678
(1.5 Density)						
SRF 250	-----	-----	-----	381,028	-----	-----
LSD _{0.05}	20,378	20,378	14,409	42,783	39,035	29,178

which were 588,425 and 243,981 plants/ha, respectively. In this case, the high density treatment had 141% more plants per unit area than the low density treatment. If density treatments were averaged in the above example, the third date, 25 cm 'Corsoy' cultivar still had 487,962 plants/ha to the 288,232 plants/ha for the first date, 76 cm 'Evans' cultivar, or 69.3% more plants/ha. The above examples illustrate the large stand fluctuations which occurred. These may have been part of the reason why plant density yield differences were not significant, and also why some of the observed responses, which were either unexplained or attributed to other treatment factors, actually occurred.

B. 1979

Since seed quantities planted were adjusted by warm germination tests for each cultivar, percentage emergence figures reflected the percentage emergence of the desired plant stand.

Emergence percentages were again a little higher at the Chesaning than at the southern location. At both locations and for the combined figures, differences were significant for planting date and cultivar. Chesaning and combined figures also revealed significant differences for row width, and a significant planting date x row width interaction.

At Chesaning, the percentage emergence for the second date was again a little lower than that of the first date, as was the case at both locations in 1978. The third date had a much higher percentage emergence than the first and second as would normally be expected. The Dundee location showed a more consistent response of increasing

emergence percentages at later dates with a larger difference between dates one and two, than between dates two and three. The location x planting date interaction was significant. As in 1978, plants in narrower rows emerged better than those in wider rows, with larger differences between 25 and 51 cm row widths than between 51 and 76 cm widths. This was significant for Chesaning and combined figures but not for Dundee alone.

At the Chesaning location, the planting date x row width interaction was significant, as was also the same interaction for the combined locations. For both of the above interactions, narrow rows responded, as previously noted, with higher emergence than wide rows for the first date. The same response was present for the second date, except that 76 cm widths emerged slightly better than did 51 cm widths. However, at the third date a totally reversed and consistent response occurred with wide rows emerging better than narrow rows. This last response might possibly have been the result of the greater ability of 76 cm rows to push thorough a dry crust which existed to some degree at the later dry June date. The same interaction at Dundee, although not significant, responded in a similar fashion. The low emergence figure for first date, 76 cm widths at Chesaning may perhaps give a clue for explaining the lower yield response of the first over the second date for 76 cm rows.

The combined planting date x row width interaction also consistently responded with increased emergence percentage at later dates for all row widths. However, at Chesaning, this response consistently occurred only for the 76 cm widths. At the 25 cm row widths, the first date surprisingly emerged better than the third date, and the

second date was poorest. At the 51 cm width, the first date emerged slightly better than the second date, while the third emerged best. These last two observations account for the overall lower emergence figure for the second date versus the first at this location.

As was true at the 1978 Carleton location, significant cultivar differences occurred at both 1979 locations although the seed planted was adjusted by warm germination tests. Because of the above adjustment prior to planting, initial cultivar stands listed in Table 20 also reflect relative emergence, so both will be discussed together. At both locations, 'Nebsoy' exhibited the highest percentage emergence. At Dundee, emergence of the 1.5 density treatment was noticeably lower than that of the regular density which was similar to plant density response in 1978, and initial stand was 1.42 times that of the regular density. At Chesaning, emergence percentages of the two densities of 'Nebsoy' were nearly equal and the initial stand of the 1.5 density was 1.49 times that of the regular density. 'Corsoy' had the next highest emergence, followed by 'Evans,' 'Hodgson 78,' 'SRF 200' and 'Beeson.' At Dundee, 'SRF 250' had a percentage emergence between that of 'SRF 200' and 'Beeson.' 'Beeson' responded with noticeably lower emergence which corresponded with visibly poor seed quality at planting time. Although the warm germination test for this cultivar was 88%, the average emergence percentage of actual seed planted was only 75% while the same figure for the regular density of 'Nebsoy' was 96% in comparison with a 90% warm germination test. The poor response of 'Beeson' may have resulted not only in fewer plants/ha, but also in lowered seedling vigor which might explain the poor yield performance of this cultivar in 1979.

Consideration of 1979 initial plant stands in Table 20 indicates that planting date effects were even more pronounced than the year before. Differences were especially pronounced at Dundee where the third date had 21.4% more plants than did the first date. Due to the design of the experiment, row width differences were expected. However, due to the higher percentage emergence of 25 cm widths over other widths, the 25 cm widths had average stands which were 46.5 and 60.4% greater than those of the 51 and 76 cm widths, respectively. This is somewhat larger than the 42.7 and 52.0% figures originally intended.

An extreme example of the large fluctuations in initial stand can be found at Dundee where the initial stands of the third date, 25 cm 'Hodgson 78' cultivar and the first date, 76 cm 'Beeson' cultivar were 592,167 and 245,431 plants/ha respectively. The first treatment combination had 141% more plants per unit area than the second, and, although some of these differences may be the result of sampling error, there still exists strong reason to believe that differing plant stands had some effects on the final yield.

2. Numbers of Mainstem Nodes and Growth

The number of mainstem nodes above the cotylendonary nodes were recorded by field observations for the R_1 and R_5 stages at both locations for each planting date and cultivar treatment combination, averaged across the other treatments in 1978. The final numbers of mainstem nodes at maturity were also recorded from the component of yield samples from each plot at the Chesaning location in both 1978 and 1979. Applicable 1978 results are recorded by planting date and cultivar in Table 21. The Chesaning figures for mature plants averaged over row width and plant density, nicely matched those obtained earlier by field observations.

The ordering of cultivars within planting dates in Table 21 remained fairly constant at each developmental stage, with the Group II cultivars possessing more nodes at each stage than the earlier maturing cultivars, 'Evans' and 'Hodgson.' In all but one case, 'Hodgson' had more or an equal number of nodes than 'Evans.' At the R_1 and M stages, 'Corsoy' had more than or an equal number of nodes than 'SRF 200,' but this trend was reversed at the R_5 stage. This last reversed observation was probably the result of the longer R_1 to R_5 periods of 'SRF 200.'

At Chesaning, numbers of nodes of cultivars across dates at the R_1 stage remained fairly constant although there was a trend for 'Corsoy' to have fewer nodes at later dates. At the Carleton location, dates two and three were the same (5.5) and were both less than date one (6.8) at the R_1 stage. This uniform flowering response at the late planting dates would seem to support the concept of "ripeness to flower" in which a plant must reach a certain stage

Table 21. Vegetative growth expressed in mainstem nodes above the cotyledonary nodes at various developmental stages in 1978 for the Chesaning and Carleton locations as affected by planting date and cultivar, and averaged over plant density and row width.

Planting Date	Cultivar	Chesaning Developmental Stages				Carleton Developmental Stages			
		R ₁		R ₅		R ₁		R ₅	
		R ₁	R ₅	M		R ₁	R ₅	M	
1st	Corsoy	10	16	16					
	Evans	6	13	13					
	Hodgson	6	14	14					
	SRP 200	8	16	16					
	$\bar{x}$	7.5	14.8	14.8					
2nd	Corsoy	9	14	16					
	Evans	7	12	13					
	Hodgson	7	13	14					
	SRP 200	8	14	16					
	$\bar{x}$	7.8	13.3	14.8					
3rd	Corsoy	8	11	15					
	Evans	6	10	13					
	Hodgson	6	10	13					
	SRP 200	8	12	14					
	$\bar{x}$	7.0	10.8	13.8					
		X Differences				X Differences			
		R ₁ /R ₅	R ₅ /M	R ₁ /M	R ₁	R ₅	R ₁ /R ₅		
		62.5	100.0	62.5	8	13	61.5		
		46.2	100.0	46.2	6	12	50.0		
		42.9	100.0	42.9	6	11	54.5		
		50.0	100.0	50.0	7	15	46.7		
		50.7	100.0	50.7	6.8	12.8	53.1		
		64.3	87.5	56.3	6	11	54.5		
		58.3	92.3	53.8	5	9	55.6		
		53.8	92.9	50.0	5	9	55.6		
		57.1	87.5	50.0	6	11	54.5		
		58.6	89.9	52.7	5.5	10.0	55.0		
		72.7	73.3	53.3	6	7	85.7		
		60.0	76.9	46.2	5	7	71.4		
		60.0	76.9	46.2	5	7	71.4		
		66.7	85.7	57.1	6	9	66.7		
		64.8	78.3	50.7	5.5	7.5	73.3		

of development before flowering may occur. If the ratio of mature to immature leaves is the critical factor in "ripeness to flower," then the number of mainstem nodes with mature leaves would provide a good indicator of this factor.

There was a noticeable decrease in mainstem nodes as planting was delayed for all cultivars at the R_5 stage. This result would seem to indicate that reproductive development at this stage was proceeding independently of vegetative development. However, the maturity figures for the Chesaning location indicated that by the end of the growing season, the difference which existed between dates at R_5 had largely disappeared. Node numbers for dates one and two were identical, and those for date three were only slightly less than those for other dates.

The information in Table 21 not only provides a record of node numbers at each stage, but also provides data on the nature of the vegetative development of the soybean plants in relation to their reproductive development. The most important trend observed was that of greater delay in vegetative development with later planting date. Essentially no vegetative development occurred after R_5 in the first date. However, increasingly larger amounts of development occurred after R_5 in the succeeding dates. The increasing percentage of nodes at R_1/R_5 at Carleton in a manner similar to that at Chesaning suggests that the same vegetative developmental response to delayed planting date was also occurring there. The yields resulting from later planting dates, therefore, may possibly have been not so much affected by decreased final vegetative development, as by delayed vegetative development which caused a smaller portion of the final

plant to be available to support early reproductive functions, and also which caused more partitioning of assimilate for vegetative development later in the season. Other effects which might be expected as a result with later planting date would be decreased seed and pod numbers, and perhaps decreased seed size. As will be seen later, only seed size was consistently reduced at later dates.

By combining the developmental periods discussed earlier and the node development above, growth rate data was obtained reflecting nodal growth per day, and is presented in Table 22. The growth rate for the $E - R_1$ period at Chesaning generally tended to increase at later planting dates, although some cultivar fluctuations occurred. This response was logical since the shortened growing season resulting from later planting date would hasten the plant to reach the "ripeness to flower" vegetative stage so that reproductive development could commence. The $E - R_1$ growth rates remained fairly constant at Carleton with later dates which would seem to suggest that the drought conditions there slowed growth even at this stage of vegetative development of plants planted late. This difference from the Chesaning results would aid in explaining the very short mature plants of the second and third dates at Carleton.

Another observation of interest is that the $E - R_1$ growth rates for the first date, 'Evans' and 'Hodgson' plants were quite slow in comparison with the other cultivars and dates at Chesaning. This may help explain why 'Evans' yielded less at the first date than the second here.

Table 22. Vegetative growth rate expressed as increase of minimum nodes above the cotyledonary nodes per day between various developmental stages in 1978 for each location as affected by planting date and cultivar, and averaged over plant density and row width.

Planting Date	Cultivar	Christiana Developmental Stages						Carlston Developmental Stages					
		$S - V_3$	$V_3 - R_1$	$R_1 - R_3$	$R_3 - M$	$M - R_1$	$R_1 - R_3$	$S - M$	$S - V_3$	$V_3 - R_1$	$R_1 - R_3$	$S - R_1$	$S - R_3$
1st	Carney	0.18	0.23	0.22	0.00	0.20	0.21	0.12	0.17	0.21	0.20	0.18	0.19
	Evans	0.18	0.04	0.24	0.00	0.15	0.19	0.11	0.17	0.14	0.27	0.16	0.20
	Madison	0.18	0.07	0.26	0.00	0.14	0.19	0.12	0.17	0.14	0.20	0.16	0.18
	SNF 200	0.18	0.19	0.24	0.00	0.18	0.21	0.12	0.17	0.18	0.25	0.17	0.21
	$\bar{X}$	0.18	0.14	0.24	0.00	0.17	0.20	0.12	0.17	0.17	0.23	0.17	0.20
2nd	Carney	0.17	0.19	0.22	0.03	0.18	0.19	0.12	0.18	0.10	0.25	0.16	0.19
	Evans	0.17	0.18	0.19	0.02	0.18	0.18	0.12	0.18	0.00	0.20	0.15	0.17
	Madison	0.17	0.18	0.19	0.02	0.18	0.18	0.12	0.18	0.00	0.19	0.15	0.16
	SNF 200	0.17	0.21	0.19	0.04	0.19	0.19	0.13	0.18	0.13	0.22	0.17	0.19
	$\bar{X}$	0.17	0.19	0.20	0.03	0.18	0.19	0.12	0.18	0.06	0.22	0.16	0.18
3rd	Carney	0.19	0.21	0.15	0.07	0.20	0.18	0.13	0.19	0.14	0.06	0.18	0.14
	Evans	0.19	0.14	0.19	0.04	0.18	0.18	0.12	0.19	0.00	0.13	0.15	0.14
	Madison	0.19	0.20	0.16	0.04	0.19	0.18	0.12	0.19	0.00	0.13	0.15	0.14
	SNF 200	0.19	0.27	0.17	0.04	0.21	0.19	0.12	0.19	0.14	0.16	0.18	0.17
	$\bar{X}$	0.19	0.21	0.17	0.04	0.20	0.18	0.12	0.19	0.07	0.12	0.17	0.15

The $R_1 - R_5$ growth rates decreased quite rapidly with later planting dates at both locations. However, the reduction at the Carleton location was much greater, which again probably reflected drought conditions there and resulted in the very short third date plants. The decrease in $R_1 - R_5$ growth rates at both locations with later planting dates would suggest that the priorities of the partitioning of assimilate shifted increasingly to the reproductive processes during the period as planting dates were delayed. This reduction was pronounced enough that with the $E - R_5$ growth rates, the increasing rates of the $E - R_1$ portion with later dates were negated.

A final observation of great interest was that, although $E - R_5$ rates decreased with later dates, $E - M$ rates remained essentially constant across all planting dates and cultivars. This observation would seem to suggest that, although vegetative growth rates varied at different periods of the growing season for different reasons, in the end the plants were pacing themselves so that the season-long vegetative development directly reflected the length of growing season available. Unfortunately, since component samples were not obtained at Carleton, corroborating evidence was not available. It may be that the drought conditions there would have altered the constant $E - M$ rate observed at Chesaning.

Since mature plant samples from each plot at the 1978 and 1979 Chesaning location were measured for average mainstem node numbers, statistical analysis of the results was possible. For both years, significant differences occurred for planting date and cultivar. In 1978, average mainstem nodes per plant were 14.79, 14.61 and

13.57, while in 1979 they were 15.88, 15.75 and 14.51 for the first, second and third planting dates, respectively. Surprisingly, although overall yields were slightly lower in 1979, mainstem node numbers were slightly higher. A consistent trend occurred each year with the second date plants having only a slightly smaller node number than those of the first, while the third date plants had an average of about one node less than those of the other two dates. This result closely paralleled that of yield.

Before discussing cultivar differences, it is necessary to note that due to the small size of the yield component samples, area grain yields extended from sample plants did not correlate as closely with overall plot yields as might have been desired. This correlation was only 0.53 in 1978 and 0.44 in 1979. As a result, some trends for yields from the samples also varied from the overall plot yields discussed earlier. The trend most consistently altered was that of cultivar, although other treatment trends were also affected. Therefore, data obtained from the component samples will be briefly discussed, but little attempt will be made to correlate these results with overall plot yields when extended sample yield trends do not closely coincide. Sample yields on a per plant and per squared meter basis, as influenced by the main treatments, are provided in Table A2 for further reference.

Average mainstem node numbers for the 1978 cultivars of 'Corsoy,' 'Evans,' 'Hodgson' and 'SRF 200' were 15.40, 12.94, 13.67 and 15.27, respectively. For the 1979 cultivars of 'Corsoy,' 'Evans,' 'Hodgson 78,' 'SRF 200,' 'Beeson,' 'Nebsoy' (Regular Density) and 'Nebsoy' (1.5 Density) node numbers were 15.04, 13.91, 14.72, 17.04, 16.92, and 14.18 respectively. As would normally be expected, long season

cultivars tended to have more mainstem nodes than those adapted to shorter seasons.

Row width differences in 1978 were also significant and closely reflected yield. There was an interesting trend of 15.30, 14.17, and 13.49 mainstem nodes for 25, 51 and 76 cm row widths, respectively. It may be that the plants in narrower rows produced more nodes because they were less crowded, and therefore did not have to grow upward so fast in competition for light. Row width responses in 1979 varied very little which would support the above supposition, since higher plant densities at narrower row widths probably negated the reduced crowding effect. The increased node numbers in 1978 at narrower row widths provided additional sites for reproductive growth and may partly account for the increased yields at those widths.

Although row width differences in 1979 were not significant, the planting date x row width interaction was significant. Node numbers were higher at the second dates over the first for the 25 and 76 cm widths. Node numbers were higher for the 51 cm widths than for the 25 and 76 cm widths for the first and third dates. These trends almost exactly parallel those of overall plot yield figures which would seem to indicate some relationship here, although the overall correlation between yield and mainstem node numbers was low (0.17).

Plant density differences were also significant in 1978 with an average of 15.06 nodes at low densities and 13.58 nodes at high densities. This response further supports the concept that increased competition, especially competition for light, caused decreased node numbers as the plants were forced to grow upward more rapidly. The nodal response of narrow row widths at the higher 1979 densities is

also further supported.

The planting date x plant density interaction was also significant in 1978. The major observation of interest was that the second date had slightly more nodes than the first date at low density, while the high density had a consistent downward trend from the first through third dates.

Before leaving this section it should be noted that the correlation between mainstem nodes and overall plot yield was much higher in 1978 (0.51) than in 1979 (0.17). The 1978 correlation was significant.

3. Numbers of Branches and Nodes on Branches Per Plant

Since significant treatments and interactions were the same for number of branches and of nodes on branches per plant, and since these two developmental components were similar in response, they are discussed here together. All future references to branch number or to number of branch nodes should be understood to reflect per plant values. Row width and cultivar differences were significant both years. In 1978, branches per plant were 1.34, 0.96 and 0.77 and numbers of branch nodes per plant were 4.36, 2.69, and 1.91 for 25, 51 and 76 cm row widths, respectively. This response would be expected where plant densities were uniform across row widths since 25 cm width plants were more evenly spaced, and therefore, more likely to branch. The increased number of branches and therefore of branch nodes available at narrower row widths provided additional sites for reproductive growth, and perhaps account for the similar yield response in 1978. The especially high plant density of the 25 cm widths in 1979 was reflected in the branch numbers of 0.92, 1.66 and 1.56, and in the number of branch nodes of 2.24, 4.39, and 4.26 for row widths of 25, 51 and 76 cm, respectively. The reduced numbers for 25 cm rows in 1979 again may have accounted for some of the yield reduction experienced, although the increased number of plants available would in a more moist year perhaps have made up for this decreased number.

Cultivar influences in 1978 upon branch number were 1.19, 1.04, 1.33, and 0.53; and upon branch node numbers were 3.49, 2.67, 4.14 and 1.65 for 'Corsoy,' 'Evans,' 'Hodgson' and 'SRF 200,' respectively. In 1979 the same figures were 1.50, 1.41, 2.09, 1.67, 1.74, 1.03, and 0.23; and 4.28, 3.76, 5.67, 4.14, 4.36, 2.68 and 0.53 for 'Corsoy,' 'Evans,' 'Hodgson 78,' 'SRF 200,' 'Beeson,' 'Nebsoy' (Regular Density) and

'Nebsoy' (1.5 Density), respectively. Observations of interest included the consistently superior branching response of the 'Hodgson (78)' cultivar although it was a shorter season cultivar. Perhaps this branching characteristic aids in explaining the consistent overall yielding ability of this cultivar. 'SRF 200' indicated a much lower relative branching response in 1978 than in 1979. This may have been due in part to the fact that overall plant density of this cultivar was 16% higher in 1978 than in 1979, and also was relatively higher than the other cultivars in 1978 while the opposite was essentially true in 1979. Although 'Nebsoy' branched less than the other cultivars at the regular density, effects at the increased density were quite marked to almost no branching at all. Perhaps this branching character along with the overall structure of the plant provide some clues to the observed superior yield performance in dry conditions.

From this point, the significant branching responses of the two growing seasons were quite different. During the 1979 season, planting date responses were significantly different. Number of branches were 1.43, 1.20 and 1.52, while number of branch nodes were 4.03, 3.14 and 3.72 for the first, second and third dates, respectively. Surprisingly, the second date which had the highest overall plot yield and sample yield, had the lowest amount of branching which would seem to indicate that this factor in itself was not critical for yield. Also of interest is the fact that emergence was also lowest for the second date which would seem to warrant more branching. As would be expected, there were fewer nodes per branch for the third dates. The 1978 response, which was not significant, showed a decrease in branching at later planting dates.

The 1979 planting date x row width interaction was also significant. First date plants had the most branches with the third and second dates following in decreasing order for the 51 and 76 cm widths. However, the 25 cm widths responded with consistently more branches at later planting dates. First and third date plants had more branches in 51 than 76 cm widths, and the least branches in 25 cm widths. However, second date plants had consistently more branches at wider row widths. Branch nodes had similar responses except that 25 cm widths had more nodes at the first over the second date, and the 76 cm widths had more nodes at the second over the third date.

In 1978, plant density responses were significant as expected with 1.41 and 0.64 branches, and 4.35 and 1.63 branch nodes per plant at the low and high densities, respectively. Responses here highlight the high level of adaptability of the soybean plant to varying plant densities.

In 1978, the row width x plant density interaction was also significant. For both branch numbers and nodes there was a consistently decreasing trend from low density, 25 cm widths to high density, 76 cm widths, with the size of decreases diminishing in the same manner.

Another significant interaction in 1978 was between cultivar and planting date. The branch number and nodes of the longer season cultivars, 'Corsoy' and 'SRF 200' decreased in the order of the second, first and third dates while for the shorter season 'Evans' and 'Hodgson' cultivars, the order was the first, third and second dates; and the first, second and third dates respectively. The 'Evans' response was very similar to that of 'Hodgson.' However,

the opposite response of the other two cultivars suggests that branch numbers and nodes were not only a function of plant density and available growing season length, but also of the arrival of rainfall and other climatic factors in relation to the unique genome of each cultivar, since responses appeared to be grouped by maturity class.

The last significant interaction for branch numbers and nodes was the three-way interaction in 1979 between row width, planting date and cultivar. This interaction was characterized by fairly random fluctuations which probably were due to the small number of sample plants represented by each mean, but also perhaps due to the various combinations of the factors mentioned above. However, some general trends and notes of interest did appear. The 'Hodgson 78' cultivar within planting dates and row widths tended to have the most branches and branch nodes followed in varying order by 'Beeson,' 'Corsoy,' and 'SRF 200'; with 'Evans' and 'Nebsoy' usually having the least. 'Hodgson's' largest branching advantage over other cultivars tended to be at 25 cm row widths in which plant densities were quite high. Within cultivar and planting date, 25 cm widths tended to uniformly have less branching than the other widths, with some exceptions. The most notable exception was with 'SRF 200' in the third date where 25 cm widths had the most branching followed by the 51 and 76 cm widths in decreasing order. The most consistent ordering of row width responses within cultivar and planting date occurred at the first planting date for both branch numbers and nodes where differences appeared to be related to maturity groups, as noted before. 'Nebsoy' plants in 25 cm widths (1.5 Density) had no branching at any planting dates.

Total nodes per plant were calculated and analyzed along with the percentage of total plant nodes found on branches. The influences of the main treatments on these factors are recorded in Table 23. In 1978, row width, plant density and cultivar responses were all significantly different for both factors. The row width x plant density and planting date x cultivar interactions were also significant. In 1979, planting date, row width and cultivar responses were all significantly different for both factors, and the planting date x row width x cultivar interaction for percentage of total plant nodes found on branches was also significant. Total nodes per plant in 1978 increased from 15.41 to 19.66 as row width was changed from 76 to 25 cm. The percent nodes on branches was 11.3 and 18.7 for 76 and 25 cm rows, respectively. The reverse trend occurred in 1979 with total nodes and percent branch nodes both significantly decreasing as rows became more narrow.

Table 23. Influence of planting date, row width, plant density and cultivar upon total nodes per plant and upon percentage branch nodes of total plant nodes for the 1978 and 1979 Chesaning locations, averaged over all other factors.

<u>Treatments</u>	<u>Year</u>			
	<u>1978</u>		<u>1979</u>	
	<u>Total Nodes/Plant</u>	<u>% Branch Nodes</u>	<u>Total Nodes/Plant</u>	<u>% Branch Nodes</u>
<u>Planting Date</u>				
1st	18.50	17.2	19.91	18.5
2nd	17.49	13.6	18.89	15.4
3rd	15.93	13.3	18.23	18.6
LSD 0.05	n.s.	n.s.	0.77	2.5
<u>Row Width (cm)</u>				
25	19.66	18.7	17.59	11.3
51	16.86	14.1	19.93	20.6
76	15.41	11.3	19.50	20.6
LSD 0.05	1.15	3.0	0.77	2.5
<u>Plant Density</u>				
Low	19.41	19.8	----	----
High	15.21	9.6	----	----
LSD 0.05	0.79	2.1	----	----
<u>Cultivar</u>				
Corsoy	18.89	16.0	19.32	20.8
Evans	15.61	15.2	17.67	20.2
Hodgson 78	17.82	19.7	20.40	26.9
SRF 200	16.92	7.9	21.18	18.4
Beeson	----	----	21.28	19.8
Nebsoy	----	----	18.53	13.1
(Regular Density)				
Nebsoy	----	----	14.70	3.5
(1.5 Density)				
LSD 0.05	1.12	2.9	1.23	4.0

4. Leaf Area

A limited number of leaf area readings were obtained from border row plants in an attempt to explain cultivar light reading responses. 'SRF 200,' 'Corsoy,' 'Hodgson 78,' 'Nebsoy' (Regular Density) and 'Beeson' plots in the first planting date were measured with respective responses of leaf area per plant (cm^2/plant) being 1544, 1580, 1992, 2082, and 2481. Cultivar differences were significant. Although some difference in cultivar responses to border row conditions may have occurred due to branching, the above results seemed to be representative of the cultivar differences within the canopy at the time measurements were made. Since cultivar values were averaged over row widths, the leaf area per land area means (LAI) were in exact proportion to leaf area per plant means. 'Beeson' had the most leaf area as would be expected for a wide-leaf cultivar. 'Nebsoy' and then 'Hodgson 78' had intermediate values, with 'Corsoy' and then 'SRF 200' having the least leaf areas. It was surprising that the early maturing 'Hodgson 78' cultivar had more leaf area than did two Group II cultivars. However, its superior branching character may have been expressed to a larger degree in border row conditions.

Because 'Evans' in the first date had already begun final maturation with leaf senescence and some abscission, leaf area per plant measures were also recorded for the second date plots of this cultivar along with those of 'SRF 200' for reference. Results were 1306 and 1922 cm^2 for 'Evans' and 'SRF 200,' respectively. Although the value of 'Evans' was quite low in comparison to 'SRF 200,' it should be noted that the leaves of the second date plots were also just beginning to senesce, and some leaves may have already fully

senesced and abscised. This explanation is supported by the fact that second date values for the 'SRF 200' cultivar were much higher than the first date values, which would seem to indicate that perhaps some leaves of the first date plants had already senesced and abscised.

Row width differences were also significant for the first date measurements. Measures for 25, 51 and 76 cm widths were 2,299, 1,795, and 1,713 cm², respectively, for leaf area per plant and 10.78, 5.99, and 5.35, respectively, for LAI using within canopy extrapolation factors. It would appear that more leaf area was produced in narrower row widths. However, because these plants were border row plants, the row width treatments were effective only on one side, and essentially no competition effect was present on the other side. Therefore, extrapolated LAI measures above, based upon average densities within the canopy, were not true measures.

5. Penetration of Photosynthetically Active Radiation (PAR)

It would be expected that closely related to leaf area measures would be those for photosynthetically active radiation. All subsequent readings are an expression of photosynthetically active radiation (PAR) penetrating the crop canopy as a percentage of total PAR striking a bare soil surface at a distance from the crop canopy. Readings were taken only in 1979 at both ground level and mid-canopy heights within the plant canopy for all plots at the Chesaning location. Means of PAR readings at mid-canopy were about three times greater than those at ground level. Both levels had significant row width and cultivar differences, as well as significant planting date x cultivar and row width x cultivar interactions. Planting date differences were not significant which would seem to suggest that by the R_5 developmental stage, plants had reached a fairly uniform level of light absorption regardless of planting date. If planting date yield differences were not due in part to differences in PAR penetration, they would most likely be a function of the length of time of exposure to total PAR (i.e. length of growing season) rather than the level of penetration of the canopy at any one developmental stage. Such exposure differences would occur due to shorter daylengths and less growing days for later planting dates than for earlier ones.

PAR readings for 25, 51 and 76 cm row widths were 3.28, 3.39 and 7.11, respectively, at ground level and 9.01, 12.32, and 18.72, respectively, at mid-canopy. At both canopy levels, 76 cm width readings were approximately double those of 25 cm widths. However, the 51 cm reading was only 3.4% higher than that of the 25 cm widths at ground level; while at mid-canopy, the 51 over 25 cm row width

reading was 36.7% higher. Apparently, at ground levels, plants in 20 cm rows had grown together so densely that there was no significant difference between 25 and 51 cm widths, while at mid-canopy level the 51 cm wide rows were still somewhat more separated. It would appear that the overall yield trend was more closely correlated to that of the ground level PAR since 51 cm row widths actually yielded slightly more than 25 cm rows.

When the percentages of mid-canopy light which reached the ground level were calculated, no significant differences occurred between row width means. This would seem to suggest that the amount of PAR interception (or reflection) by the lower half of the plant canopy was a proportional response to the amount of PAR penetrating the top half. Perhaps leaf senescence at lower canopy levels would partly account for this proportional response. However, arithmetic differences between PAR readings for the two levels revealed significantly different row width means which were 5.73, 8.93, and 11.61 for 25, 51 and 76 cm widths, respectively. These means were noteworthy in that the smaller PAR readings at narrower row widths decreased less from mid-canopy to ground level than the larger readings at wider widths. However, since the differences between the two canopy level readings were direct percentages of the total PAR available above the canopy, higher percentages of the total PAR available were evidently absorbed (or reflected) in the lower half of the canopy with wide row spacings. It would seem that the lower leaves of wider row canopies would also not senesce as rapidly as the canopy increased in height, and that perhaps more reproductive growth would occur on the lower portions of the plants.

PAR means by cultivar at ground level and mid-canopy were as follows: 'Nebsoy' at 1.5 Density (1.56, 5.99), 'Nebsoy' at Regular Density (2.18, 6.54), 'Beeson' (2.74, 8.21), 'SRF 200' (4.05, 12.37), 'Hodgson 78' (5.87, 16.51), 'Corsoy' (6.25, 18.72) and 'Evans' (9.50, 25.11). The ranking of cultivars remained the same at both canopy levels. It would be expected that the early maturing cultivars, 'Evans' and 'Hodgson 78,' would allow the most PAR to pass through their respective canopies, since early maturing cultivars do not have as long a period to develop vegetatively. However, the fact that 'Corsoy' had a higher PAR reading than the narrow-leaf 'SRF 200' cultivar was somewhat surprising. This response was somewhat explained by the previous observation that the second date, 'SRF 200' plots had more leaf area per unit land area than did first date, 'Corsoy' plots. In a preliminary fashion, this PAR and leaf area response would seem to indicate that possession of a more lanceolate leaf shape was no guarantee of reduced leaf area or of greater PAR penetration in every case. It is also interesting to note that 'Corsoy' yields were slightly higher than those of 'SRF 200,' as was also initial stand. 'Beeson,' as expected for a wide leaf cultivar with a large leaf area, had quite low PAR readings. However, it is interesting that 'Nebsoy' had lower PAR readings than 'Beeson' while the first date leaf area response was reversed. Either the loss by 'Nebsoy' of more leaves due to senescence and abscission than by 'Beeson' between the times of PAR readings and leaf area readings, or some other factor such as differing morphological arrangement of leaves might explain this reversed response. The two 'Nebsoy' plant densities responded in the expected manner with the higher density having lower PAR readings.

As with the row width treatment, when the percentages of mid-canopy light which reached the ground level were calculated and analyzed, no significant differences between cultivar means occurred. This again would suggest that for the various cultivars, the amount of PAR interception by the lower half of the plant canopy was a proportional response to the amount of PAR penetrating the top half. Analysis of the simple differences between PAR readings at the two canopy levels revealed significant differences between cultivar means. The means for these differences were 4.43, 4.36, 5.47, 8.32, 10.64, 12.47 and 15.61 for 'Nebsoy' (1.5 Density), 'Nebsoy' (Regular Density), 'Beeson,' 'SRF 200,' 'Hodgson 78,' 'Corsoy' and 'Evans,' respectively. With the exception of the two plant densities of 'Nebsoy,' the order above was the same as for the PAR readings at each level. This response would suggest that since higher percentages of the total PAR available were evidently intercepted by the lower half of the canopy of cultivars with large values above, these same cultivars may have responded with more reproductive production on the lower portion of the crop plants. The reversed order of the two 'Nebsoy' plant densities indicated that more of the total available PAR was intercepted in the lower half of the canopy at the higher versus the lower density, even though less total PAR actually penetrated this far. This response may have been due to the presence of more plants in the canopy resulting in more leaves per land area in the lower half of the canopy.

The significant cultivar x planting date interactions for PAR readings at both levels are portrayed in Figure 5. Cultivar within planting date responses followed basically the same trend as the

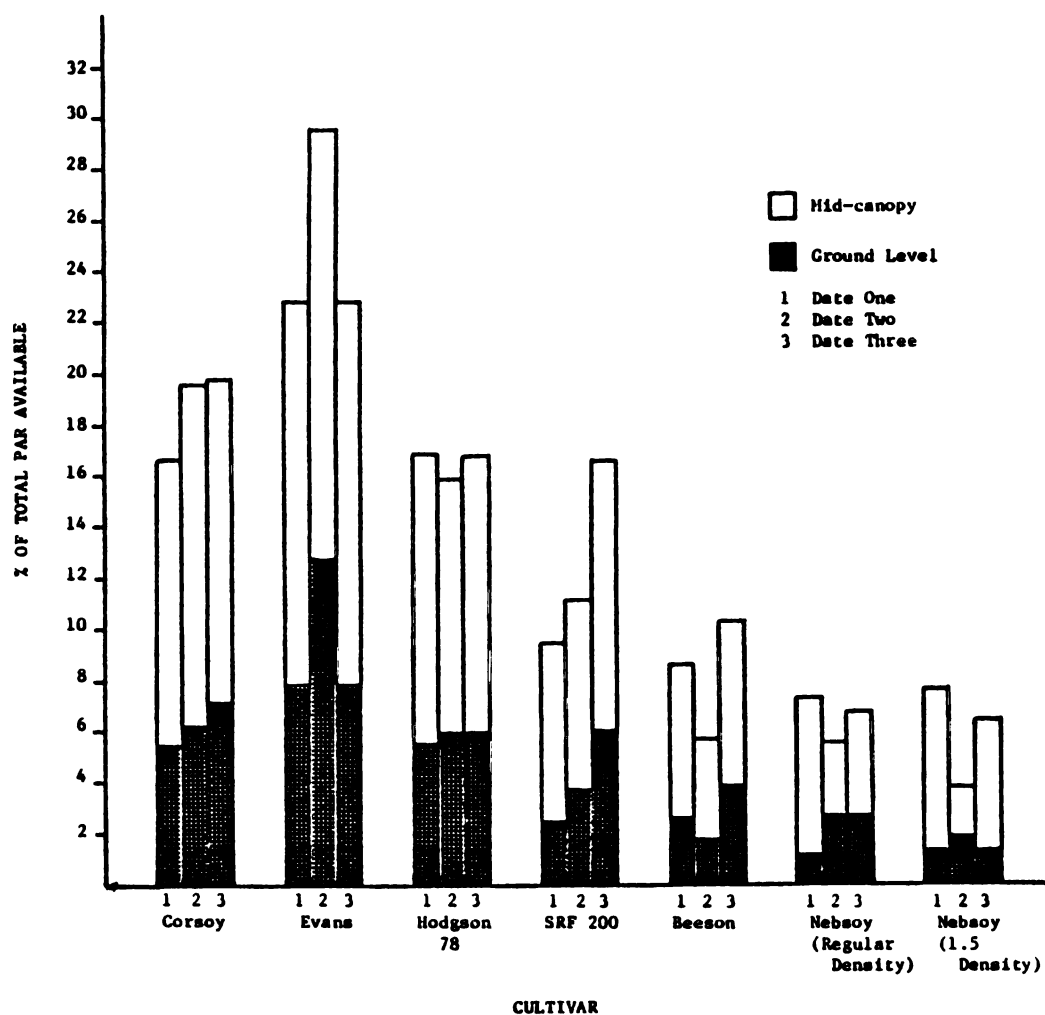


Figure 5. Ground level and mid-canopy penetration of photosynthetically active radiation (PAR) as influenced by cultivar and planting date, averaged over row width at the 1979 Chesaning location.

overall cultivar response with some minor exceptions. However, planting date within cultivar responses fluctuated widely with no consistent trend. This response perhaps aids in explaining why overall planting date responses were not significant. Also, the varying trends would seem to suggest that foliage growth was to some extent dependent upon climatic conditions at the various times of development of the differing cultivars and dates. Planting date within cultivar response trends were similar for readings at both levels except for the 'Beeson' and 'Nebsoy' (1.5 Density) cultivars. The second date plots of both 'Nebsoy' densities responded in an unusual manner with the ground level readings having about one-half the value of those of the mid-canopy, instead of the more normal one-third comparison.

The cultivar x row width interactions for PAR readings at both levels, and also for simple differences of the two readings were significant. These interactions are displayed in Figure 6. Cultivar within row width responses generally agreed with those of overall cultivar means except that the ground level readings for 'Nebsoy' (Regular Density) were lower than those of the higher 'Nebsoy' density in 25 cm row widths. Mid-canopy readings were consistently higher for wider row widths than for more narrow rows. The ground level readings and difference values generally responded in similar fashion.

Since it would be expected that PAR and leaf area measurements would be related, the applicable PAR measures were segregated out. Ground level readings were 5.47, 5.65, 2.42, 2.60, and 1.11; and mid-canopy readings were 16.67, 16.84, 9.44, 8.58, and 7.24 for the

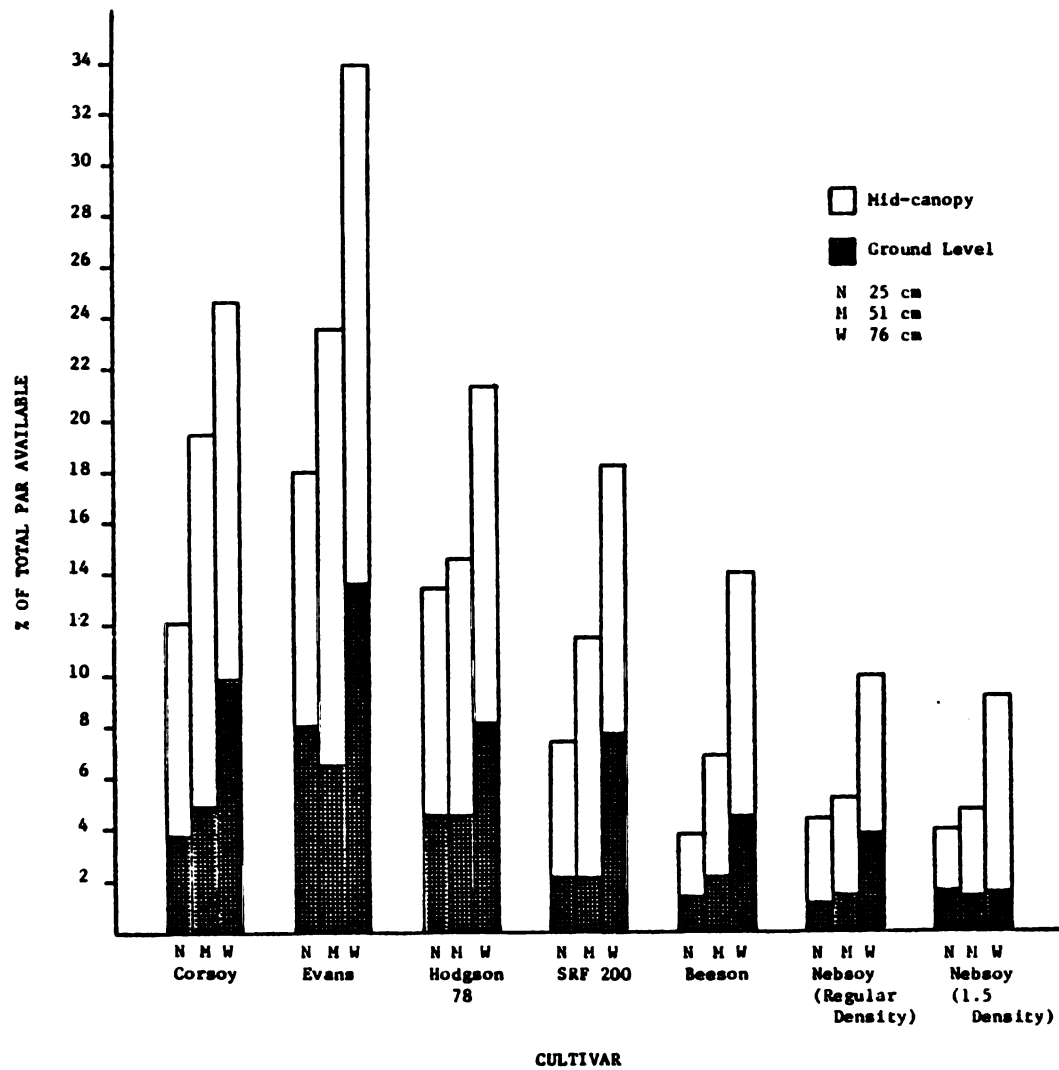


Figure 6. Ground level and mid-canopy penetration of photosynthetically active radiation (PAR) as influenced by cultivar and row width, averaged over planting date at the 1979 Chesaning location.

first date plots of 'Corsoy,' 'Hodgson 78,' 'SRF 200,' 'Beeson,' and 'Nebsoy' (Regular Density), respectively. Also, ground level readings were 12.78 and 3.73; and mid-canopy readings were 29.64 and 11.09 for second date plots of 'Evans' and 'SRF 200,' respectively. The second date PAR readings correlated significantly with LAI measurements at a level of 0.60 for ground level readings and of 0.66 for mid-canopy readings. However, similar correlations for the first date readings with many more degrees of freedom evidenced no significance. This lack of correlation was evidently due to the fact that PAR readings for the first date plots were recorded 15 days before leaf area measures were recorded, while for the second date plots both readings were recorded at the same time. As noted before, 'SRF 200,' plants in the first planting date had evidently experienced significant leaf abscission by the time leaf area readings were recorded. Also 'Hodgson 78' PAR readings indicated that the unusually large leaf area values may have resulted from full expression of this cultivar's branching character by the border plants sampled, while PAR readings were within the canopy. The PAR readings of the 'Nebsoy' cultivar appeared to respond in a manner somewhat unique from the other cultivars. It appeared that most of the PAR was intercepted by the initial thick layer of leaves at the very top level of the canopy, and that only a small amount of leaf area existed below this level. Visual inspection reinforced this observation. 'Beeson' also appeared to respond somewhat similarly, although to a lesser degree.

By deleting the 'SRF' cultivar from the above first date correlation, the resulting correlations more nearly approached

significant levels, even though degrees of freedom were decreased. When 'Hodgson 78' readings were also deleted, the mid-canopy readings correlated with LAI readings at a significant level, with a correlation of 0.56. This was true even though degrees of freedom were reduced. However, correlations using ground level readings were not significant. When the 'Nebsoy' cultivar readings were also deleted, leaving only the 'Corsoy' and 'Beeson' cultivars, the same correlation using mid-canopy readings jumped to 0.71 and was even more significant, even though degrees of freedom were reduced to very low levels. Again, correlations with ground level readings were not significant.

The above responses seem to indicate, in conjunction with significant second date correlations, that the time period between readings plus the use of border row plants and divergent cultivars were the primary factors for the lack of overall significant correlations between PAR readings and LAI readings for the first date plots sampled. There is reason to believe that the correlation between these two factors under more favorable circumstances would have been fairly high. It should also be noted that there were no significant correlations between the PAR readings and overall yield.

6. Mature Plant Height

a. 1978

Mature plants at the dry Carleton location averaged about three-fourths the height of plants at Chesaning. Apparently, the different climatic conditions in conjunction with the different measuring techniques at each location were responsible for the fact that there was only one significant response, that of cultivar, common to both locations. The cultivar response at Chesaning was 87.7, 69.9, 77.6, and 85.1 cm while at Carleton it was 62.0, 53.5, 58.3 and 65.8 cm for 'Corsoy,' 'Evans,' 'Hodgson,' and 'SRF 200,' respectively. As would be expected, the shorter season cultivars had shortened plants. The reversed response of 'Corsoy' and 'SRF 200' may have been due to more resistance to drought effects upon vegetative growth in the 'SRF 200' cultivar. It also may have been due to stem elongation in the 'Corsoy' cultivar subsequent to fairly heavy lodging which characterized this cultivar at the Chesaning location. In the significantly different combined cultivar responses, 'SRF 200' was slightly taller than 'Corsoy.' The location x cultivar interaction was significant.

Planting date means were significantly different at the Carleton location, but the Chesaning means were not. The longer planting date intervals plus drought effects at Carleton probably accounted for this significant planting date x location interaction. The Carleton means for the first, second and third planting dates were 76.6, 58.3 and 44.8 cm, respectively. The significantly different planting date means were 79.6, 71.1, and 59.3 cm for the first, second and third dates for the combined locations, respectively. The late

planting dates responded with much shorter plants at the Carleton location which was probably also due to later season drought. Normal mechanical harvesting of these plants would have been very difficult.

The planting date x cultivar interaction was also significant at the Carleton location, but at Chesaning this interaction was not quite significant at the 5% level. Means for both interactions are recorded on Figures 1 and 2. One observation of special interest at Chesaning was the fact that second date plants of 'Evans' and 'Hodgson' were actually taller than those of the first planting date. This response again reinforced earlier observations that these cultivars appeared to respond more slowly vegetatively with the colder first planting. According to the final yield figures, first date 'Evans' plants never fully recovered from this apparent slow initial growth while 'Hodgson' did to some extent, perhaps due to its superior branching ability. The combined planting date x cultivar interaction was also significant.

Means for height as influenced by plant density were significantly different at Chesaning but not at Carleton. Drought effects and uneven emergence may have masked differences here. Plant heights at Chesaning averaged 81.8 cm at low density and 78.4 cm at high density. This response was somewhat surprising since it would have been expected that the more closely clustered, high density plants would have been taller. Perhaps lack of soil moisture was an overriding factor here, especially for final vegetative growth later in the season. The plant density means for the combined locations were also significantly different with values of 70.8 and 69.2 cm for the low and high densities, respectively. The location x plant

density interaction was also significant.

The three-way planting date x row width x plant density interaction at Chesaning was significant, and is portrayed in Figure 7. Only in the instance of the third date, 76 cm row widths was the high density mean greater than that of the low density. Row width within planting date and density responses showed a general trend of shorter plants at wider row widths with three noticeable exceptions. The second date, low density plants were much taller in the 76 cm width over the other two row widths. Also, the 76 cm width plants were slightly taller than those of the 51 cm widths at dates two and three of the high density treatment. Planting date within row width and plant density response consistently indicated shorter plants at later dates with one major exception. At both plant densities, the first date, 76 cm width plants were shorter than those of the second date. This closely corresponds with the yield response observed both years at three locations and suggests some vegetative growth disadvantage for early plantings at this width.

The combined planting date x row width and location x planting date x row width x cultivar interactions were also significant. However, due to the lack of significant interactions at either location and also, due to the widely varying planting dates, the meaningfulness of these interactions was probably negligible.

Mature plant height had a correlation of 0.56 at Chesaning and 0.60 at Carleton with overall yield. It was also interesting to note that the correlation with overall yield was greater than that with the yields of the sample from which the height readings were taken at Chesaning, which was 0.45. At Chesaning the number

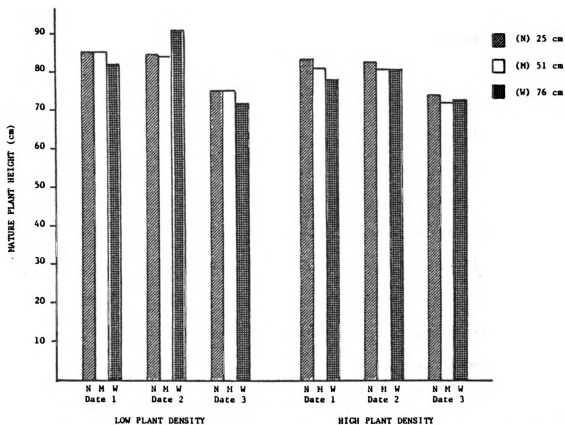


Figure 7. The influence of plant density, planting date and cultivar upon mature plant height (cm) at the 1978 Chesaning location, averaged over cultivar.

of mainstem nodes had a correlation with plant height of 0.74.

b. 1979

Plant heights in 1979 at the Chesaning location were 9.2% greater than those at the same location in 1978. This difference may have been due in part to the different measuring techniques. Dundee plant heights were 17.4% higher than those at Chesaning due to greater rainfall and the vining effects from heavy lodging at Dundee.

The responses of the two locations were much more similar than in 1978. At both locations and with the combined locations the planting date and cultivar means varied significantly, and the planting date x cultivar interactions were also significant.

Plant heights were 108.5, 111.5 and 88.3 cm at Dundee; 93.3, 89.5 and 79.8 cm at Chesaning; and combined averages were 101.3, 101.1 and 84.4 cm for the first, second, and third dates, respectively. Second date plants were taller than those of the first date at Dundee while the reverse was true at Chesaning. However, the order of yield responses to planting date was just the opposite at the two dates. The planting date x location interaction was significant.

Cultivar responses are shown in Figure 8. 'SRF 200' plants were always tallest with 'Corsoy' and 'Beeson' next in plant height. Of interest is the fact that 'Evans' plant height was greater than that of 'Hodgson 78,' and 'SRF 250' appeared to be the shortest cultivar at Dundee. At both locations, the higher density 'Nebsoy' plants were taller than those at regular density,

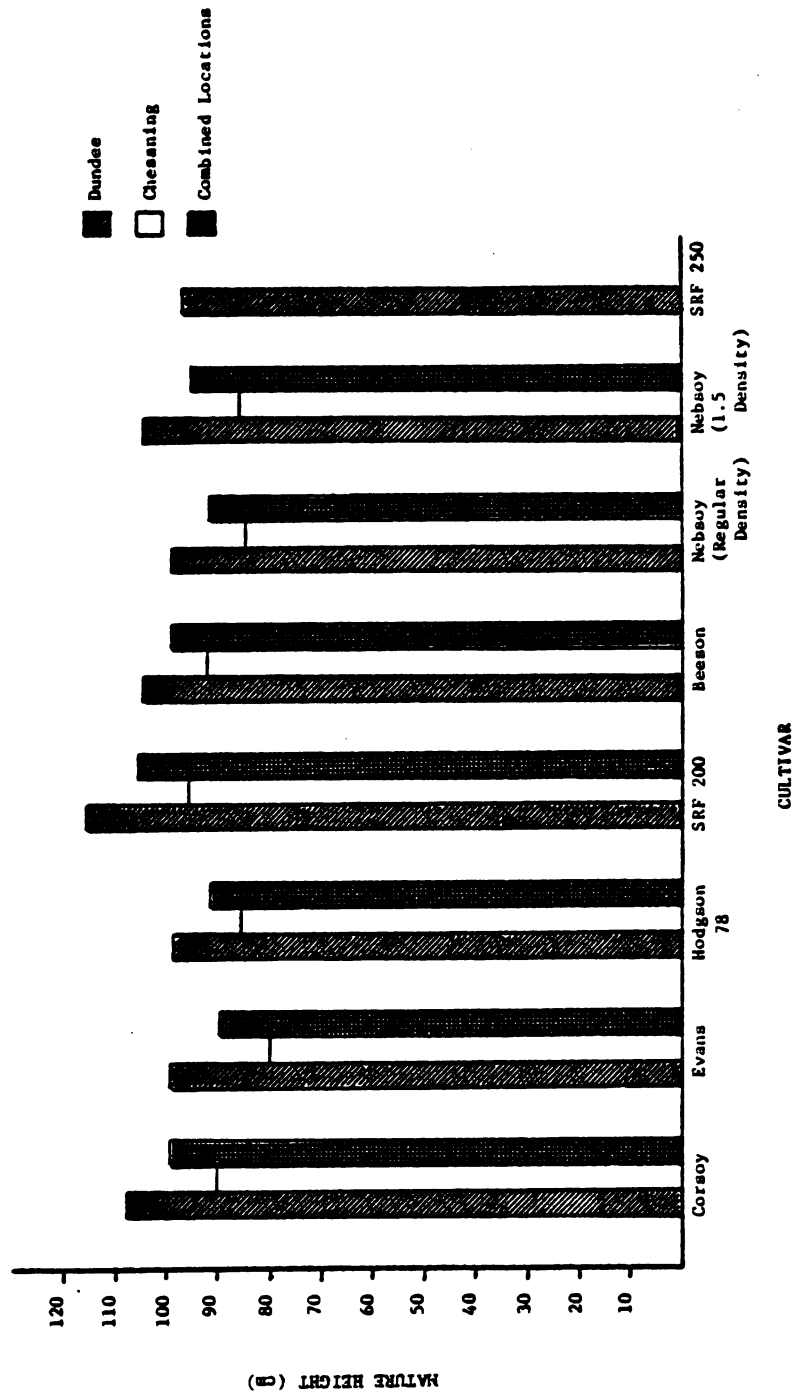
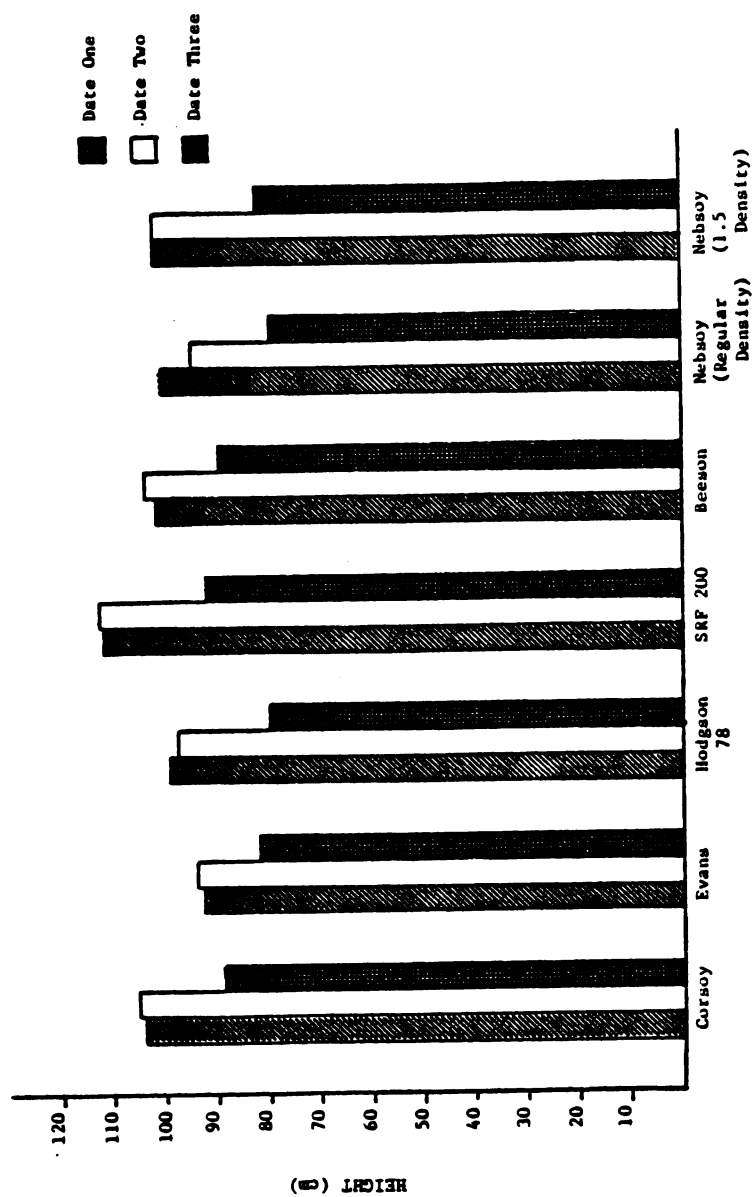


Figure 8. Influence of cultivar upon mature plant height (cm) at the 1979 Dundee, Chesaning and combined locations, averaged over row width and planting date.

but the difference was much greater at Dundee. The fact that the higher density was taller at both locations may have been due in part to the postulated drought resistance of 'Nebsoy,' and the greater difference at Dundee would probably be the expected response where rainfall was adequate. The cultivar x location interaction was significant.

The planting date x cultivar interactions for the two locations were presented in Figures 3 and 4, while the same interaction for the combined locations is presented in Figure 9. At Chesaning, a consistent trend of decreasing height with later planting dates was observed for all cultivars. At Dundee, second date plant heights were greater than those for the first date for all cultivars but 'Nebsoy' (Regular). 'SRF 200' was the tallest cultivar at both locations except for the third date in Chesaning where 'Beeson' was taller. 'Evans' was always shorter than 'Hodgson 78' at Chesaning, but at Dundee, there was a trend from 'Evans' being shorter than 'Hodgson 78' at date one to 'Evans' being 8.4% taller at date three. The higher 'Nebsoy' density plants were almost always taller than those at regular density at Chesaning. The high density plants of 'Nebsoy' were unusually taller than the regular density plants for the second date at Dundee. Both 'Nebsoy' and 'SRF 200' tended to be fairly short in comparison to the other Group II cultivars.

The location x row width interaction was also significant, even though row width means at the individual locations were not significantly different. At Chesaning, there was a consistent trend toward greater plant heights at wider row widths, while at Dundee, the same trend was observed between plants of the 51 and 76 cm



CULTIVAR

Figure 9. Mature plant height (cm) in 1979 as influenced by planting date and cultivar, averaged over location and row width.

row widths, but those of the 25 cm widths were taller than those at the other two widths.

At Chesaning, mature plant height had the following correlations: 0.64 for emergence to flowering period, 0.51 for flowering to maturity period, 0.71 for total growing season length, and 0.51 for lodging but only 0.34 for yield. At Dundee, plant height correlations were 0.47 for emergence to flowering period, 0.60 for flowering to maturity period, 0.61 for total growing season length, and 0.47 for yield. Similar correlations for the combined locations were as follows: only 0.19 for the emergence to flowering period, 0.68 for the flowering to maturity period, 0.61 for the total growing season length, 0.70 for lodging, and 0.66 for yield.

7. Plant Lodging

a. 1978

Little lodging occurred at the Carleton location in 1978, probably due to drought-shortened plants. However, the significantly different treatment responses and significant interactions were nearly the same at both locations. At both locations and in the combined analysis, treatment means for planting date, row width and cultivar were significantly different. Also significant were the planting date x row width, planting date x cultivar, and row width x cultivar interactions. In addition to the above, the planting date x row width x cultivar interaction was significant at Carleton (Table 24). At Chesaning and with the combined analysis, plant density means were significantly different, and the cultivar x plant density interactions were significant. Main treatment means are presented in Table 25. With the analysis for the combined locations, the row width x plant density interaction was also barely significant along with numerous location interactions.

At both locations, the second date plants lodged more extensively than those of the first as well as of the third date. A consistent row width trend occurred at both locations with the wider widths having more lodging. However, the difference between 51 and 76 cm widths was much larger than that between 25 and 51 cm row widths. At both locations, high plant densities lodged more extensively than low densities, as would be expected. The taller, later maturing cultivars, 'Corsoy' and 'SRF 200,' lodged more than did the early maturing 'Evans' and 'Hodgson.' 'Hodgson' lodged more than did 'Evans' at both locations. At Carleton, 'SRF 200' lodged slightly more than did 'Corsoy'

Table 24. Plant lodging as influenced by planting date, row width (25, 51 and 76 cm) and cultivar at the 1978 Carleton location, averaged over plant density (1 = all plants upright, 5 = all plants prostrate).

<u>Cultivar</u>	<u>Planting Date</u>								
	<u>5/25</u>			<u>6/15</u>			<u>7/7</u>		
	<u>25</u>	<u>51</u>	<u>76</u>	<u>25</u>	<u>51</u>	<u>76</u>	<u>25</u>	<u>51</u>	<u>76</u>
Corsoy	1.02	1.08	1.05	1.06	1.06	1.59	1.02	1.11	1.12
Evans	1.00	1.00	1.00	1.00	1.00	1.08	1.00	1.08	1.03
Hodgson	1.02	1.02	1.03	1.00	1.00	1.18	1.00	1.02	1.05
SRF 200	1.11	1.16	1.13	1.08	1.03	1.68	1.07	1.13	1.07

Table 25. Plant lodging as influenced by planting date, row width, plant density, and cultivar at all the 1978 and 1979 locations, averaged over all other factors (1 = all plants upright, 5 = all plants prostrate).

Treatments	1978			1979		
	Carleton	Chesaning	$\bar{X}$	Dundee	Chesaning	$\bar{X}$
<u>Planting Date</u>						
1st	1.05	1.62	1.33	4.59	2.14	3.37
2nd	1.15	1.70	1.42	4.67	1.62	3.16
3rd	1.06	1.26	1.16	4.00	1.38	2.77
LSD _{0.05}	0.07	0.13	0.06	0.18	0.14	0.12
<u>Row Width (cm)</u>						
25	1.03	1.32	1.18	4.54	2.01	3.29
51	1.06	1.40	1.23	4.32	1.36	2.88
76	1.17	1.85	1.51	4.41	1.77	3.12
LSD _{0.05}	0.03	0.14	0.07	0.18	0.14	0.12
<u>Plant Density</u>						
Low	1.08	1.38	1.23	-----	-----	-----
High	1.09	1.68	1.38	-----	-----	-----
LSD _{0.05}	n.s.	0.09	0.04	-----	-----	-----
<u>Cultivar</u>						
Corsoy	1.12	2.13	1.63	4.61	1.98	3.30
Evans	1.02	1.19	1.11	4.46	1.55	3.00
Hodgson (78)	1.04	1.21	1.12	4.21	1.73	2.97
SRF 200	1.16	1.57	1.37	4.77	1.82	3.30
Reeson	-----	-----	-----	4.60	1.59	3.09
Nebaoy	-----	-----	-----	4.15	1.46	2.80
(Regular Density)						
Nebaoy	-----	-----	-----	4.60	1.85	3.23
(1.5 Density)						
SRF 250	-----	-----	-----	3.96	-----	-----
LSD _{0.05}	0.04	0.12	0.06	0.17	0.16	0.14

while the reverse was true at Chesaning. These cultivar lodging responses closely paralleled those of plant height. All location interactions with the main treatments were significant.

Because Carleton lodging means were so low, little reference will be made to them in the narrative and the results may be observed in the applicable tables and figures. The significant row width x planting date interaction at Chesaning, portrayed in Figure 10, showed a trend of more lodging at wider row widths within each planting date. Lodging of the 25 and 51 cm row widths showed steady decreases with later planting dates, while lodging of the 76 cm row widths went up dramatically from first to second dates, and then down even further to a third date level below that of the first. The Carleton interaction also revealed this sharp second date increase for 76 cm widths.

At Chesaning the significant cultivar x row width interaction revealed a consistent rise in lodging at wider row widths for each cultivar (Figure 11). At each row width, 'Corsoy' lodged the most, followed by 'SRF 200,' then 'Hodgson' and 'Evans.' The 76 cm widths of 'Evans' lodged slightly more than the corresponding width of 'Hodgson.' Figure 12 indicates the significant planting date x cultivar interactions. The early maturing cultivars lodged most at date two, followed by dates one and three in that order. This response corresponded with plant height for these cultivars. However, the Group II cultivars responded with decreased lodging at later dates, as would more normally be expected. The order of cultivars within dates generally remained the same as above, except that the second date 'Evans' plants lodged more than did the second

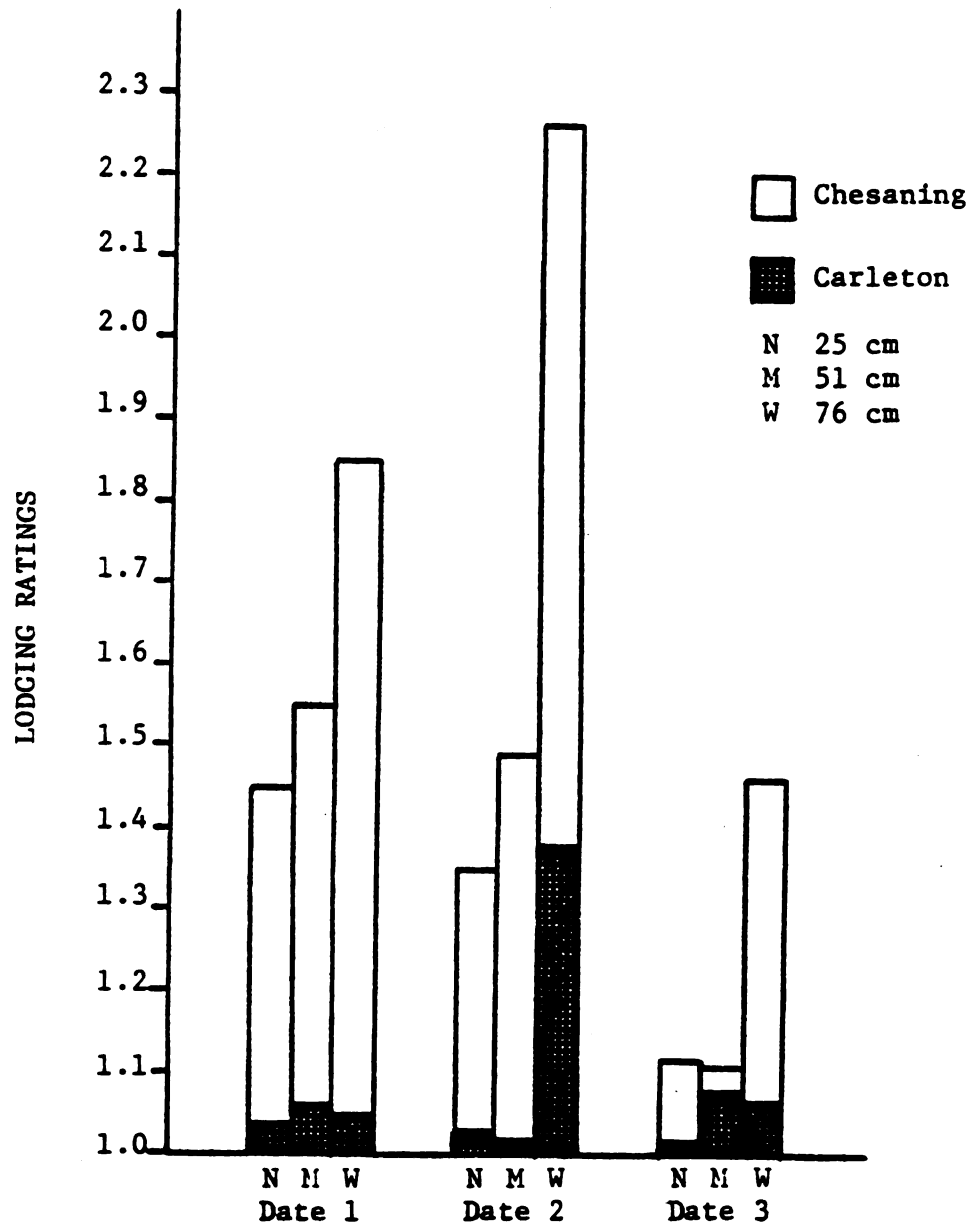


Figure 10. Plant lodging as influenced by row width and planting date at both 1978 locations, averaged over cultivar and plant density (1 = all plants upright, 5 = all plants prostrate).

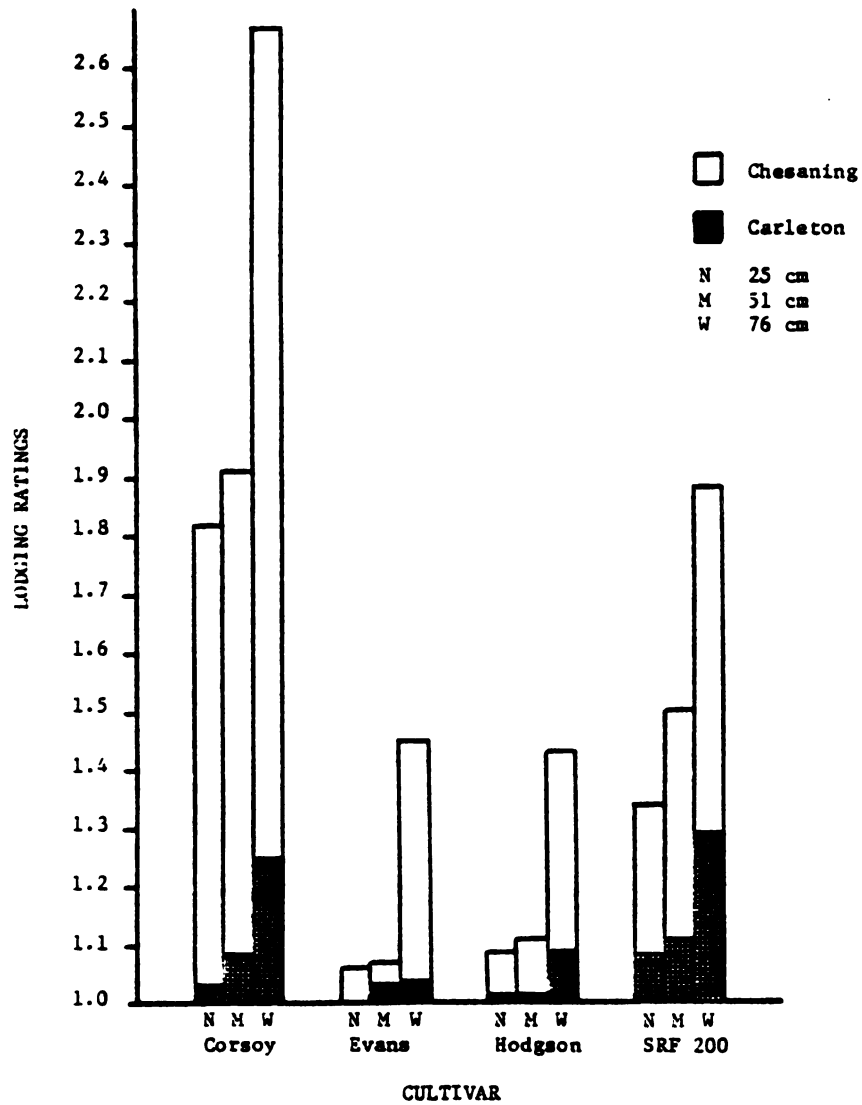


Figure 11. Influence of row width and cultivar upon plant lodging at both 1978 locations, averaged over plant density and planting date (1 = plants upright, 5 = all plants prostrate).

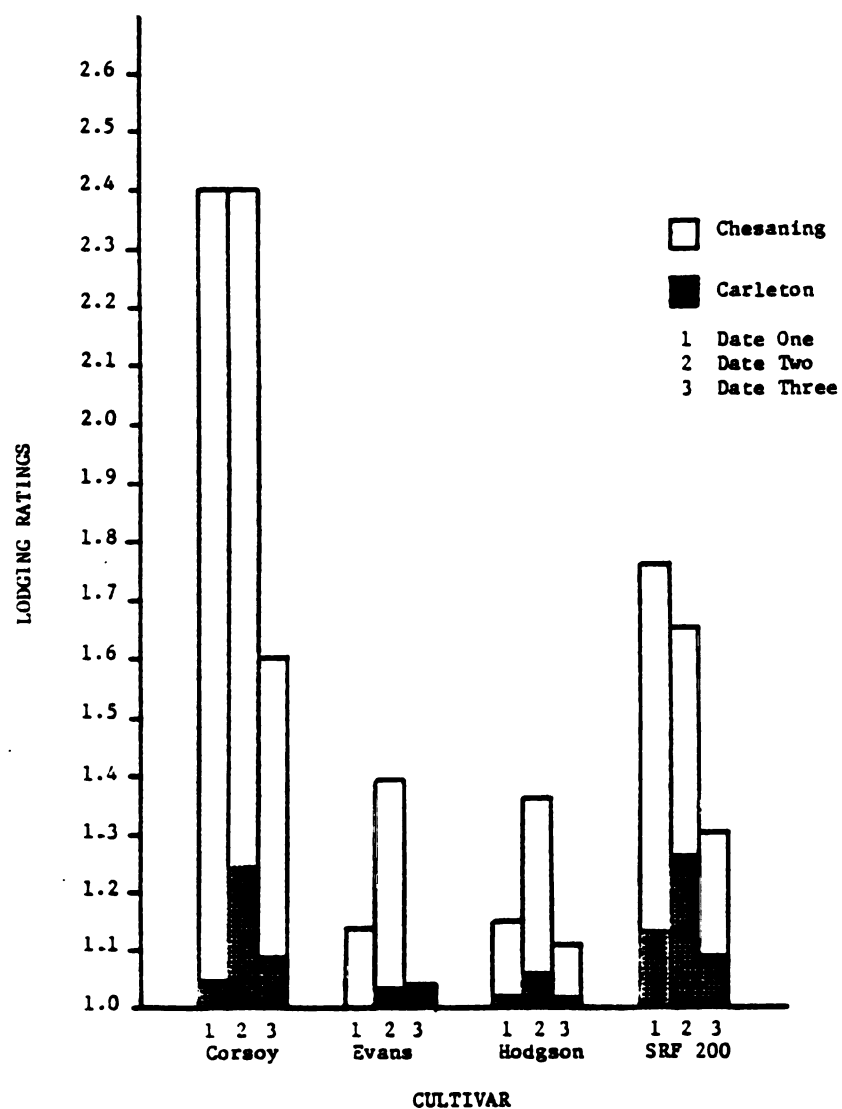


Figure 12. Plant lodging as influenced by planting date and cultivar at both 1978 locations, averaged over row width and plant density (1 = all plants upright, 5 = all plants prostrate).

date 'Hodgson' plants. The significant plant density x cultivar interaction at the Chesaning location is portrayed in Figure 13. All cultivars lodged more at the high than the low density. Within each density 'Corsoy' always lodged more than 'SRF 200' and 'SRF 200' always lodged more than the other two cultivars. However, 'Evans' lodged less than 'Hodgson' at low density and slightly more than 'Hodgson' at high density. This reversed response was somewhat reflected in the plant height response.

Lodging had a correlation of 0.51 with plant height at Chesaning but no significant correlation existed with yield. No correlations with lodging were above 0.50 at Carleton or with the combined location means.

b. 1979

Almost complete lodging occurred at Dundee in 1979 in comparison to almost none at Carleton in 1978. The significantly different treatment responses and significant interactions were nearly the same at both locations, even though lodging levels were quite different. Planting date, row width and cultivar means were all significantly different at both locations and for the combined locations. The planting date x row width, planting date x cultivar, and planting date x row width x cultivar interactions were also significant for the above analyses. The location interactions with all the above treatments and interactions were also significant in the combined location analysis. At Dundee, the row width x cultivar interaction was significant.

Main treatment means are presented in Table 25. Lodging responses to planting date closely reflected plant heights at the

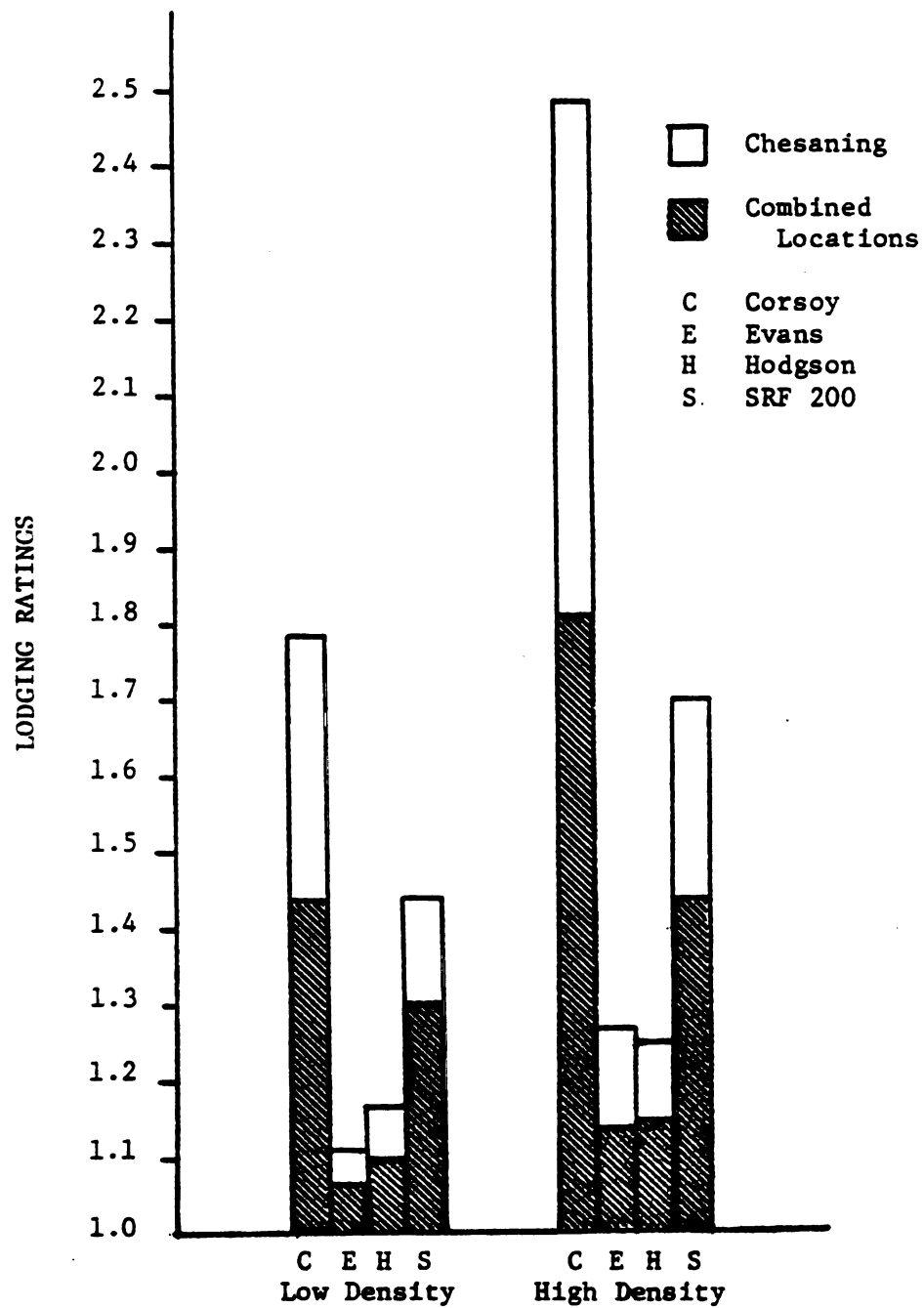


Figure 13. Influence of cultivar and plant density upon plant lodging at the 1978 Chesaning and combined locations, averaged over row width and planting date (1 = all plants upright, 5 = all plants prostrate).

respective locations. At Dundee, the second date lodged more than did the first or third as in 1978. However, at Chesaning, the first date lodged more than the other two. At both locations, the 51 cm row widths lodged less than the 76 cm widths, as in 1978. However, the 25 cm widths lodged more than the 76 cm widths, probably due to the high plant density at the 25 cm width. This response may aid in explaining the reduced 25 cm row width yields in comparison to those of 51 cm widths in 1979. As in 1978, 'Corsoy' lodged slightly more than 'SRF 200' at Chesaning while the reverse was true at the southern location. 'Evans' lodged more than 'Hodgson 78' at Dundee which correlated with its higher plant height there. 'SRF 250' lodged least at Dundee followed by 'Nebsoy' (Regular Density). 'Nebsoy' (Regular Density) lodged the least in Chesaning.

The significant row width x planting date interactions in Figure 14 reveals the following departures from the main treatment trends noted above. The 25 cm widths at Dundee responded consistently with decreased lodging at later planting dates. Also at Dundee, the 25 cm widths lodged more than the other two only at the first planting date, where 76 cm widths also lodged less than did 51 cm widths. At Chesaning, 25 cm widths lodged less than 76 cm widths at the third date.

The significant planting date x cultivar interactions are presented in Figure 15. At Dundee, there was a fairly consistent trend of reduced lodging at later planting dates except for the 'Evans,' 'Hodgson 78' and 'Nebsoy' (1.5 Density) cultivars where the second date plants lodged the most.

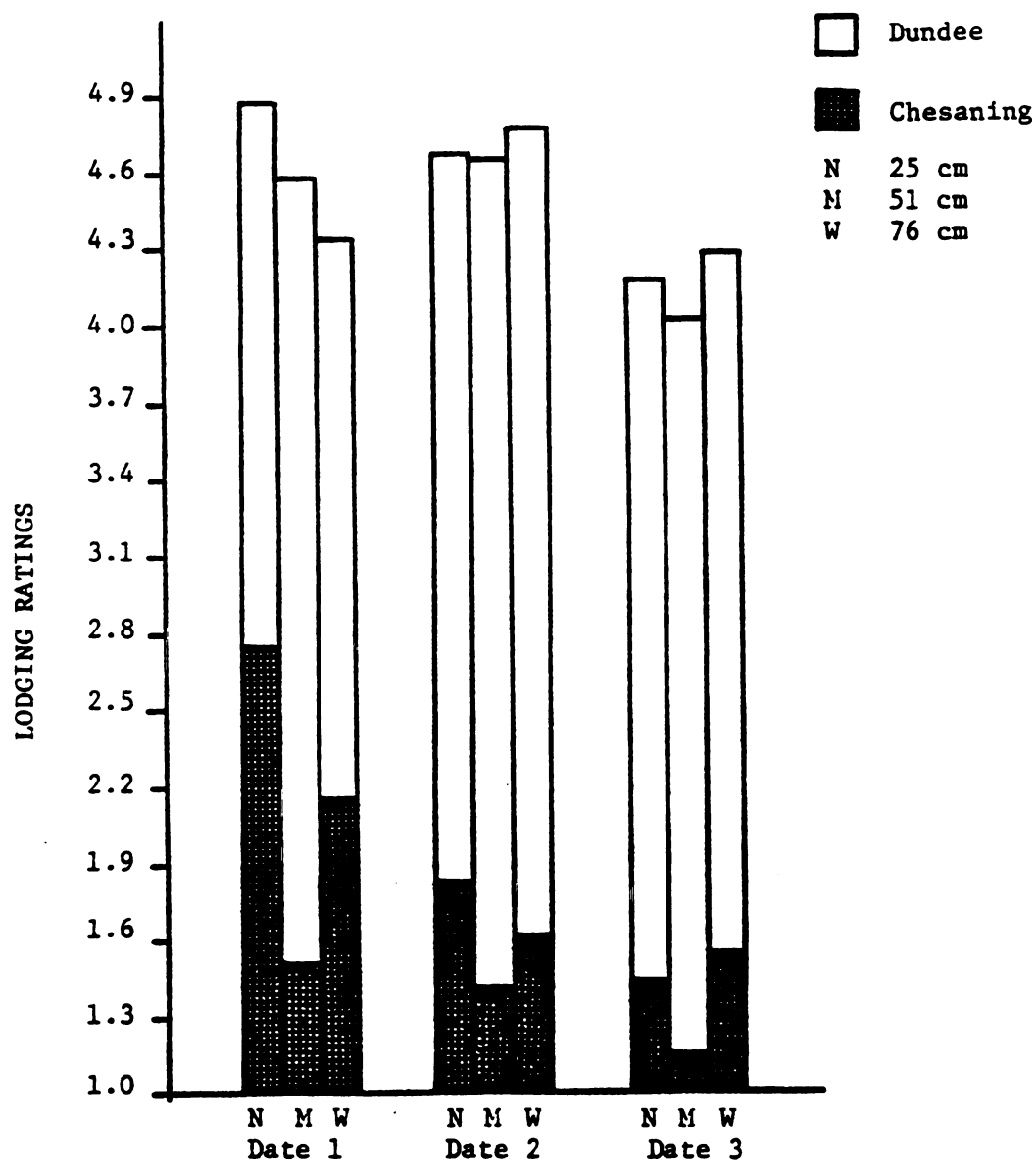


Figure 14. Plant lodging as influenced by row width and planting date at both 1979 locations, averaged over cultivar (1 = all plants upright, 5 = all plants prostrate).

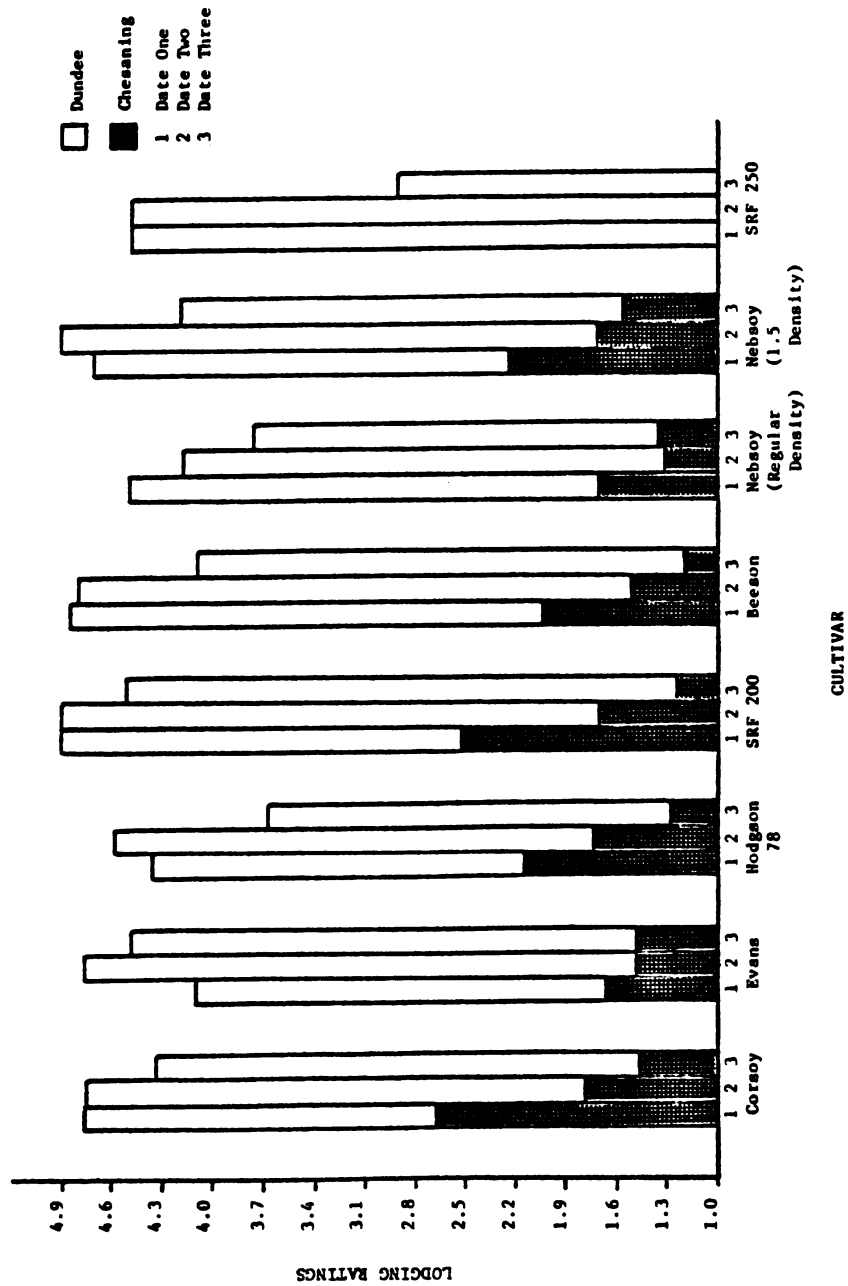


Figure 15. Influence of planting date and cultivar upon plant lodging at both 1979 locations, averaged over row width (1 = all plants upright, 5 = all plants prostrate).

Widely varying responses occurred in the significant row width x planting date x cultivar interactions at both locations (Table 26) and in the significant cultivar x row width interaction at Chesaning (Figure 16).

At Chesaning, lodging had a correlation of 0.51 with plant height, but no significant correlation with yield occurred. The same correlation with plant height at Dundee was 0.69 and again there was no significant correlation with yield. When locations were combined, lodging had the following notable correlations: 0.59 with the flowering to maturity period, 0.58 with 100 seed weight, and 0.70 with plant height.

In 1979, early lodging readings were also recorded for the first and second dates at the Dundee location on August 1. Date two had lodged significantly less than date one with ratings of 2.13 and 2.92, respectively, as would have been expected since readings were not taken at the same developmental stage for each date. Cultivar means were also significantly different. They were 3.52, 3.09, 2.85, 1.46, 1.87, 2.56, 3.79 and 1.06 for 'Corsoy,' 'Evans,' 'Hodgson 78,' 'SRF 200,' 'Beeson,' 'Nebsoy' (Regular Density), 'Nebsoy' (1.5 Density) and 'SRF 250,' respectively. For the same cultivars above in respective order, the differences between early and final lodging ratings were 1.23, 1.34, 1.62, 3.44, 2.96, 1.78, 1.03 and 3.44 and the percentages of final ratings represented by early lodging ratings were 73.9, 69.6, 63.8, 29.8, 38.6, 59.1, 78.8 and 23.6. 'Corsoy,' the two 'Nebsoy' densities, and the early maturing cultivars had the highest early lodging ratings. They also experienced the

Table 26. Influence of planting date, row width (25, 51 and 76 cm), and cultivar upon plant lodging at both 1979 locations (1 = all plants upright, 5 = all plants prostrate).

Location	Cultivar	Planting Date								
		1st			2nd			3rd		
		Row Width (cm)								
Chesaning	Corsoy	25	51	76	25	51	76	25	51	76
	Evans	3.80	1.71	2.51	1.80	1.76	1.80	1.53	1.18	1.71
	Hodgson 78	1.89	1.09	2.02	1.62	1.31	1.58	1.67	1.22	1.58
	SRF 200	3.13	1.49	1.84	2.07	1.49	1.67	1.44	1.09	1.31
	Beeson	2.24	2.02	3.27	2.24	1.27	1.62	1.27	1.09	1.40
	Nebsoy	2.69	1.44	1.98	1.62	1.36	1.62	1.31	1.09	1.22
	(Regular Density)	2.42	1.27	1.44	1.36	1.22	1.36	1.22	1.09	1.76
	Nebsoy (1.5 Density)	3.09	1.62	2.02	2.16	1.40	1.62	1.58	1.31	1.84
Dundee	Corsoy	5.00	4.82	4.47	4.78	4.60	4.87	4.29	4.24	4.47
	Evans	4.56	4.11	3.67	4.78	4.69	4.82	4.33	4.64	4.51
	Hodgson 78	4.78	4.24	4.07	4.38	4.64	4.73	3.40	3.44	4.20
	SRF 200	4.91	4.91	4.87	4.91	4.87	4.91	4.24	4.64	4.69
	Beeson	4.96	4.87	4.78	4.82	4.78	4.82	4.24	3.71	4.38
	Nebsoy	4.96	4.56	3.98	4.16	4.16	4.20	3.80	3.53	3.98
	(Regular Density)									
	Nebsoy (1.5 Density)	5.00	4.60	4.56	4.91	4.82	5.00	4.87	3.93	3.76
	SRF 250	4.60	4.51	4.38	4.60	4.38	4.51	3.67	1.89	3.13

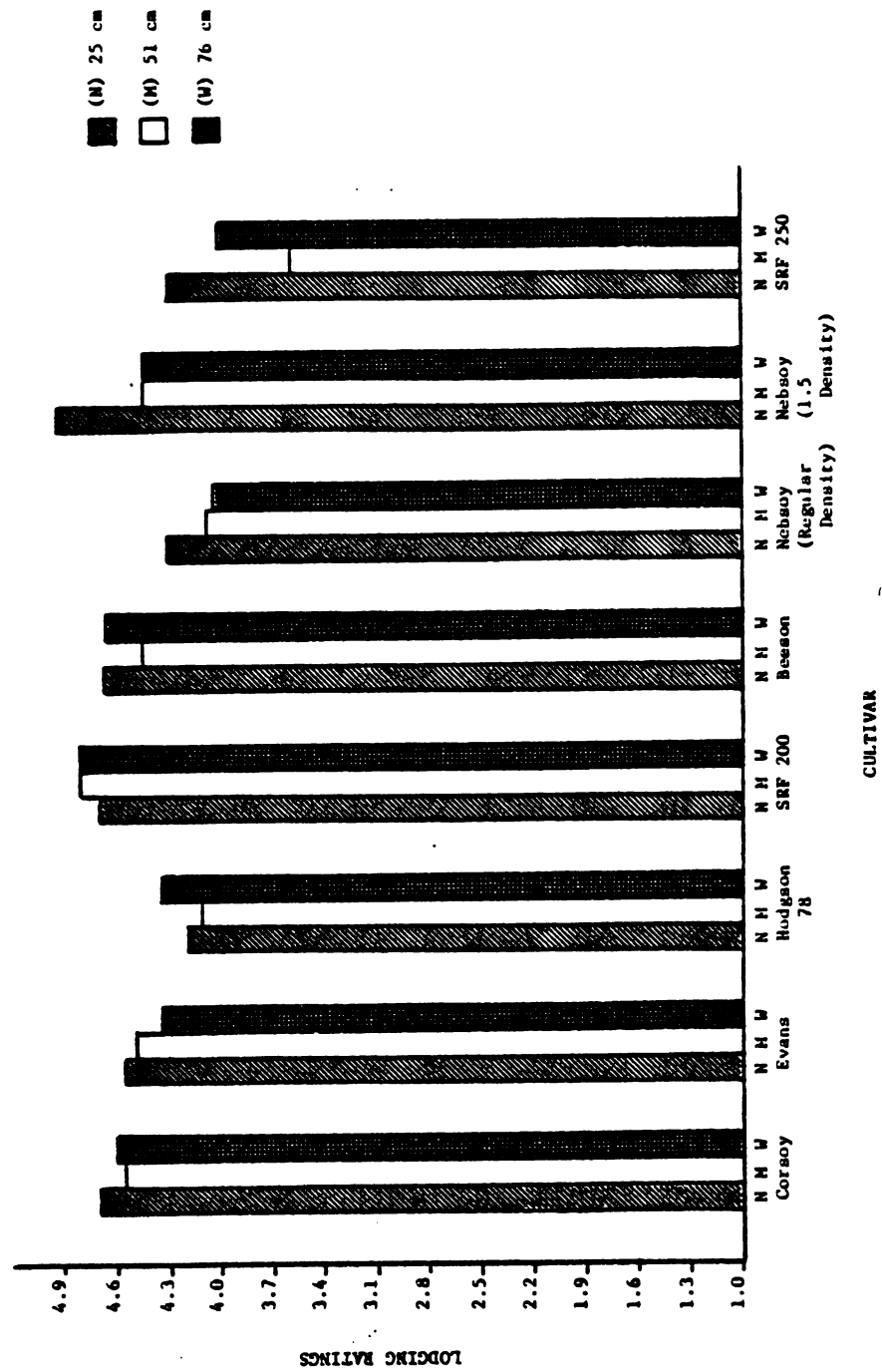


Figure 16. Plant lodging as influenced by cultivar and row width at the 1979 Dundee location, averaged over planting date (1 = all plants upright, 5 = all plants prostrate).

highest percentages of the final lodging at this time. The higher 'Nebsoy' density had much more early lodging than did the regular density, and the two 'SRF' cultivars evidenced noticeably low amounts of early lodging.

The significant planting date by cultivar interactions for both early and final lodging at Dundee are presented in Figure 17.

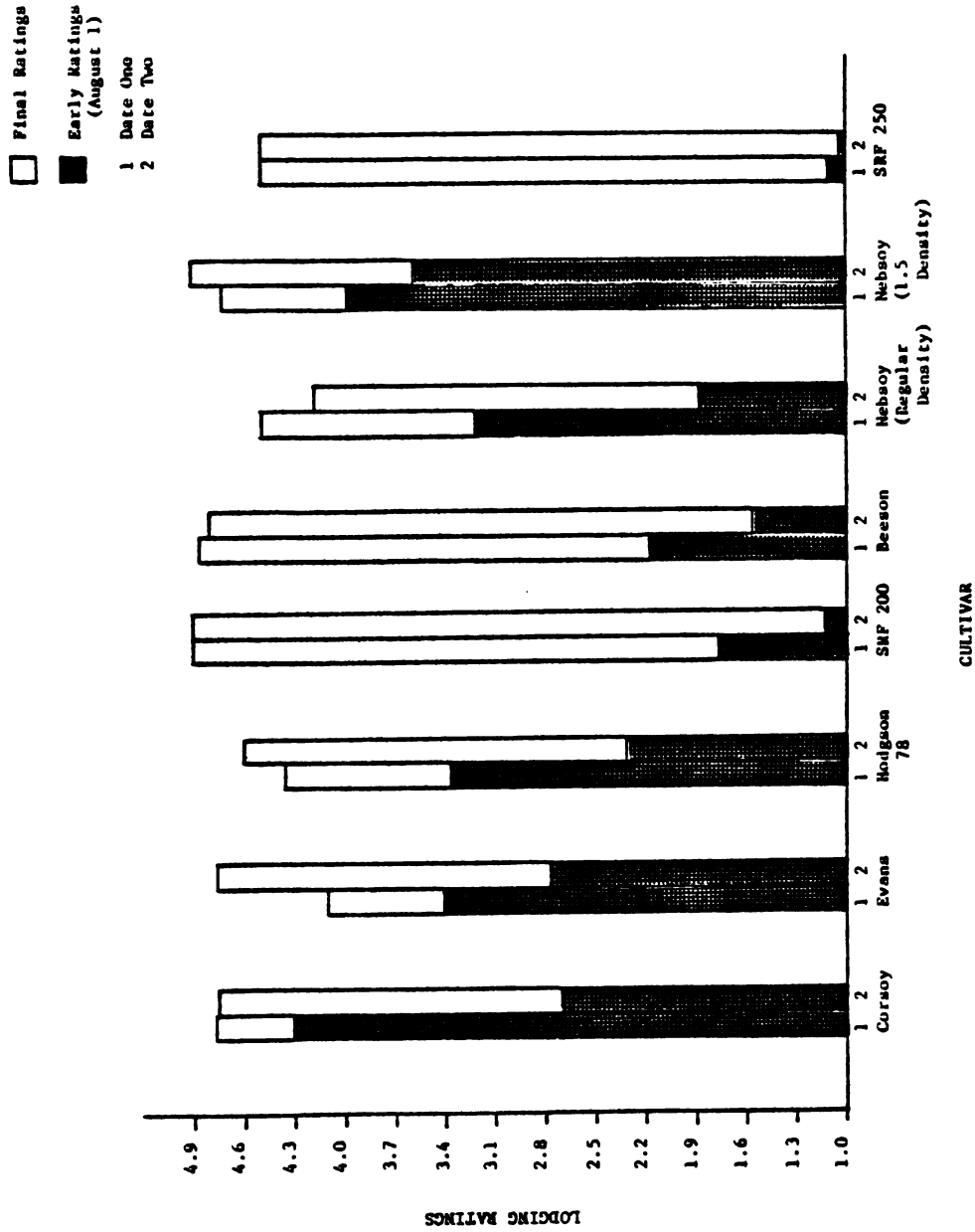


Figure 17. Influence of planting date and cultivar upon early and final plant lodging at the 1979 Dundee location, averaged over row width (1 - all plants upright, 5 - all plants prostrate).

8. Internode length

By combining mainstem nodes and plant height, it was possible to calculate and analyze mainstem internode lengths. In 1978 planting date means were not significantly different but those for row width, plant density and cultivar were. The row width response was 5.31, 5.64 and 5.91 cm for 25, 51 and 76 cm widths, respectively. This response seems to indicate that plants in closer proximity to one another as in 76 over 25 cm widths, tend to have greater stem elongation between nodes. This is further supported by the plant density response where the low and high densities had internode lengths of 5.45 and 5.79 cm, respectively. Cultivar responses were 5.74, 5.43, 5.71, and 5.60 cm for 'Corsoy,' 'Evans,' 'Hodgson' and 'SRF 200,' respectively. Internode lengths for 'Hodgson' were quite high in comparison with the longer season 'Corsoy' and 'SRF 200.' The planting date x cultivar interaction was also significant in 1978.

In 1979, planting date, row width and cultivar responses were all significant. The planting date response was 5.92, 5.70 and 5.52 cm for the first, second and third dates, respectively. Row width responses for 25, 51 and 76 cm widths were 5.64, 5.63, and 5.86, respectively. Internode lengths for 25 cm widths were not less than those for 51 cm widths, probably because higher plant densities at the 25 cm widths offset the more equidistant plant spacings at that row width. Cultivar responses were 6.00, 5.76, 5.82, 5.60, 5.44, 5.32 and 6.04 cm for 'Corsoy,' 'Evans,' 'Hodgson 78,' 'SRF 200,' 'Beeson,' 'Nebsoy' (Regular Density) and 'Nebsoy' (1.5 Density), respectively. The effects of plant density were here apparent since

internodes for 'Nebsoy' (Regular Density) were shortest and for 'Nebsoy' (1.5 Density) were longest of the cultivar treatments. No interactions were significant in 1979 and no correlations were of interest either year.

C. Reproductive Development

All reproductive development measurements, except some 100 seed weights, were derived from the yield component samples obtained from the 1978 and 1979 Chesaning locations. As noted before, the sample yields did not correlate very highly with overall plot yields. Therefore, only significant main treatments results and a few significant interactions of interest will be discussed. In some cases, significantly different main treatment means will not be mentioned in the narrative, but may be determined from the applicable tables. All correlations listed were significant and above 0.50. A correlation listed one year and not the next for the same measurement may be assumed to have been below 0.50 the year for which it was not listed. Any further analyses may be derived by utilizing the raw data presented in Tables A5, A6 and A7. The main treatment, sample yield means are included in Table A2 for reference.

1. Pod Numbers

Pod numbers per plant, presented in Table 27, surprisingly were not significantly different for planting dates either year. This would seem to indicate that within the range of planting dates used, the plants tended to produce essentially the same number of total pods, and that yield differences for planting dates were due to other factors. Row width means for pods per plant were significantly different both years, but the trend was reversed in 1979 from that in 1978. Plant density responses for pods per plant in 1978 were also significantly different. This density response perhaps helps explain the reversed 1979 row width response, since plant densities were higher at the narrower widths. Significant cultivar

Table 27. Total pods per node, per plant and per land area (m^2) as influenced by planting date, row width, plant density and cultivar at the 1978 and 1979 Chesaning locations, averaged over all other factors.

<u>Treatments</u>	<u>Year</u>				
	<u>1978</u>		<u>1979</u>		
	<u>Per Node</u>	<u>Per Plant</u>	<u>Per m^2</u>	<u>Per Node</u>	<u>Per Plant</u>
<u>Planting Date</u>					
1st	1.13	21.13	831	1.12	22.48
2nd	1.30	22.75	893	1.24	23.50
3rd	1.38	22.35	882	1.25	22.76
LSD _{0.05}	0.10	n.s.	n.s.	0.06	n.s.
<u>Row Width (cm)</u>					
25	1.31	25.97	1018	1.11	19.48
51	1.27	21.36	841	1.23	24.40
76	1.23	18.91	747	1.27	24.86
LSD _{0.05}	0.05	2.04	78	0.06	1.85
<u>Plant Density</u>					
Low	1.31	25.48	883	---	---
High	1.23	18.68	854	---	---
LSD _{0.05}	0.04	1.35	n.s.	---	---
<u>Cultivar</u>					
Corsoy	1.35	25.63	1007	1.39	27.27
Evans	1.31	20.46	809	1.37	24.30
Hodgson (78)	1.32	23.48	920	1.33	27.14
SRP 200	1.10	18.74	739	1.03	21.88
Beeson	---	---	---	0.92	19.51
Nebsoy	---	---	---	1.28	23.78
(Regular Density)	---	---	---	---	---
Nebsoy	---	---	---	1.12	16.52
(1.5 Density)	---	---	---	---	---
LSD _{0.05}	0.06	1.91	74	0.08	2.25
					92

mean differences for pods per plant both years are also presented in Table 27. 'SRF 200' tended to have lower pod numbers, as also did 'Beeson' which perhaps was an indication of greater potential yield reductions with adverse pod filling conditions. In 1978, the row width x plant density interaction was also significant and responded with trends consistent with those of the main treatments.

Pod number per plant correlations in 1978 were 0.83 with total nodes per plant, 0.89 with yields per plant derived from the samples, 0.58 with mainstem nodes per plant, 0.80 with branch nodes per plant, and 0.75 with branch number per plant. In 1979 pod numbers per plant had correlations of 0.81 with yields per plant derived from the samples, 0.64 with total nodes per plant, 0.72 with branch nodes per plant and 0.63 with branch number per plant.

Table 27 also reveals that pods per plant node responded in a manner similar to that of pods per plant, except for some cultivar differences, evidently due to varying numbers of nodes characterizing individual cultivars. Planting date differences were significant and indicated more pods per node at later dates, evidently due to the fact that, although pod numbers varied little, node numbers decreased with later dates. The planting date x cultivar interaction was also significant in 1978. In 1979, pods per overall plant node had a correlation of 0.51 with total days in the growing season.

When pod numbers per plant were extended to pod number per land area (m^2) using the forced sample spacings, only row width and cultivar means were significantly different (Table 27). Plant density mean differences in 1978 were negated in this manner so that they were no longer significant. Of special interest is the fact

that the row width response of pods per land area was the opposite of that for pods per plant which reflected the different plant densities which were at each width. The rankings of cultivars varied only slightly from those for pods per plant.

Total plant pods were also separated into branch and mainstem pods. Table 28 presents treatment means for branch pods per plant node, per plant and per land area (m^2), and also for the percentages of total pods being pods on branches. Planting date differences were not significant for any of the above measurements except percentage of branch pods in 1979, when the percentage was lowest for the second date. Row width response again tended to be reversed in 1979 and 1978. Branch pods per land area were still less at the 25 cm row width in 1979 than at the other widths which would seem to indicate that the higher plant densities at this width had more influence upon branch pod numbers than upon total pod numbers. In 1978, the row width x plant density, planting date x cultivar and row width x cultivar interactions were significant for branch pods per plant and per land area (m^2), and also for percentage branch pods. The planting date x row width x plant density x cultivar interaction for percentage branch pods was also significant in 1978. In 1979, the planting date x row width x cultivar interaction was significant for all four of the branch pod measurements. In addition to the above, the planting date x cultivar and row width x cultivar interactions were significant for branch pods per branch node, and the planting date x cultivar interaction was significant for percentage branch pods.

Branch pods per plant had correlations of 0.75 with sample yields per plant, 0.86 with total nodes per plant, 0.95 with branch

Table 28. Branch pods per branch node, per plant and per land area (m^2), and branch pod percentage of total pods as influenced by planting date, row width, plant density and cultivar at the 1978 and 1979 Chesaning locations, averaged over all other factors.

Treatments	Year					
	1978			1979		
	Per Branch Node	Per Plant	Per m^2	% Branch Pods	Per Branch Node	Per Plant
<u>Planting Date</u>						
1st	0.93	3.99	152	15.4	0.64	3.18
2nd	0.88	2.85	106	10.2	0.63	2.41
3rd	1.10	2.98	112	11.5	0.66	3.07
LSD 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
<u>Row Width (cm)</u>						
25	0.95	4.91	183	15.2	0.42	1.46
51	0.91	2.78	105	11.6	0.69	3.39
76	1.06	2.14	82	10.4	0.82	3.80
LSD 0.05	n.s.	1.40	51	3.2	0.10	0.84
<u>Plant Density</u>						
Low	1.06	4.79	166	16.3	---	---
High	0.88	1.76	80	8.4	---	---
LSD 0.05	0.11	0.74	27	1.9	---	---
<u>Cultivar</u>						
Corsoy	1.17	4.26	160	14.4	1.01	4.78
Evans	1.02	2.91	110	12.7	0.84	3.66
Hodgson (78)	1.02	4.61	174	16.6	0.96	5.51
SRF 200	0.67	1.31	48	5.8	0.48	2.36
Beeson	---	---	---	---	0.39	1.83
Nebsoy	---	---	---	---	0.46	1.71
(Regular Density)	---	---	---	---	0.36	0.36
Nebsoy	---	---	---	---	---	---
(1.5 Density)	---	---	---	---	---	---
LSD 0.05	0.15	1.05	39	2.7	0.14	0.88
						31
						2.6

nodes per plant, and 0.90 with branch number per plant in 1978. In 1979 correlations were 0.62 with sample yields per plant, 0.65 with total nodes per plant, 0.85 with branch nodes per plant, 0.75 with branch number per plant, 0.57 with mid-canopy PAR readings, and 0.56 with the difference between mid-canopy and ground level PAR readings. There were no interesting correlations above 0.50 for branch pods per branch node in 1978, and those in 1979 were similar to those for branch pods per plant.

Table 29 presents the main treatment means for mainstem pods per mainstem node, per plant and per land area (m^2). All main treatment means were significantly different. Planting date responses for all three measurements were similar both years. The first date had the least mainstem pods for all measurements. The second date plants had more mainstem pods per plant and per land area (m^2) than did those of the third date, but the reverse was true for mainstem pods per mainstem node. This indicates that plants in the second date had more total nodes on mainstems. In 1979 the reversed row width response between mainstem pods per plant and mainstem pods per land area (m^2) indicated that the high density influences at 25 cm row widths were not as severe upon mainstem pod numbers as upon branch pod numbers where this reversal did not completely take place. In 1978, the planting date x cultivar interaction was significant for all three mainstem pod measurements.

Mainstem pods per plant had correlations of 0.78 with sample yields per plant, 0.59 with total nodes per plant, and 0.59 with mainstem nodes per plant in 1978. In 1978 the correlations were 0.79 with sample yields per plant and 0.52 with total nodes per plant.

Table 29. Influence of planting date, row width, plant density and cultivar upon mainstem pods per mainstem node, per plant and per land area (m²) at the 1978 and 1979 Chesaning locations, averaged over all other factors.

Treatments	Year				
	1978		1979		
	Per Mainstem Node	Per Plant	Per m ²	Per Mainstem Node	Per Plant
<u>Planting Date</u>					
1st	1.15	17.14	679	1.22	19.30
2nd	1.36	19.90	787	1.34	21.09
3rd	1.42	19.37	770	1.36	19.68
LSD 0.05	0.10	1.80	71	0.07	1.27
<u>Row Width (cm)</u>					
25	1.38	21.06	835	1.18	18.02
51	1.31	18.58	736	1.35	21.01
76	1.24	16.77	665	1.39	21.05
LSD 0.05	0.05	1.04	44	0.07	1.27
<u>Plant Density</u>					
Low	1.38	20.69	717	---	---
High	1.25	16.92	774	---	---
LSD 0.05	0.05	0.87	35	---	---
<u>Cultivar</u>					
Corsoy	1.38	21.37	846	1.49	22.49
Evans	1.35	17.55	699	1.48	20.64
Hodgson (78)	1.38	18.87	746	1.47	21.63
SRP 200	1.13	17.43	691	1.14	19.52
Beeson	---	---	---	1.05	17.67
Nebsoy	---	---	---	1.39	22.08
(Regular Density)	---	---	---	---	---
Nebsoy	---	---	---	1.14	16.15
(1.5 Density)	---	---	---	---	---
LSD 0.05	0.07	1.24	50	0.09	1.71
					75

2. Seed Numbers

Main treatment means for seeds per pod, per node, per plant and per land area (m^2) are presented in Table 30. Seed numbers were highest at the second date for the four measurements where significant. This response along with that for pod numbers may aid in explaining why yields were higher at the second date than at the first in 1979. The same reversed row width response occurred between 1978 and 1979 as occurred with pods. Of special interest is the fact that seeds per pod were much higher for 'SRF 200' than for the other cultivars which may have balanced the low pod numbers for this cultivar. Seeds per node in 1978 and seeds per plant and per land area (m^2) in 1979 were highest for 'SRF 200' also. The planting date x plant density interaction was significant for seeds per pod in 1978. Also in 1978, the planting date x cultivar interaction was significant for seeds per node, the planting date x row width x cultivar interaction was significant for seeds per land area (m^2), and the row width x plant density and planting date x row width x cultivar interactions were significant for seeds per plant.

The 1978 correlations with seeds per plant were 0.96 with sample yields per plant, 0.83 with total nodes per plant, 0.69 with mainstem nodes per plant, 0.74 with branch nodes per plant, 0.91 with total pods per plant, 0.83 with mainstem pods per plant, 0.72 with branch pods per plant, and 0.66 with number of branches per plant. In 1979 the correlations were 0.91 with sample yields per plant, 0.67 with total nodes per plant, 0.64 with branch nodes per plant, 0.84 with total pods per plant, 0.82 with mainstem pods per plant, 0.64 with branch pods per plant and 0.59 with branch numbers per plant.

Table 30. Number of seeds per pod, per node, per plant and per land area (m^2) as influenced by planting date, row width, plant density and cultivar at the 1978 and 1979 locations, averaged over all other factors.

Treatments	Year							
	1978				1979			
	Per Pod	Per Node	Per Plant	Per m ²	Per Pod	Per Node	Per Plant	Per m ²
Planting Date								
1st	2.12	2.38	44.21	1742	2.04	2.27	45.61	1726
2nd	2.16	2.78	48.62	1910	2.16	2.66	50.32	1950
3rd	2.03	2.77	44.65	1757	1.96	2.44	44.82	1712
LSD 0.05	n.s.	0.31	n.s.	n.s.	0.09	0.17	4.46	166
Row Width (cm)								
25	2.11	2.75	54.26	2128	2.02	2.23	39.38	1946
51	2.10	2.63	44.13	1738	2.09	2.55	50.78	1790
76	2.09	2.54	39.09	1543	2.05	2.58	50.59	1651
LSD 0.05	n.s.	0.10	4.04	155	n.s.	0.17	4.46	166
Plant Density								
Low	2.11	2.74	52.91	1834	----	----	----	----
High	2.10	2.55	38.75	1772	----	----	----	----
LSD 0.05	n.s.	0.10	2.89	n.s.	----	----	----	----
Cultivar								
Corsoy	1.89	2.56	48.65	1913	1.88	2.62	51.36	1867
Evans	2.04	2.67	41.66	1644	1.96	2.69	47.69	1744
Hodgson (78)	1.93	2.54	45.26	1772	1.97	2.60	52.98	1949
SRF 200	2.55	2.80	47.75	1884	2.49	2.58	54.88	1982
Beeson	-----	-----	-----	-----	2.02	1.86	39.55	1436
Nebsoy	-----	-----	-----	-----	2.02	2.59	48.45	1740
(Regular Density)								
Nebsoy	-----	-----	-----	-----	2.02	2.26	33.50	1850
(1.5 Density)								
LSD 0.05	0.05	0.14	4.08	157	0.14	0.21	5.35	217

3. Seed Weights

Weights of randomly selected 100 seed samples (g) were recorded for the 1978 Chesaning location, and for both 1979 locations. The 100 seed weights were 2.28 g lower at the 1979 Chesaning location than at the 1978 Chesaning location for the four cultivars grown both years. This general response would seem to indicate that conditions during podfill were more unfavorable in 1979 than in 1978. The main treatment means are listed in Table 31.

As would be expected, 100 seed weights decreased with later planting dates, but there was little difference between dates one and two. This response would seem to indicate that podfilling was not seriously restricted until the growing season was noticeably shortened. However, it may also be true that due to unfavorable early season conditions, the first date response was not as large as it might have been. Row width differences were significant only at Dundee in 1979. The 25 cm widths had slightly lighter seed than did the 51 cm widths, perhaps due to the higher plant density at the 25 cm row width. This explanation is reinforced by the fact that the 1978 Chesaning plant density response was one of heavier seed at lower densities. Although 'SRF 200' tended to have more seeds per pod, it also tended to have lighter seed than did 'Corsoy', 'Evans' or 'Hodgson(78)'. 'Beeson' tended to have quite heavy seed in comparison to the other cultivars which would tend to disprove the earlier premise that 'Beeson's' reduced yields were due to the late season dry period in 1979, although it is not possible to determine what the relative 100 seed weights would have been if the September dry period had not occurred in 1979. However, at the drier 1979 Chesaning location, 'Beeson' was 12.4%

Table 31. Weight of 100 seeds (g) as influenced by planting date, row width, plant density, and cultivar at the 1978 Chesaning location and at both 1979 locations, averaged over all other factors.

<u>Treatments</u>	<u>Year</u>		<u>$\bar{X}$</u>
	<u>1978</u>	<u>1979</u>	
	<u>Chesaning</u>	<u>Dundee</u>	
<u>Planting Date</u>			
1st	18.36	18.82	18.08
2nd	18.09	18.62	17.63
3rd	16.22	16.55	15.63
LSD 0.05	0.71	0.33	0.34
<u>Row Width (cm)</u>			
25	17.60	18.07	16.95
51	17.52	18.17	17.25
76	17.56	17.74	17.15
LSD 0.05	n.s.	0.33	n.s.
<u>Plant Density</u>			
Low	17.68	-----	-----
High	17.45	-----	-----
LSD 0.05	0.22	-----	-----
<u>Cultivar</u>			
Corsoy	17.03	17.60	16.42
Evans	17.63	18.01	16.60
Hodgson (78)	16.67	18.96	17.56
SRP 200	16.90	18.16	16.36
Beeson	-----	20.46	19.31
Nebsoy	-----	17.87	16.88
(Regular Density)			
Nebsoy	-----	17.35	16.68
(1.5 Density)			
SRP 250	-----	15.55	-----
LSD 0.05	0.32	0.41	0.34

heavier than the second ranking 'Hodgson 78' cultivar, while at the more moist Dundee location it was only 7.9% heavier which would seem to indicate that podfilling factors were not the primary cause for the poor 'Beeson' yield response.

At the 1978 Chesaning location, the planting date x cultivar and planting date x row width x cultivar interactions were significant, while at the 1979 Dundee location the planting date x cultivar interaction was also significant. When the two 1979 locations were combined in one analysis, the location x row width, location x cultivar, planting date x cultivar, and planting date x row width x cultivar interactions were significant.

Weights of 100 seed samples had correlations of 0.60 with total days of growing season and 0.55 with the flowering to maturity period at the 1979 Chesaning location. At the 1979 Dundee location, there was one correlation equal to or over 0.50 which was 0.50 with the flowering to maturity period. When the two 1979 locations were combined, correlations were 0.62 with overall plot yield, 0.54 with total growing season days, 0.67 with the period from flowering to maturity, 0.60 with mature plant height and 0.58 with lodging.

As noted before, Table A2 contains the main treatment means for sample grain yields in grams per plant and per land area (m^2) for the 1978 and 1979 Chesaning locations. Table A2 also contains sample grain weights for the same locations expressed in grams per pod and per node. The weight per pod tended to remain constant for the first two planting dates and then decreased sharply between the second and third. Weights per node were greatest for the second date. The

reversed row width trend between 1978 and 1979 was again observed for weight per node. Weight per pod was not significantly different for the two plant densities in 1978, but low density weight per node was higher than that at the high density. Of the four cultivars grown both years, 'SRF 200' had the highest seed weight per pod both years, but had the lowest weight per node in 1979. This latter 1979 response may help explain the poor overall yield of 'SRF 200' for that year. In 1978 for the seed weight per pod, the planting date x plant density, planting date x cultivar, planting date x plant density x cultivar and planting date x row width x plant density x cultivar interactions were all significant. The planting date x row width and planting date x cultivar interactions were also significant for seed weight per node in 1978 as was the row width x cultivar interaction in 1979.

In 1978, seed weight per pod had a correlation of 0.83 with seed number per pod. In 1979 it had correlations of 0.54 with 100 seed weight, 0.56 with mature plant height, 0.54 with mainstem nodes per plant, 0.74 with seed number per pod, 0.59 with total growing season days, and 0.59 with the period from flowering to maturity. In 1978, seed weight per node had correlations of 0.86 with seed number per node, 0.58 with seed number per plant, 0.63 with total pods per node, 0.61 with mainstem pods per plant and 0.65 with mainstem pods per mainstem node. Correlations of 0.85 with seed number per node, 0.70 with mainstem pods per plant, 0.75 with seed number per plant, 0.62 with overall pods per plant, 0.64 with mainstem pods per mainstem node, and 0.63 with total pods per node were computed for seed weight per node in 1979.

4. Percentages of Whole Plant Yield and Other Responses
of Evenly-Divided One-Third Sections of Sample Plants

Yield component plant samples from the 1979 Chesaning location were subdivided into three equal sections (bottom, middle and top) for the 'Hodgson 78,' 'SRF 200' and 'Beeson' cultivars. Divisions were not only across mainstems but also across any branch passing through a plane perpendicular to the mainstem axis. For counts of branch numbers, branches were considered to be associated with a particular section if attached to the mainstem of that section. However, branch pods and nodes from detached branch sections were included with the plant portion with which they were found.

Percentage yield responses of each section in comparison with whole plant grain yields are portrayed for cultivars in Figure 18 and for row widths in Figure 19. Cultivar differences were significant for all three plant portions. 'Hodgson 78' plants produced the highest percentage yield in the bottom plant portions followed by 'SRF 200' and 'Beeson' plants. This order is the same as that observed for the difference in PAR penetration at mid-canopy and ground level for these cultivars with 'Hodgson' having the highest percentage PAR intercepted between the two reading levels. It might be that the greater PAR levels at low canopy heights may have contributed to these higher percentage yield responses of the bottom plant portions. 'SRF 200' plants had lower percentage responses for the middle portions and higher percentage responses for the top portions than did the other two cultivars. This may have been due partly to lower branching levels with the 'SRF 200' cultivar.

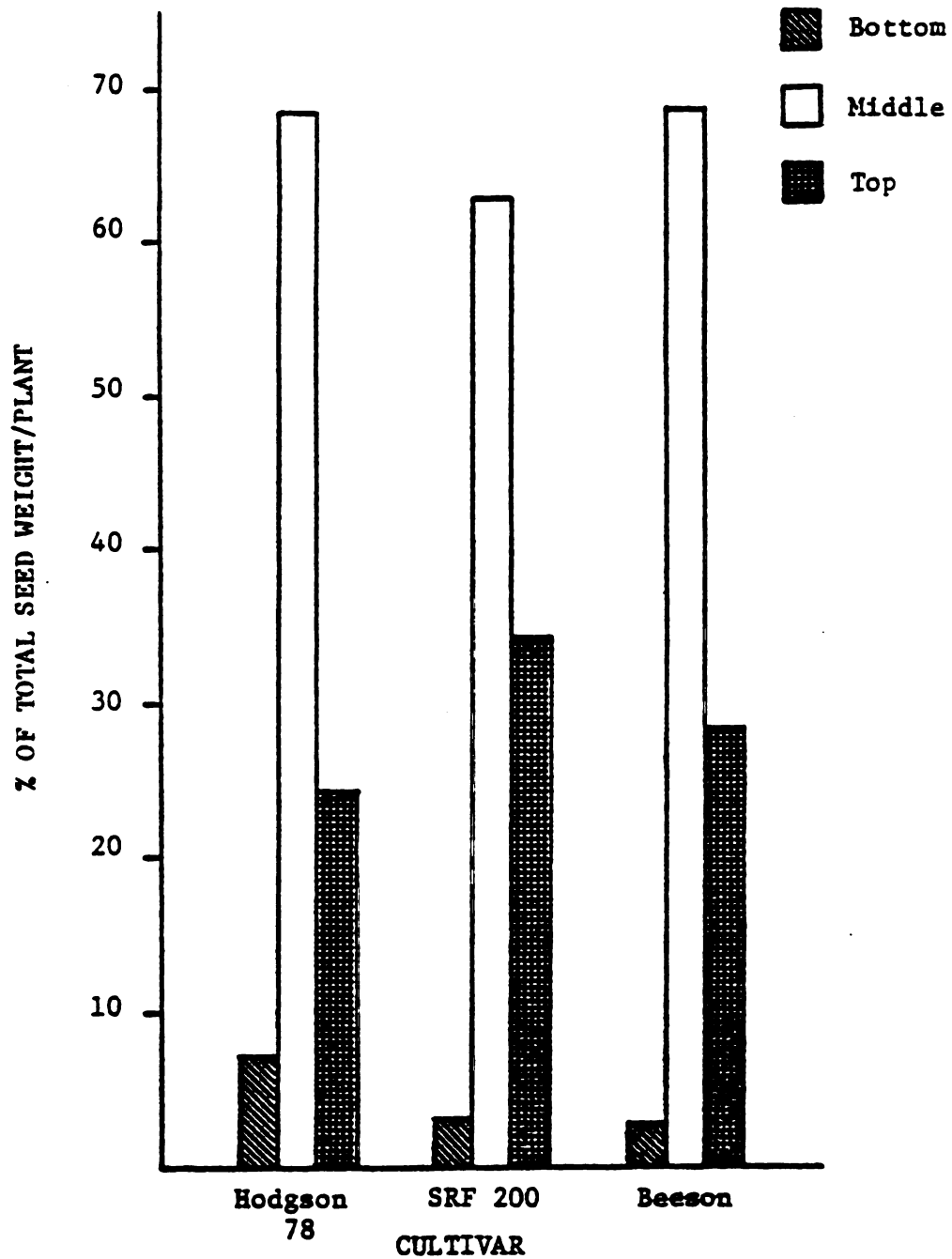


Figure 18. Influence of cultivar upon percentages of sample whole plant seed yields produced by one-third plant sections at the 1979 Chesaning location, averaged over all other factors.

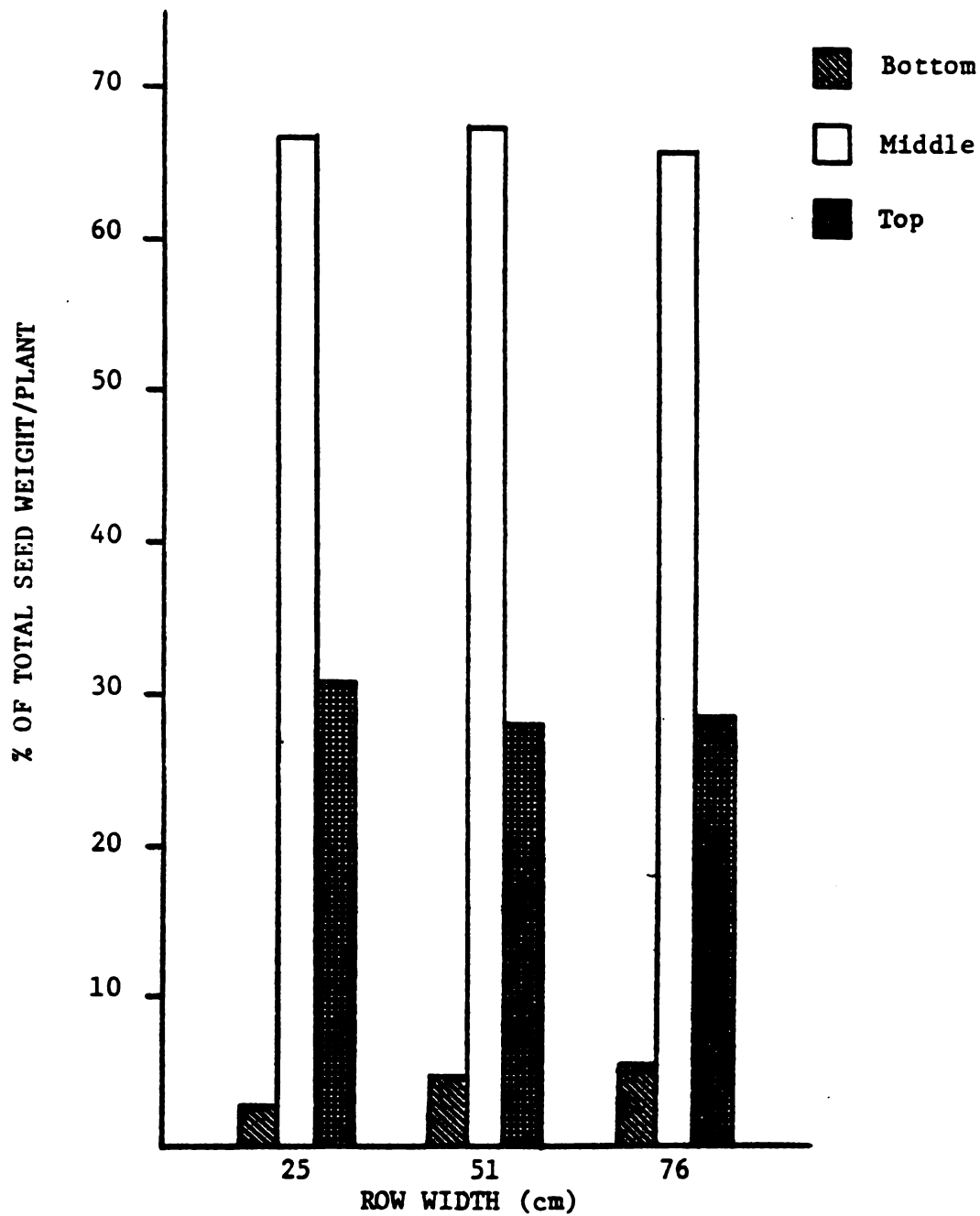


Figure 19 . Percentages of sample whole plant seed yields produced by one-third plant sections as influenced by row width at the 1979 Chesaning location, averaged over all other factors.

Row width percentage yield responses were significantly different only for the bottom plant portions (Figure 19). Bottom portions had increasing percentage yield responses with increasing row widths. Row width responses paralleled PAR penetration readings in the same manner as did cultivar responses.

Percentages of whole plant totals are listed for each plant portion in Tables 32 and 33 for branch nodes, mainstem pods, branch pods, total pods and branch numbers, as influenced by the main treatment. Percentages of mainstem nodes in each plant third were not included, since equal plant divisions were based upon mainstem nodes. Essentially all row width percentage responses were not significantly different nor were the top portion planting date responses. Second date plants tended to have higher percentages of branches, branch nodes and pods associated with bottom plant portions than did the other two dates. 'Hodgson 78' had a higher percentage of mainstem and total pods associated with bottom plant portions than did the other two cultivars, and 'SRF 200' was second which may aid in explaining the percentage yield response for these cultivars. 'Hodgson 78' had lower percentage responses of branch nodes and pods associated with bottom plant portions than did 'SRF 200,' but the percentage of total pod responses indicated that branch pods were a relatively small fraction of the total. 'SRF 200' also had a lower percentage response of mainstem pods associated with middle portions and a higher response with top portions than did the other cultivars which may aid in explaining its variant percentage yield response for these plant portions.

Table 32. Influence of planting date, row width and cultivar upon percentage branch nodes, percentage mainstem pods, percentage branch pods and percentage total pods associated with evenly divided bottom, middle and top (B, M and T) plant sections at the 1979 Chesaning location, averaged over all other factors.

Treatments	Measurements											
	Z Branch Nodes			Z Mainstem Pods			Z Branch Pods			Z Total Pods		
	B	M	T	B	M	T	B	M	T	B	M	T
<u>Planting Date</u>												
1st	32.4	61.9	2.0	2.6	59.4	38.0	12.3	71.3	1.7	4.4	63.7	32.0
2nd	49.9	46.0	0.4	4.1	59.7	36.2	29.6	62.5	0.5	6.5	61.0	32.6
3rd	30.4	68.6	1.0	2.3	58.2	39.4	18.0	81.0	1.0	5.2	61.6	33.2
LSD 0.05	6.9	8.2	n.s.	n.s.	n.s.	n.s.	6.6	8.9	n.s.	---	---	---
<u>Row Width (cm)</u>												
25	36.9	55.4	0.3	2.0	59.3	38.7	15.4	62.3	0.1	3.6	62.0	34.4
51	37.7	61.5	0.8	3.2	59.5	37.3	20.0	79.6	0.4	4.7	63.5	31.8
76	38.2	59.5	2.2	3.7	58.6	37.6	24.5	72.8	2.7	7.1	61.1	31.8
LSD 0.05	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	---	---	---
<u>Cultivar</u>												
Hodgson 78	24.8	74.3	0.9	5.1	60.0	34.8	17.8	81.4	0.8	7.7	64.5	27.8
SRF 200	48.4	44.0	0.2	2.1	56.4	41.6	28.3	63.9	0.4	4.1	58.7	37.2
Beeson	39.6	58.2	2.2	1.8	60.9	37.3	13.8	69.4	2.0	3.1	62.9	34.1
LSD 0.05	12.7	8.9	n.s.	1.6	3.3	3.3	10.9	12.3	n.s.	---	---	---

Table 33. Seed weight/node (g), seed weight/pod (g), and percentage of branches associated with evenly divided bottom, middle, and top (B, M and T) plant sections as influenced by planting date, row width, and cultivar at the 1979 Chesaning location, averaged over all other factors.

Treatments	Measurements									
	Seed Weight/Node					Seed Weight/Pod				
	B	M	T	B	M	T	B	M	T	% Branch Numbers
<u>Planting Date</u>										
1st	0.04	0.58	0.45	0.25	0.38	0.33	72.8	19.2	0.5	
2nd	0.07	0.75	0.46	0.25	0.41	0.32	87.6	8.7	0.0	
3rd	0.05	0.55	0.43	0.22	0.34	0.26	62.8	37.2	0.0	
LSD 0.05	n.s.	0.05	n.s.	n.s.	0.01	0.02	6.2	5.7	n.s.	
<u>Row Width (cm)</u>										
25	0.03	0.57	0.39	0.15	0.36	0.29	65.0	23.4	0.5	
51	0.05	0.64	0.46	0.29	0.38	0.30	80.8	19.2	0.0	
76	0.07	0.67	0.48	0.29	0.38	0.31	77.4	22.6	0.0	
LSD 0.05	0.02	n.s.	0.04	0.04	n.s.	n.s.	6.2	n.s.	n.s.	
<u>Cultivar</u>										
Hodgson 78	0.10	0.65	0.45	0.28	0.34	0.27	77.7	21.8	0.5	
SRP 200	0.03	0.64	0.51	0.23	0.39	0.33	72.5	20.1	0.0	
Beeson	0.03	0.60	0.38	0.22	0.40	0.31	73.0	23.3	0.0	
LSD 0.05	0.02	n.s.	0.05	n.s.	0.02	0.03	n.s.	8.1	n.s.	

Table 33 also contains main treatment responses of seed weights (g/node) and seed weights (g/pod) for the three plant portions. Bottom portions tended to have higher weights at wider row widths and with the 'Hodgson 78' cultivar versus the other cultivars, while 'SRF 200' top portions tended to have higher weights than the other cultivars. These responses again parallel yield responses.

Branch pods per branch node, mainstem pods per mainstem node and overall pods per overall node main treatment responses of plant thirds are listed in Table 34. Again, responses for bottom portions tended to be higher for wider row widths and for the 'Hodgson 78' cultivar compared to other cultivars.

The planting date x cultivar interaction was significant for percentages of branch pods associated with the bottom and middle portions, for percentages of branches associated with the middle portion, and for branch pods per branch node for the middle portion. The planting date x row width interaction was also significant for percentages of branches associated with the middle portion, and the planting date x row width x cultivar interaction was significant for the branch pods per branch node characterizing the middle plant portion.

Some correlations of interest for the percentage of seed yields associated with each plant portion are as follows. Correlations for percentage of plant seed yields associated with the bottom plant portion were -0.59 with the height of the lowest mainstem node to which a pod or pod-bearing branch was attached, -0.66 with the number of the lowest mainstem node to which was attached a pod or pod-bearing branch, 0.87 with mainstem pods associated with the bottom portion, 0.71 with branch pods associated with the bottom portion,

Table 34. Influence of planting date, row width and cultivar upon branch pods/branch node, mainstem pods/mainstem node and overall pods/node associated with evenly divided bottom, middle and top (B, M and T) sample plant sections at the 1979 Chasening location, averaged over all other factors.

Treatments	Measurements								
	Branch Pods/Branch Node			Mainstem Pods/Mainstem Node			Overall Pods/Node		
	B	M	T	B	M	T	B	M	T
<u>Planting Date</u>									
1st	0.32	0.76	0.18	0.09	2.00	1.38	0.14	1.52	1.36
2nd	0.34	0.64	0.07	0.16	2.28	1.46	0.20	1.87	1.46
3rd	0.46	0.84	0.04	0.09	2.13	1.62	0.17	1.64	1.62
LSD 0.05	n.s.	n.s.	n.s.	n.s.	0.12	0.11	n.s.	0.09	0.11
<u>Row Width (cm)</u>									
25	0.24	0.59	0.02	0.07	1.94	1.38	0.10	1.57	1.38
51	0.36	0.75	0.05	0.12	2.17	1.52	0.17	1.68	1.51
76	0.51	0.90	0.23	0.15	2.30	1.56	0.23	1.77	1.55
LSD 0.05	0.09	0.13	0.09	n.s.	0.12	n.s.	0.05	0.09	n.s.
<u>Cultivar</u>									
Hodgson 78	0.66	1.06	0.18	0.22	2.63	1.63	0.31	1.92	1.62
SRF 200	0.26	0.69	0.04	0.07	1.90	1.56	0.12	1.63	1.55
Beeson	0.19	0.50	0.07	0.06	1.88	1.27	0.08	1.46	1.26
LSD 0.05	0.12	0.14	n.s.	0.06	0.16	0.13	0.06	0.15	0.13

0.88 with percentage of plant mainstem pods associated with the bottom portion, 0.52 with overall pods per plant, 0.60 with mainstem pods per mainstem node, 0.57 with branch pods per branch node, and 0.62 with overall pods per overall node.

Correlations for percentages of seed yields associated with the middle plant portion were 0.80 with percentage of plant mainstem pods associated with the middle portion and -0.69 with percentage of mainstem pods associated with the top portion.

Finally, correlations for percentages of seed yields associated with the top plant portion were -0.50 with mainstem pods associated with the bottom portion, -0.52 with seed weights associated with the bottom portion, -0.61 with mainstem pods associated with the middle portion, -0.52 with seed weights associated with the middle portion, -0.68 with percentage of plant mainstem pods associated with the middle portion and 0.85 with percentage of mainstem pods associated with the top portion.

5. Height and Number of the Lowest Mainstem Node to Which was Attached a Pod or Pod-Bearing Branch

A factor of particular interest in avoiding harvest losses is the height and also the number (counting up from the ground level) of the lowest mainstem node to which is attached a reproductive structure, or reproductive supporting structure, since mechanical harvesting necessitates the severing of the mainstem at a small distance above the ground surface. These measurements were recorded using the yield component samples from the 1978 and 1979 Chesaning locations. Table 35 contains the main treatment responses for the height and number of this critical mainstem node both years.

Planting date responses were significantly different for the number of this lowest reproductive mainstem node, but not for its height. This would possibly suggest that planting date differences affected most directly the nodes which supported reproduction, rather than the height of that production of reproductive structures. For both years, the number of this critical node dropped with later planting dates as might be expected, since later date plants were shorter and had fewer total mainstem nodes available for reproduction.

Row width responses were significantly different for the height of the lowest reproductive mainstem node both years, but were significantly different for the nodal number of this node only in 1979. In 1978, heights increased with wider row widths. This was true even though PAR levels were higher in the lower canopy of wider row widths which might have been expected to have resulted in lower podding, since percentages of plant yields were higher for bottom portions of plants in wide rows. The row width height response

Table 35. Influence of planting date, row width, plant density, and cultivar upon the height (cm) and nodal number of the lowest mainstem node bearing either a pod or a pod-bearing branch at the 1978 and 1979 Cheesaning locations.

<u>Treatments</u>	<u>Year</u>			
	<u>1978</u>		<u>1979</u>	
	<u>Height (cm)</u>	<u>Nodal Number</u>	<u>Height (cm)</u>	<u>Nodal Number</u>
<u>Planting Date</u>				
1st	16.06	4.98	16.61	5.59
2nd	15.52	4.49	15.72	5.44
3rd	13.30	4.32	15.75	5.06
LSD 0.05	n.s.	0.43	n.s.	0.33
<u>Row Width (cm)</u>				
25	12.69	4.51	18.48	6.06
51	14.32	4.48	14.44	5.08
76	17.87	4.81	15.16	4.95
LSD 0.05	1.61	n.s.	1.53	0.33
<u>Plant Density</u>				
Low	13.06	4.31	-----	-----
High	16.86	4.88	-----	-----
LSD 0.05	0.86	0.19	-----	-----
<u>Cultivar</u>				
Corsoy	16.07	5.19	13.52	4.88
Evans	12.33	3.87	11.53	4.19
Hodgson (78)	11.27	3.70	11.37	4.30
SRF 200	20.18	5.62	17.48	6.00
Beeson	-----	-----	18.50	6.16
Nebsoy	-----	-----	17.19	5.79
(Regular Density)	-----	-----	22.58	6.21
Nebsoy	-----	-----	-----	-----
(1.5 Density)	-----	-----	-----	-----
LSD 0.05	1.22	0.27	1.88	0.36

for 1978 would seem to suggest that the nearer proximity of plants to one another in the wider row widths was the dominant factor in this response. The 1979 node height response to varied row widths was similar between the 51 and 76 cm widths, but the 25 cm width had a much higher height which was evidently a response to the higher plant densities at that width. The 1978 plant density responses evidenced a similar trend of increased height and nodal number of the critical node at higher plant densities.

Cultivar responses were significantly different for both height and nodal number of the lowest reproductive mainstem node in both years. Longer season cultivars tended to have greater heights and longer nodal numbers than the shorter season cultivars. This may partly be the result of the fact that plant heights of shorter season cultivars were shorter also. 'SRF 200' consistently had larger heights and nodal numbers than did 'Corsoy' both years, even though 'SRF 200' plants were shorter than those of 'Corsoy' in 1978. 'Nebsoy' (Regular Density) means were lower than those for 'SRF 200' and 'Beeson' in 1979, but the 1.5 density treatment of 'Nebsoy' resulted in means well above those of any other cultivar. The cultivar responses would seem to indicate that these traits may be both genetically inherent and also modulated by the proximity of neighboring plants. Another note of interest is that when the 1979 responses of four cultivars grown in 1978 were segregated out, the average height of the lowest reproductive support mainstem node was less in 1979 (13.48 cm) than in 1978 (14.96 cm) even though plants were taller in 1979 than in 1978. The reverse was true for annual averages of the nodal number means for those four cultivars

with the 1979 average value (4.84) slightly higher than that in 1978 (4.60).

In 1978, the cultivar x planting date interaction for height of the lowest reproductive mainstem node was significant and is graphically portrayed in Figure 20. The trends of planting date responses were the same for all cultivars, but 'Hodgson' and 'SRF 200' appeared to vary relatively little at different dates in comparison to 'Corsoy' and 'Evans.' The plant density x row width interaction for nodal number was also significant in 1978 and is portrayed in Figure 21. One interesting observation is that the nodal number for the high plant density was higher at 25 cm row widths than at 51 cm widths.

The 1979 cultivar x planting date interaction in Figure 22 for nodal number was also significant, and revealed widely varying planting date responses for the cultivars.

Correlations for nodal height in 1978 were -0.55 with branch nodes per plant, -0.55 with branch pods per plant, -0.59 with number of branches per plant, -0.60 with overall pods per plant, -0.60 with mainstem pods per mainstem node, and -0.55 with overall pods per overall node. In 1979 correlations were -0.50 with mid-canopy PAR readings, -0.61 with branch nodes per plant, -0.54 with mainstem pods per plant, -0.69 with branch pods per plant, -0.58 with number of branches per plant, -0.50 with seed yields per sample plant, -0.54 with seed number per plant, -0.67 with overall pods per plant, -0.64 with mainstem pods per mainstem node, -0.67 with branch pods per branch node, -0.55 with overall pods per overall node, -0.68 with percent branch nodes of total nodes, -0.71 with percent branch pods

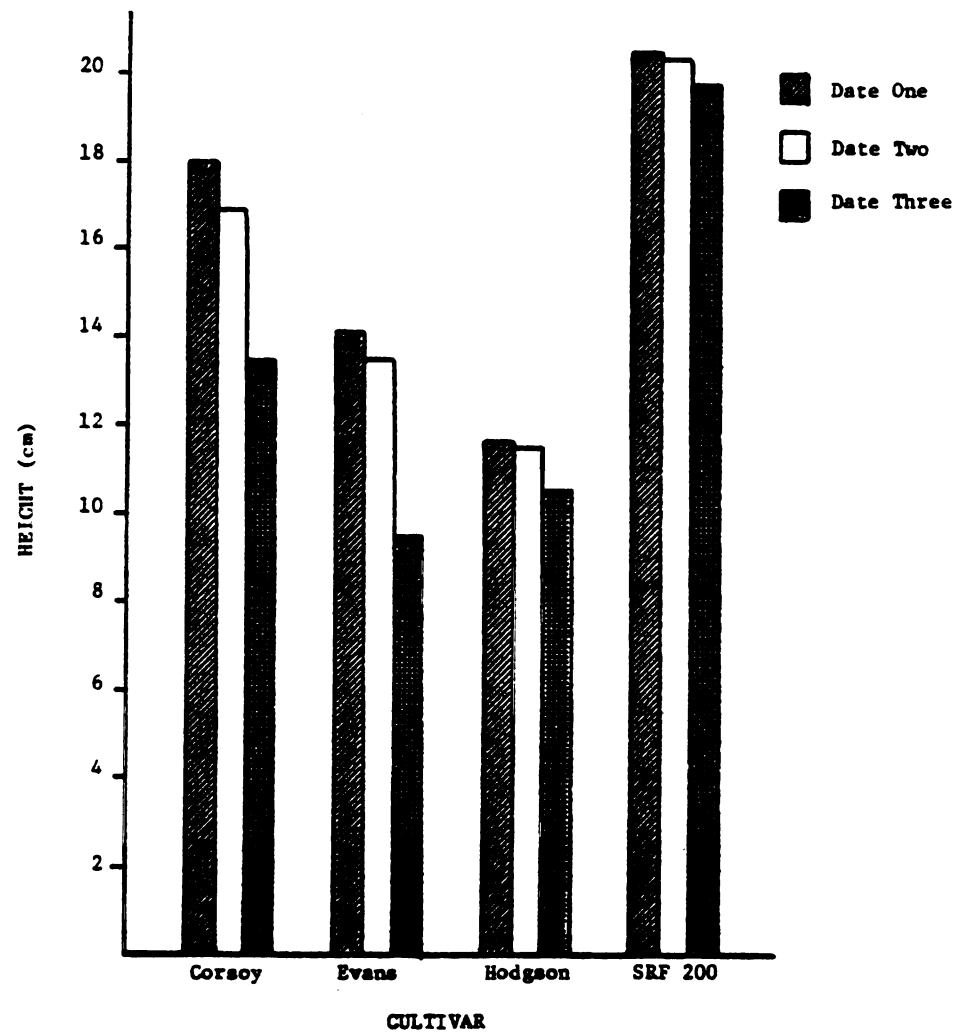


Figure 20. Influence of cultivar and planting date upon the height of the lowest mainstem node bearing either a pod or pod-bearing branch at the 1978 Chesaning location, averaged over row width and plant density.

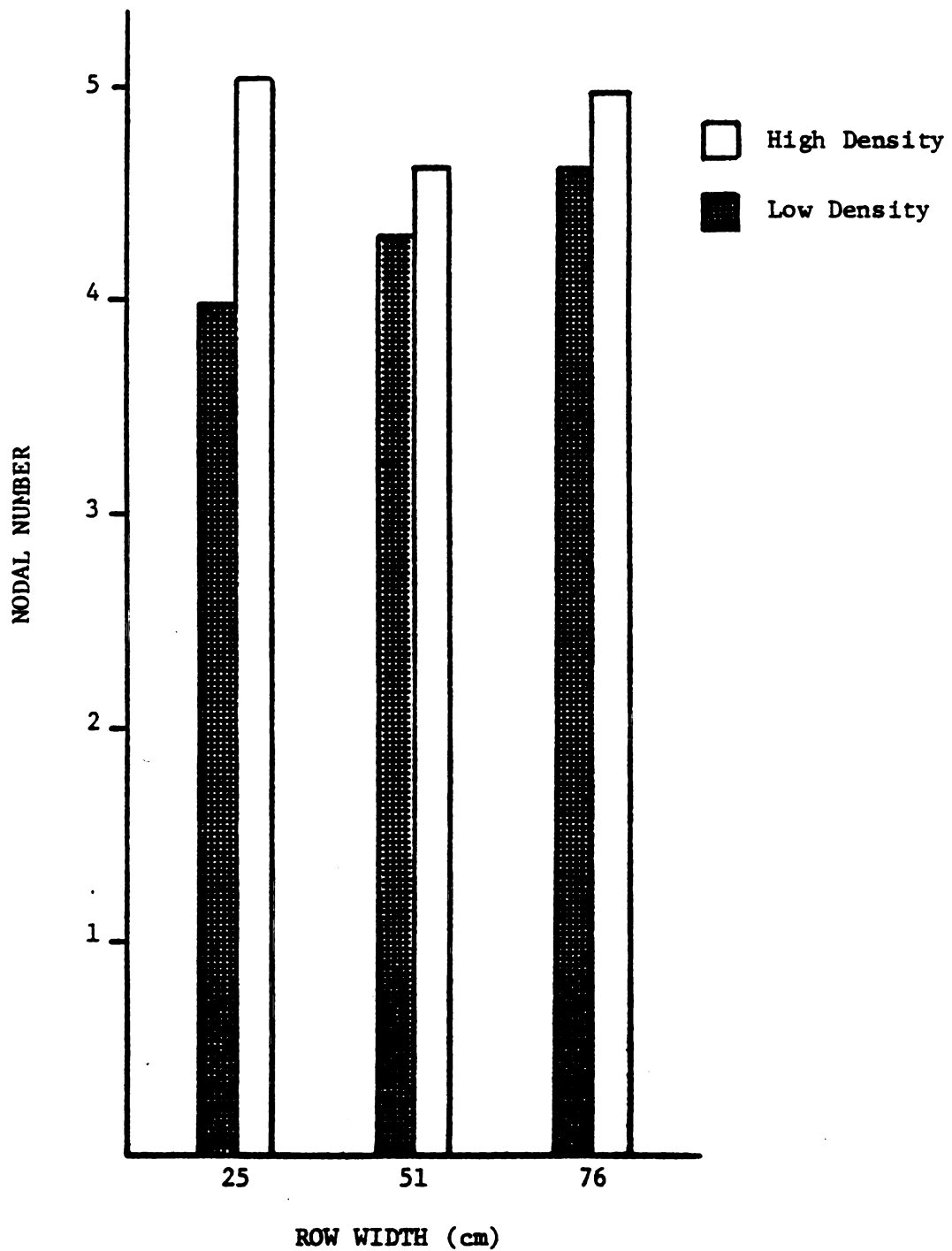


Figure 21. Nodal number of the lowest mainstem node bearing either a pod or pod-bearing branch as influenced by row width and plant density at the 1978 Chesaning location, averaged over planting date and cultivar.

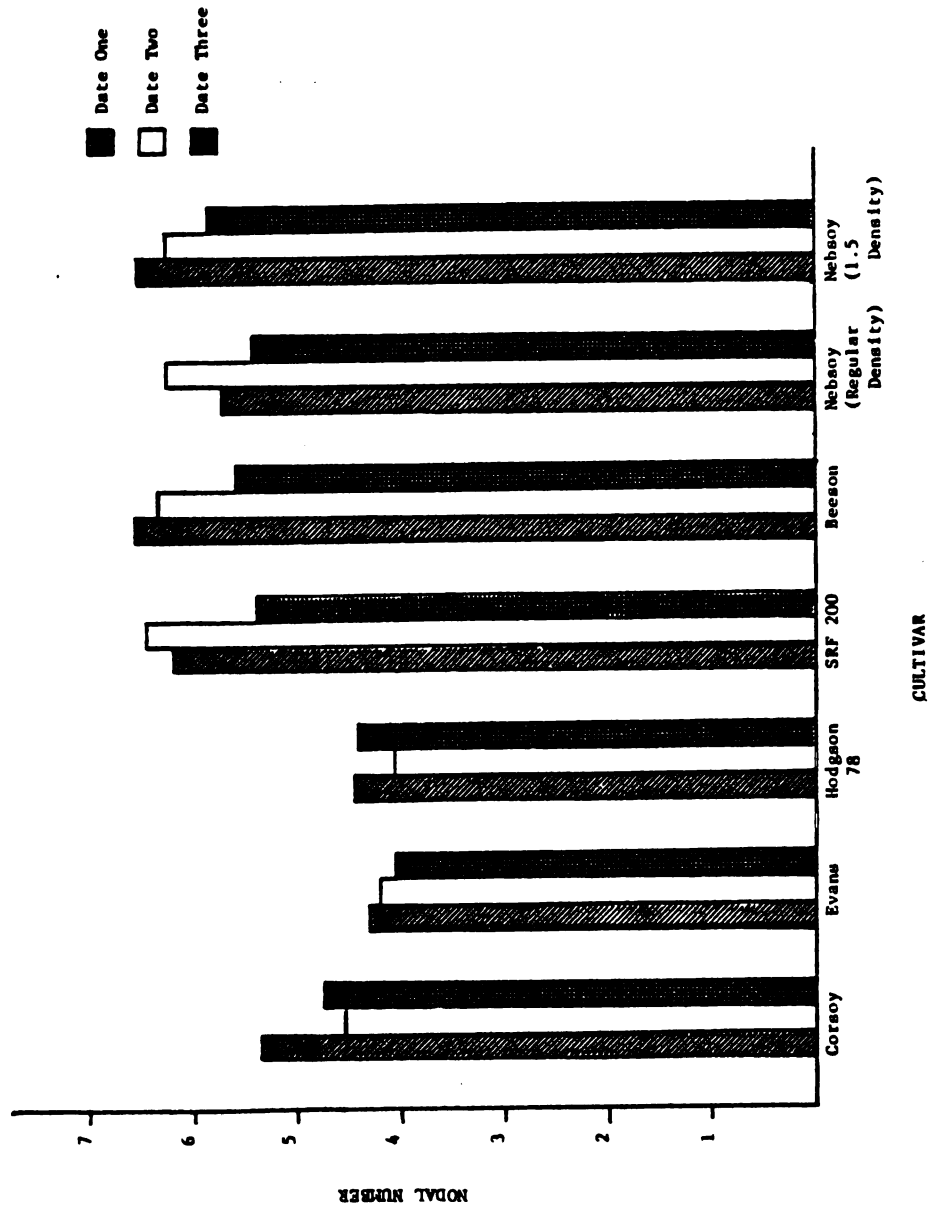


Figure 22. Nodal number of the lowest mainstem node bearing either a pod or pod-bearing branch as influenced by planting date and cultivar at the 1979 Cheasaning location, averaged over row width.

of total pods, and -0.50 with the simple difference between the mid-canopy and ground level PAR readings.

Correlations for nodal number in 1978 were -0.89 with height of the lowest mainstem node to which was attached a pod or pod-bearing branch, -0.57 with mainstem pods per mainstem node, -0.53 with overall pods per overall node and -0.54 with percent branch nodes of total nodes. And the nodal number correlations in 1979 were -0.58 with mid-canopy PAR readings, 0.89 with nodal height of the lowest mainstem node to which was attached a pod or pod-bearing branch, -0.53 with branch nodes per plant, -0.68 with branch pods per plant, -0.50 with number of branches per plant, -0.61 with overall pods per plant, -0.67 with mainstem pods per mainstem node, -0.70 with branch pods per branch node, -0.61 with overall pods per overall node, -0.63 with percent branch nodes of total nodes, -0.70 with percent branch pods of total pods, 0.50 with total growing season length and -0.59 with the simple difference between mid-canopy and ground level PAR readings.

6. Productive Nodes and Mainstem Lengths, and Related Measurements

By subtracting the height and nodal number measurements of the lowest mainstem node to which was attached either a pod or pod-bearing branch from the total plant height, and from the total mainstem and overall nodes per plant, respectively, it was possible to obtain the length of portion of the mainstem directly supporting reproduction (productive mainstem) and the number of mainstem and overall nodes above the nonproductive bottom nodes (productive nodes). Thus, these measurements were actually vegetative in nature, but dependent upon the reproductive response of the plant.

Table 36 lists the main treatment responses of productive mainstem lengths and of number of productive mainstem nodes per plant for both years. The planting date x cultivar and planting date x row width x cultivar interactions were significant both years for productive mainstem lengths. The planting date x row width and planting date x cultivar interactions were significant for productive mainstem nodes in 1978. Correlations for productive mainstem lengths in 1978 were 0.76 with mainstem nodes per plant, 0.71 with mainstem pods per plant, 0.72 with seed yields per sample plant, 0.68 with seed numbers per pod, 0.66 with overall pods per plant, 0.64 with overall nodes per plant and 0.62 with overall plot yield. In 1979 correlations for productive mainstem lengths were 0.55 with mainstem nodes per plant, 0.62 with seed yields per sample plant, 0.62 with overall nodes per plant, 0.61 with productive overall nodes per plant, 0.71 with productive mainstem nodes per plant and -0.52 with plants per land area (m^2). Productive mainstem nodes per plant in 1978 had correlations

Table 36. Productive mainstem length (cm/plant) (PML), productive mainstem node numbers/plant (PMN), productive mainstem internode lengths (cm) (PMIL) and nonproductive mainstem internode lengths (cm) (NPMIL) as influenced by planting date, row width, plant density and cultivar at the 1978 and 1979 Cheeaning locations, averaged over all other factors.

Treatments	Year							
	1978				1979			
	PML	PMN	PMIL	NPMIL	PML	PMN	PMIL	NPMIL
<u>Planting Date</u>								
1st	66.54	10.81	6.24	3.12	76.73	11.29	6.88	2.87
2nd	68.33	11.11	6.23	3.41	73.75	11.31	6.55	2.83
3rd	60.54	10.25	5.95	3.01	64.00	10.45	6.19	3.09
LSD 0.05	n.s.	0.68	n.s.	n.s.	2.49	0.37	0.25	0.13
<u>Row Width (cm)</u>								
25	68.33	11.79	5.86	2.71	67.96	10.30	6.65	3.00
51	65.38	10.70	6.16	3.13	72.69	11.47	6.38	2.78
76	61.70	9.68	6.39	3.70	73.82	11.29	6.59	3.01
LSD 0.05	2.91	0.46	0.26	0.17	2.49	0.37	n.s.	0.13
<u>Plant Density</u>								
Low	68.73	11.75	5.89	2.96	---	---	---	---
High	61.55	9.70	6.38	3.40	---	---	---	---
LSD 0.05	1.74	0.37	0.14	0.10	---	---	---	---
<u>Cultivar</u>								
Corsoy	71.68	11.21	6.50	3.04	76.61	11.16	6.94	2.74
Evans	57.61	10.07	5.78	3.11	68.43	10.72	6.41	2.70
Hodgson (78)	66.34	10.97	6.11	3.02	74.33	11.42	6.52	2.66
SRP 200	64.92	10.65	6.16	3.56	77.91	12.04	6.50	2.90
Beeson	---	---	---	---	73.41	11.76	6.26	3.01
Nebaoy	---	---	---	---	67.01	11.06	6.11	2.88
(Regular Density)	---	---	---	---	---	---	---	---
Nebaoy	---	---	---	---	62.75	8.97	7.04	3.62
(1.5 Density)	---	---	---	---	---	---	---	---
LSD 0.05	2.46	0.52	0.20	0.14	2.35	0.60	0.31	0.20

of -0.54 with height of the lowest reproductive support mainstem node, 0.71 with branch nodes per plant, 0.76 with mainstem pods per plant, 0.65 with branch pods per plant, 0.67 with number of branches per plant, 0.87 with seed yields per sample plant, 0.84 with seed numbers per plant, 0.84 with overall pods per plant and 0.79 with productive mainstem length per plant. In 1979 correlations were 0.56 with the height of the lowest reproductive support mainstem node, 0.67 with branch nodes per plant, 0.64 with mainstem pods per plant, 0.51 with branch pods per plant, 0.62 with number of branches per plant, 0.77 with seed yields per sample plant, 0.77 with seed number per plant, 0.66 with overall pods per plant, -0.56 with plants per land area (m^2) and 0.71 with productive mainstem length per plant.

The main treatment responses of other related measurements are listed in Tables 36 and 37. These include internode length of the productive and nonproductive mainstem portions, mainstem pods per productive mainstem node, seed number per productive overall node, and seed weight per productive node. The planting date x cultivar interaction was significant for all five above measurements in 1978. However, in 1979 the row width x cultivar interaction was significant only for seed numbers and seed weight per productive overall node. Internode lengths of the productive mainstem portions had almost no correlations over 0.50 while the internode length of the nonproductive mainstem portion had many correlations over 0.50, most of them negative.

Table 37. Mainstem pods/productive mainstem node (MP/PMN), seed number/overall productive node (SN/OPN) and seed weight (g/overall productive node) (SW/OPN) as influenced by planting date, row width, plant density and cultivar at the 1978 and 1979 Chesaning locations, averaged over all other factors.

Treatments	Year			
	1978		1979	
	MP/PMN	SN/OPN	SW/OPN	MP/PMN
Planting Date				SN/OPN
1st	1.59	3.14	0.57	1.71
2nd	1.79	3.56	0.64	1.86
3rd	1.88	3.57	0.58	1.89
LSD 0.05	0.15	n.s.	n.s.	0.10
Row Width (cm)				
25	1.80	3.46	0.61	1.75
51	1.74	3.40	0.59	1.84
76	1.73	3.42	0.60	1.87
LSD 0.05	n.s.	n.s.	n.s.	n.s.
Plant Density				
Low	1.76	3.37	0.59	---
High	1.74	3.48	0.60	---
LSD 0.05	n.s.	n.s.	n.s.	---
Cultivar				
Corsoy	1.91	3.37	0.57	2.00
Evans	1.75	3.33	0.59	1.93
Hodgson (78)	1.72	3.05	0.57	1.89
SRF 200	1.63	3.95	0.67	1.61
Beeson	---	---	---	1.50
Nebaoy	---	---	---	2.00
(Regular Density)	---	---	---	---
Nebaoy	---	---	---	1.79
(1.5 Density)	---	---	---	---
LSD 0.05	0.08	0.18	0.03	0.11
				0.29
				0.04
				0.50
				0.51
				0.50
				0.49
				0.45
				0.57
				0.56
				0.04

III. Planting Systems

This experiment was not only designed to test responses to individual planting practices, but also to compare responses to complete planting systems. Since plant density yield responses in 1978 were not significantly different, the density response was averaged for 1978 means in computing overall responses. Responses of 36 planting systems averaged over both years are presented in Table 38 in order of yield from highest to lowest. Overall responses to the planting systems of lodging (four locations) and height of the lowest mainstem node bearing a pod or pod-bearing branch (two locations) are also included. The first planting system ('Corsoy,' Date 1, 25 cm rows) responded with yields which were 54.0% greater than those of the lowest yielding system ('Evans,' Date 3, 76 cm rows), indicating the significant differences which can occur with a systems concept.

Table 38. Influence of planting systems composed of different planting dates, row widths and cultivars upon yield (ql/ha), lodging and height of the lowest mainstem node to which is attached a pod or pod-bearing branch (cm), averaged over year, location and plant density (where applicable).

<u>Planting Date</u>	<u>Row Width (cm)</u>	<u>Cultivar</u>	<u>Yield</u>	<u>Lodging</u>	<u>Nodal Height</u>
1	25	Corsoy	32.90	3.01	16.7
1	25	Hodgson (78)	32.77	2.51	9.9
1	51	SRF 200	32.34	2.46	17.6
1	51	Corsoy	32.06	2.48	13.7
1	25	SRF 200	31.88	2.44	18.8
2	51	Hodgson (78)	31.67	2.10	10.3
1	51	Hodgson (78)	31.63	1.95	10.3
2	51	Corsoy	31.39	2.37	14.6
1	25	Evans	30.25	2.11	15.6
2	25	Hodgson (78)	29.74	2.13	10.3
2	25	Corsoy	29.71	2.37	13.8
1	51	Evans	29.11	1.83	9.8
2	25	SRF 200	28.91	2.41	18.0
2	51	SRF 200	28.67	2.19	20.2
2	51	Evans	27.89	2.02	11.1
2	25	Evans	27.66	2.13	11.4
1	76	SRF 200	27.39	2.83	21.5
1	76	Hodgson (78)	27.20	2.07	12.9
1	76	Corsoy	27.04	2.69	18.7
2	76	SRF 200	26.98	2.56	20.1
2	76	Hodgson (78)	26.93	2.34	12.3
3	25	Hodgson (78)	26.11	1.73	11.8
2	76	Corsoy	26.08	2.90	14.2
3	25	Corsoy	26.04	2.06	15.2
3	51	Hodgson (78)	25.49	1.65	11.3
3	51	Evans	25.47	1.99	9.8
2	76	Evans	25.33	2.36	14.2
3	51	Corsoy	25.23	1.99	11.9
3	25	SRF 200	25.20	1.93	18.3
3	51	SRF 200	25.13	2.01	17.4
1	76	Evans	24.48	2.00	13.3
3	25	Evans	24.33	2.01	10.1
3	76	Corsoy	22.15	2.32	14.4
3	76	SRF 200	21.60	2.19	17.9
3	76	Hodgson (78)	21.45	1.95	13.0
3	76	Evans	21.36	2.05	12.5

SUMMARY AND CONCLUSIONS

The effects on soybeans of planting date, row width, plant density and cultivar were studied at two locations in 1978 near Carleton and Chesaning, Michigan. In 1979, the effects of planting date, row width and cultivar were studied at two Michigan locations near Chesaning and Dundee.

I. Yield

Overall planting date responses indicated that late dates of planting resulted in reduced yields. However, there were also indications that planting dates prior to normal dates for the northern locations responded with little if any yield advantage.

Overall row width yield responses were somewhat inconclusive since plant densities in each width varied by year. However, 25 and 51 cm row widths responded with definite yield advantages over 76 cm widths. 'Hodgson (78)' responded with the highest yields over all years and locations followed closely by 'Corsoy,' and then by 'SRF 200' and 'Evans.' In 1979, 'Nebsoy' (Regular Density) yields were third highest behind those of 'Corsoy' and 'Hodgson (78)' while yields of 'Nebsoy' (1.5 Density) and 'Beeson' were lowest of the seven cultivars tested at both locations. 'Nebsoy' and 'Hodgson (78)' gave some indications of resistance to moisture stress.

There were no significant plant density responses in 1978.

Planting date x cultivar interactions were significant at all locations. In 1978, the planting date x row width x plant density interaction at Carleton, and the planting date x row width, row width x cultivar, and plant density x cultivar interactions at Chesaning were significant. In 1979 the row width x cultivar interaction at the Dundee location was significant. The 76 cm row widths generally responded with lower yields at the first than at the second planting date while other row widths did not show this response. 'Evans' also yielded less at the first than at the second planting date at both northern locations.

II. Growth and Development

Within the testing locations, there were significant cultivar responses at the 5% level for maturity and flowering dates, percentage emergence, mainstem and branch nodes per plant, total nodes per plant, number of branches per plant, leaf area, photosynthetically active radiation (PAR), mature plant height, lodging, mainstem internode length, mainstem and branch pods per node and per plant, mainstem and branch pods per land area (m^2), percentage branch pods of total pods per plant, total pods per node and per plant, total pods per land area (m^2), number of seeds per pod and per node, number of seeds per plant and per land area (m^2), weights of 100 seeds, sample grain weight per pod and per node, sample grain weight per plant and per land area (m^2), percentage bottom plant portion yields of total plant yields, percentage middle plant portion yields of total plant yields, percentage top plant portion yields of total plant yields, height and nodal number of the lowest mainstem node bearing a pod or pod-bearing

branch, and productive mainstem length and nodes.

There were at least some significant planting date responses for all of the above measurements except leaf area (not measured), PAR, total pods per plant and per land area (m^2), branch pods per node and per plant, branch nodes per land area (m^2), the percentage yields of all three plant portions, and height of the lowest mainstem node bearing either a pod or a pod-bearing branch.

There were at least some significant row width responses for all of the measurements under cultivar except maturity dates, mature plant height, number of seeds per pod and percentage yields of total plant yields for the middle and top plant portions.

Plant density responses were significantly different in at least some cases for all of the measurements listed under cultivar except maturity and flowering dates (not measured statistically in 1978), total nodes per plant, leaf area (not measured), PAR (not measured), total pods per land area (m^2), number of seeds per pod and per land area (m^2), sample grain weight per pod and per land area (m^2), and percentage yields of total plant yields for all three plant portions (not measured).

There were significant main treatment effects for other related measurements. There were also numerous interactions between main treatment effects for the growth and development measurements.

III. Conclusions

The following tentative conclusions may be drawn from this experiment:

1. Delays in planting soybeans after mid-May in the Monroe County area and after late May in the Saginaw County area resulted in significantly decreased yield. The later the planting date was beyond the above times, the greater the yield reduction which resulted.

2. Plants in row widths of 25 and 51 cm yielded more than those in 76 cm rows, but little if any yield advantage of 25 cm row widths was realized in comparison with 51 cm widths. Due to the weed control problems encountered with 25 cm widths, 51 cm widths would appear advisable. More research should be conducted on row width yield responses utilizing uniform plant densities for all row widths before conclusions regarding the response of 25 and 51 cm row widths in Michigan are finalized.

3. Overall cultivar yield differences for the four cultivars tested both years were of a much smaller magnitude than were those of planting date and row width. However, 'Hodgson (78)' responded with consistently high yields across a wide variety of environmental conditions. 'Nebsoy' also appeared to have some tolerance to late summer drought.

APPENDIX

Table A¹ . Phytophthora root rot damage (percentage of plants affected) at the 1979 Chesaning location (includes only those plots with some infestation).

<u>Replication</u>	<u>Planting Date</u>	<u>Row Width (cm)</u>	<u>Cultivar</u>	<u>% Damage</u>
1	1st	25	SRF 250	15
2	1st	25	SRF 250	1
3	1st	25	SRF 250	17
1	1st	51	SRF 250	40
2	1st	51	SRF 250	20
3	1st	51	SRF 250	20
1	1st	76	Corsoy	5
1	1st	76	SRF 250	20
2	1st	76	SRF 250	6
3	1st	76	SRF 250	4
2	2nd	25	Corsoy	5
1	2nd	25	SRF 250	25
2	2nd	25	SRF 250	15
3	2nd	25	SRF 250	10
1	2nd	51	Corsoy	1
2	2nd	51	Corsoy	2
1	2nd	51	SRF 250	60
2	2nd	51	SRF 250	10
3	2nd	51	SRF 250	40
1	2nd	76	Corsoy	8
2	2nd	76	Corsoy	5
3	2nd	76	Corsoy	10
1	2nd	76	SRF 250	50
2	2nd	76	SRF 250	35
3	2nd	76	SRF 250	7
1	3rd	25	Corsoy	1
2	3rd	25	Corsoy	3
1	3rd	25	SRF 200	1
1	3rd	25	Beeson	1
1	3rd	25	SRF 250	20
2	3rd	25	SRF 250	20
1	3rd	51	Corsoy	2
2	3rd	51	Corsoy	3
1	3rd	51	SRF 250	7
2	3rd	51	SRF 250	12
3	3rd	51	SRF 250	5
1	3rd	76	Corsoy	5
2	3rd	76	Corsoy	1
2	3rd	76	Evans	1
1	3rd	76	SRF 250	30
2	3rd	76	SRF 250	1
3	3rd	76	SRF 250	4

Table A2. Component sample grain yields (g/pod, g/node, g/plant and g/m²) at the 1978 and 1979 Channing locations as influenced by planting date, row width, cultivar and plant density, averaged over all other factors.

Treatments	Year							
	1978				1979			
	Per Pod	Per Node	Per Plant	Per m ²	Per Pod	Per Node	Per Plant	Per m ²
<u>Planting Date</u>								
1st	0.39	0.43	8.14	320	0.35	0.38	7.72	291
2nd	0.39	0.50	8.79	345	0.35	0.43	8.19	316
3rd	0.33	0.45	7.20	283	0.28	0.35	6.36	242
LSD 0.05	0.02	0.05	0.87	33	0.02	0.03	0.82	31
<u>Row Width (cm)</u>								
25	0.37	0.48	9.58	376	0.31	0.34	6.08	300
51	0.37	0.46	7.71	303	0.33	0.40	8.05	284
76	0.37	0.44	6.83	269	0.33	0.41	8.14	266
LSD 0.05	n.s.	0.02	0.78	30	0.02	0.03	0.82	n.s.
<u>Plant Density</u>								
Low	0.37	0.48	9.33	323	---	---	---	---
High	0.37	0.44	6.75	309	---	---	---	---
LSD 0.05	n.s.	0.02	0.52	n.s.	---	---	---	---
<u>Cultivar</u>								
Corsoy	0.32	0.43	8.25	324	0.29	0.40	7.84	285
Evans	0.36	0.47	7.35	290	0.30	0.41	7.26	264
Hodgson (78)	0.36	0.47	8.45	331	0.32	0.42	8.56	315
SRP 200	0.43	0.47	8.11	320	0.36	0.37	7.97	286
Beeson	---	---	---	---	0.37	0.34	7.23	261
Nebsoy	---	---	---	---	0.32	0.41	7.74	278
(Regular Density)	---	---	---	---	0.32	0.36	5.35	294
Nebsoy		0.04	0.73	28	0.02	0.03	0.82	32
(1.5 Density)								

0.01

LSD 0.05

Table A 3. Temperature (degrees Celsius) at sites near the 1978 and 1979 Chesaning (St. Charles), 1978 Carleton (Willis), and 1979 Dundee (Adrian) research locations.

<u>Year</u>	<u>Site</u>	<u>Reading</u>	<u>Month</u>				
			<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>September</u>
1978	St. Charles	Average Maximum	22.9	27.6	29.0	29.1	26.1
		Average Minimum	9.3	12.6	14.7	14.8	11.8
		Average	16.1	20.1	21.8	21.9	18.9
1978	Willis	Average Maximum	21.0	25.7	29.0	28.1	26.9
		Average Minimum	8.6	12.3	16.6	13.2	10.9
		Average	14.8	19.0	22.8	20.6	18.9
		Departure from Normal	0.7	- 0.7	0.2	- 0.1	2.2
1979	St. Charles	Average Maximum	21.5	27.2	28.7	26.4	26.1
		Average Minimum	8.4	13.3	14.5	13.8	10.1
		Average	15.0	20.2	21.6	20.2	18.1
1979	Adrian	Average Maximum	20.3	26.5	27.2	25.4	23.8
		Average Minimum	6.2	11.8	13.6	12.8	8.6
		Average	13.2	19.2	20.4	19.1	16.2
		Departure from Normal	- 1.5	- 1.3	- 2.1	2.4	- 1.1

Table A4 . Key for component of yield raw data Tables A5 , A6 and A7 .

Treatment Codes

<u>1978</u>	<u>1979</u>
1st Digit--Planting Date	1st Digit--Planting Date
1st--1	1st--1
2nd--2	2nd--2
3rd--3	3rd--3
2nd Digit--Row Width (cm)	2nd Digit--Row Width (cm)
25--1	25--1
51--2	51--2
76--3	76--3
3rd Digit--Plant Density	3rd Digit--Cultivar
Low--1	Corsoy--1
High--2	Evans--2
	Hodgson 78--3
4th Digit--Cultivar	SRF 200--4
Corsoy--1	Beeson--5
Evans--2	Nebsoy--6
Hodgson--3	(Regular Density)
SRF 200--4	Nebsoy--7
	(1.5 Density)
	SRF 200--8

Abbreviations for Column Headings:

TMC--Treatment codes
 PLHT--Mature plant height
 LNH--Height of lowest mainstem node to which is attached a pod or
 pod-bearing branch
 LNN--Nodal number of lowest mainstem node to which is attached a pod or
 pod-bearing branch
 MN--Mainstem nodes per plant
 BN--Branch nodes per plant
 MP--Mainstem pods per plant
 BP--Branch pods per plant
 BNR--Number of branches per plant
 SW--Seed weight per plant
 100 SW--Weight of 100 seeds
 CHEMD--Chemical damage ratings

If any of the above abbreviations are followed by a dash and a number, the number has the following meaning:

Bottom plant portion--1
 Middle plant portion--2
 Top plant portion--3

Table A 5. Raw data for 1978 Cheesening components of yield including whole plant measurements.

TMC	PLHT	LNH	CHEXD	LNN	MN	BN	MP	BP	BNR	SH	100 SH
1111	96.00	8.37	5	4.33	20.33	11.67	25.00	17.67	3.33	16.67	19.5
1111	104.67	8.50	3	4.00	18.00	7.33	31.00	11.33	2.00	15.37	17.9
1111	89.33	15.67	5	5.67	14.00	2.00	21.67	1.00	0.67	8.73	18.9
1112	66.67	5.30	3	2.67	16.00	14.67	24.67	17.33	4.00	15.97	18.1
1112	73.67	11.70	1	4.67	14.00	1.67	18.33	1.67	0.67	7.60	17.6
1112	77.33	5.17	3	3.33	15.33	3.33	23.33	4.33	1.33	10.10	19.3
1113	70.67	5.23	5	2.67	15.67	20.33	17.33	27.00	4.33	15.83	19.2
1113	82.67	10.83	3	4.67	15.67	4.67	15.33	2.67	2.00	6.53	19.2
1113	85.00	6.77	3	2.67	15.33	13.33	23.67	16.67	3.67	15.30	18.3
1114	93.33	6.47	3	3.33	18.33	4.67	22.00	4.33	2.00	12.23	18.8
1114	96.00	18.13	3	6.00	17.00	1.33	21.33	0.33	0.33	10.27	18.7
1114	91.33	15.00	1	5.33	17.00	3.00	18.00	2.67	1.00	8.27	19.4
1121	89.75	16.75	5	5.75	14.00	3.50	19.25	5.75	1.50	8.40	19.3
1121	89.50	19.30	3	6.75	16.00	3.00	20.75	3.25	1.25	8.83	19.4
1121	85.25	32.28	1	8.50	15.50	0.00	14.00	0.00	0.00	5.03	19.0
1122	68.50	10.13	3	4.25	13.00	1.50	18.25	1.25	0.75	7.30	19.4
1122	81.25	24.83	3	7.00	16.50	0.00	15.25	0.00	0.00	6.00	18.3
1122	70.50	14.25	1	5.00	13.00	2.00	15.00	2.00	1.00	5.73	15.9
1123	73.25	7.98	5	3.75	14.50	10.75	13.00	13.00	3.00	11.30	19.4
1123	88.25	15.10	3	5.75	15.50	3.50	15.50	2.50	1.50	7.28	19.5
1123	83.00	9.18	1	3.75	15.25	3.75	17.50	3.75	1.50	8.43	19.5
1124	86.75	10.10	3	3.75	15.75	2.00	17.75	1.00	0.50	9.93	18.7
1124	99.75	17.60	1	6.00	18.50	2.25	26.75	1.50	0.75	12.70	18.7
1124	83.75	30.73	1	7.75	14.75	0.00	8.75	0.00	0.00	4.38	16.8
1211	98.60	8.18	5	3.80	20.40	12.40	26.40	13.80	2.80	14.62	19.3
1211	105.60	22.44	3	6.00	16.00	2.00	19.60	3.00	0.60	7.70	18.5
1211	95.60	10.40	3	4.60	16.80	5.60	22.40	6.60	1.60	9.96	19.0
1212	73.00	8.12	3	3.60	13.40	7.20	18.80	7.60	2.40	8.92	17.0
1212	79.00	8.02	1	4.00	16.00	7.60	18.80	6.40	2.80	9.48	18.8
1212	61.20	11.46	3	3.60	12.00	0.40	14.80	0.40	0.20	5.34	17.0
1213	81.00	11.04	5	4.20	15.20	8.60	15.00	9.20	3.00	9.38	20.7
1213	85.60	9.44	1	3.80	15.20	6.40	18.00	3.40	2.40	8.16	19.2
1213	82.20	8.68	1	3.20	14.00	6.40	18.20	6.40	2.60	10.06	20.7
1214	95.80	14.96	5	4.80	16.40	2.40	19.80	2.00	0.60	9.98	18.5
1214	89.50	17.50	1	5.75	16.25	2.50	16.25	1.25	0.50	7.25	15.6
1214	80.20	23.48	3	6.20	14.00	0.60	13.00	0.40	0.20	6.32	17.7
1221	94.43	19.43	5	6.00	15.14	0.57	16.71	0.57	0.29	6.07	18.7
1221	88.14	19.00	3	5.43	12.57	0.86	17.29	0.86	0.29	6.56	18.7
1221	86.71	14.83	3	5.00	15.14	2.00	15.57	1.86	0.86	6.87	19.0
1222	61.00	9.60	3	2.86	10.86	2.29	13.00	2.86	1.14	5.56	16.5
1222	75.71	21.30	5	5.43	13.43	2.29	15.71	1.57	1.14	5.99	16.5
1222	65.29	10.14	1	3.29	11.86	3.14	14.71	4.71	1.57	7.17	18.0

Table A 5 (cont'd.).

<u>TMC</u>	<u>PLHT</u>	<u>LNH</u>	<u>CHEMD</u>	<u>LNN</u>	<u>MN</u>	<u>BN</u>	<u>MP</u>	<u>BP</u>	<u>BNR</u>	<u>SW</u>	<u>100 SW</u>
1223	72.29	9.29	5	3.71	13.57	9.00	14.00	8.86	2.86	8.03	18.7
1223	88.29	15.67	1	4.57	15.00	3.71	15.00	2.86	1.43	6.70	19.2
1223	73.71	9.51	3	3.57	12.86	3.14	14.29	3.43	1.29	6.20	18.6
1224	82.00	22.46	3	6.43	14.86	0.00	13.71	0.00	0.00	5.89	16.3
1224	96.14	23.40	1	5.43	15.71	0.71	18.14	0.57	0.29	9.44	17.8
1224	85.86	21.36	1	6.57	16.14	0.00	18.00	0.00	0.00	8.41	18.1
1311	96.50	21.45	5	5.63	15.75	2.25	18.00	2.25	0.63	5.71	17.3
1311	80.50	19.40	5	6.50	16.13	2.13	19.38	2.25	0.63	7.83	18.5
1311	89.50	21.18	1	6.25	14.63	1.50	19.50	1.75	0.63	7.49	18.1
1312	74.13	16.18	3	4.38	12.63	2.25	15.50	2.63	1.00	6.70	18.1
1312	72.00	18.21	3	5.25	12.88	2.13	14.00	1.13	1.00	6.18	17.7
1312	70.25	16.94	3	4.88	12.63	1.88	13.13	1.75	0.88	6.18	18.7
1313	81.25	12.63	3	4.25	13.88	6.25	14.88	6.25	2.25	8.20	19.0
1313	74.63	10.44	5	4.00	16.50	9.38	19.13	8.38	2.63	10.30	19.0
1313	72.63	14.23	1	4.25	12.25	3.25	12.63	4.00	1.50	5.95	20.2
1314	88.50	20.96	3	5.75	14.75	0.50	16.75	0.75	0.38	7.63	16.2
1314	92.13	30.24	3	6.25	16.00	0.25	16.88	0.25	0.13	7.34	17.5
1314	88.63	21.16	1	5.13	14.00	1.00	17.25	1.13	0.50	7.25	17.9
1321	91.80	18.73	3	5.90	17.00	6.30	22.00	8.00	2.30	10.08	17.1
1321	91.20	21.43	3	5.50	12.90	2.00	13.40	2.70	1.00	5.43	18.5
1321	80.80	25.65	3	6.60	13.70	1.20	12.10	1.60	0.60	5.14	19.2
1322	69.60	18.45	3	4.40	11.40	3.30	12.40	2.80	1.50	5.15	17.3
1322	68.00	20.93	3	5.20	12.80	2.50	11.10	1.40	1.20	4.44	18.9
1322	69.70	22.42	3	5.30	11.50	0.70	13.90	0.90	0.30	5.52	17.7
1323	72.90	20.47	1	5.10	11.70	2.00	9.80	2.00	0.90	4.51	19.2
1323	73.10	14.66	3	4.40	13.50	4.30	11.50	3.30	1.60	5.55	17.8
1323	69.00	19.64	3	5.20	11.40	0.20	11.80	0.20	0.10	3.99	20.0
1324	84.00	23.24	1	5.80	14.20	1.00	14.60	1.20	0.50	7.06	17.2
1324	84.10	26.52	1	6.50	15.10	0.70	15.40	0.60	0.30	6.71	16.3
1324	89.00	26.01	1	6.80	15.70	0.50	15.90	0.50	0.20	7.21	17.9
2111	93.33	10.83	3	4.33	18.67	13.33	26.67	15.33	3.33	13.93	17.7
2111	93.67	10.50	5	4.33	18.67	10.00	32.67	13.33	2.67	14.47	16.8
2111	87.67	15.47	3	5.67	18.00	8.00	22.00	5.33	2.67	9.30	19.0
2112	74.33	7.43	3	2.00	13.67	5.33	23.33	6.67	1.67	9.83	18.5
2112	65.67	7.77	5	3.33	14.67	5.00	20.33	6.33	1.33	10.30	18.3
2112	69.00	7.67	1	3.33	13.00	5.00	21.00	7.33	2.33	10.77	17.6
2113	82.00	6.03	3	2.33	15.33	13.00	29.67	15.00	2.67	17.37	19.9
2113	74.33	7.73	5	3.00	14.33	3.33	27.00	4.33	1.33	12.50	19.6
2113	86.33	7.63	1	3.00	14.67	3.00	19.33	2.00	0.67	8.53	18.4
2114	93.67	16.17	3	5.33	18.33	4.67	22.67	3.00	1.33	12.30	17.6
2114	94.33	9.80	5	3.33	19.67	17.67	28.00	12.33	4.00	18.93	17.5
2114	101.33	14.90	3	4.67	19.00	8.33	25.67	4.33	2.00	14.07	16.6

Table A 5 (cont'd.).

<u>THC</u>	<u>PLHT</u>	<u>LNI</u>	<u>CHEPD</u>	<u>LNN</u>	<u>MN</u>	<u>BN</u>	<u>MP</u>	<u>BP</u>	<u>BNR</u>	<u>SW</u>	<u>100 SW</u>
2121	94.50	9.58	3	4.00	18.25	8.00	30.25	8.75	2.50	15.75	18.3
2121	79.25	25.88	5	7.00	14.25	0.00	15.00	0.00	0.00	5.85	18.2
2121	100.25	13.50	3	4.75	17.00	2.25	25.00	2.25	0.75	11.33	18.3
2122	77.50	11.15	3	4.25	15.50	1.75	19.75	1.50	0.75	8.20	20.8
2122	67.00	9.88	5	4.25	12.75	0.50	19.00	1.00	0.25	7.30	17.5
2122	81.25	10.08	1	3.00	12.75	0.50	21.00	0.75	0.25	8.93	18.9
2123	84.00	8.85	3	3.25	14.75	2.75	20.50	2.50	1.00	8.65	18.6
2123	80.00	11.58	5	3.75	13.75	3.75	20.50	4.25	1.25	9.50	18.8
2123	62.25	11.65	5	3.75	11.75	2.00	14.75	2.25	0.50	5.88	19.4
2124	96.25	21.00	1	6.25	16.25	0.00	24.00	0.00	0.00	11.48	16.9
2124	88.75	21.23	3	6.25	16.75	1.00	17.75	1.00	0.50	8.55	16.9
2124	83.75	16.23	5	4.75	16.25	0.75	19.00	0.75	0.25	8.63	16.4
2211	84.80	13.42	3	4.60	16.40	2.00	21.60	1.40	0.60	8.72	20.0
2211	94.40	16.48	5	5.80	17.40	2.40	21.20	1.80	0.80	6.68	18.8
2211	87.80	22.06	1	6.60	16.60	2.80	21.00	3.00	1.20	7.88	16.8
2212	60.40	9.38	3	3.80	13.40	2.80	16.20	2.40	1.00	7.10	17.5
2212	80.80	8.86	3	3.40	16.20	8.60	20.40	7.00	3.00	10.12	17.2
2212	68.20	16.48	1	4.60	11.60	0.40	16.20	0.80	0.20	5.86	15.2
2213	84.60	9.18	3	3.00	14.20	3.80	24.20	4.20	1.20	11.50	19.6
2213	90.00	9.98	5	3.40	13.60	2.80	25.00	2.00	1.20	10.06	18.2
2213	80.80	10.50	1	3.20	15.00	5.40	22.40	6.00	1.80	10.16	18.9
2214	87.40	19.96	3	5.40	16.80	0.80	14.40	0.80	0.40	7.96	19.3
2214	82.20	20.16	3	6.20	15.60	3.20	16.20	2.00	1.00	9.00	18.3
2214	103.20	17.40	1	5.20	18.60	2.80	30.40	1.00	1.00	14.08	17.8
2221	82.57	17.50	3	5.14	13.29	0.00	16.57	0.00	0.00	5.74	17.7
2221	91.29	17.31	3	5.14	14.43	1.14	17.71	1.57	0.43	6.83	18.0
2221	86.29	15.57	1	3.86	13.00	0.57	19.14	0.29	0.14	6.10	17.6
2222	66.71	11.31	3	3.00	11.43	2.71	16.71	2.43	1.00	6.97	16.8
2222	69.50	13.16	5	3.86	11.29	0.00	15.43	0.00	0.00	6.34	18.1
2222	73.14	20.77	1	5.29	13.14	0.57	18.29	0.29	0.29	6.30	16.2
2223	80.43	13.19	3	3.86	13.14	0.86	19.71	1.00	0.43	7.64	19.3
2223	83.86	10.54	3	3.57	13.29	1.14	20.14	0.57	0.43	7.74	20.2
2223	87.29	14.90	1	4.29	12.14	1.86	16.14	0.71	0.29	6.59	18.3
2224	72.57	23.29	5	5.43	11.86	0.57	11.43	1.00	0.14	5.29	17.7
2224	79.71	25.09	5	6.43	13.43	0.00	10.57	0.00	0.00	4.71	16.0
2224	90.29	26.00	1	6.14	14.29	0.00	15.86	0.00	0.00	7.19	15.9
2311	89.75	16.91	3	5.00	15.00	4.13	13.63	4.13	1.50	6.10	18.6
2311	109.50	17.31	5	5.13	16.75	7.00	23.63	8.25	2.75	10.86	17.6
2311	101.25	22.13	1	5.63	16.50	3.63	23.13	5.00	1.63	9.79	18.4
2312	80.13	10.70	1	2.63	12.50	1.63	22.38	1.88	0.50	8.75	17.9
2312	76.00	15.55	3	4.13	12.50	0.63	19.00	0.63	0.25	6.86	19.0
2312	87.13	18.30	1	5.00	14.13	1.63	19.75	1.00	0.75	7.86	16.0

Table A 5 (cont'd.).

<u>TMC</u>	<u>PLHT</u>	<u>LNH</u>	<u>CHEND</u>	<u>LNH</u>	<u>MN</u>	<u>BN</u>	<u>MP</u>	<u>BP</u>	<u>BNR</u>	<u>SW</u>	<u>100 SW</u>
2313	91.00	10.29	3	2.13	13.88	3.88	26.75	4.63	1.25	12.69	20.9
2313	85.25	11.98	3	3.63	14.00	2.63	22.25	3.75	1.13	9.16	19.7
2313	88.13	16.94	1	4.50	14.13	1.50	20.75	1.50	0.63	8.63	19.9
2314	94.63	20.05	3	5.50	16.75	1.38	21.13	1.13	0.50	9.84	17.1
2314	91.50	19.39	1	5.75	16.88	1.00	21.50	0.63	0.38	9.65	17.8
2314	98.63	24.51	1	6.13	16.50	1.25	17.88	0.75	0.50	8.83	17.5
2321	92.40	18.23	1	4.90	14.50	3.60	15.40	4.30	1.50	5.89	17.4
2321	81.80	18.51	3	5.40	13.70	0.80	17.10	1.20	0.30	6.37	18.2
2321	84.40	22.22	1	5.40	12.70	0.50	19.00	0.90	0.20	6.60	16.9
2322	71.40	21.14	1	4.80	11.00	0.00	13.80	0.00	0.00	5.31	18.6
2322	82.10	19.16	3	4.30	12.90	0.20	14.90	0.20	0.10	5.75	19.1
2322	74.00	23.30	1	5.10	12.00	0.80	14.60	0.60	0.40	5.22	16.9
2323	80.70	12.70	1	3.20	12.60	0.70	18.30	0.80	0.40	7.33	18.9
2323	83.30	15.73	3	4.00	12.70	1.10	18.90	0.80	0.40	7.16	19.7
2323	79.50	17.12	1	3.90	12.20	0.00	17.80	0.00	0.00	7.09	17.9
2324	88.78	22.79	1	5.56	15.56	0.56	14.89	0.33	0.22	7.16	18.0
2324	71.90	16.50	5	4.10	12.30	2.10	16.00	2.30	0.70	6.47	16.9
2324	75.70	31.29	1	6.60	11.90	0.00	8.70	0.00	0.00	4.34	18.0
3111	79.00	5.63	0	3.00	15.00	6.67	29.33	7.00	2.33	9.27	12.9
3111	92.33	8.97	0	4.67	18.33	5.00	29.33	6.67	1.67	10.10	14.5
3111	67.00	9.97	0	4.67	14.00	3.00	23.33	2.33	1.00	6.03	12.9
3112	76.33	5.37	0	2.33	13.33	5.67	21.67	6.33	2.00	11.47	18.6
3112	69.00	5.57	0	2.67	14.67	2.00	21.33	1.67	0.67	7.93	17.8
3112	55.67	7.03	0	3.00	13.33	5.67	17.67	5.33	2.33	8.00	15.3
3113	82.00	7.00	0	2.67	15.67	12.00	30.00	20.00	3.00	17.23	17.6
3113	85.33	6.90	0	2.67	15.33	4.33	26.00	7.00	1.33	10.87	17.7
3113	68.67	8.23	0	4.00	15.67	8.33	23.33	9.33	2.67	9.57	16.2
3114	80.00	20.13	0	6.00	14.67	0.67	17.67	0.67	0.33	7.20	16.1
3114	81.83	22.60	0	6.67	14.67	0.00	15.00	0.00	0.00	5.93	14.5
3121	71.33	19.30	0	7.00	15.00	1.33	15.67	1.67	0.67	6.30	16.7
3121	90.50	18.75	0	6.25	15.50	0.75	27.25	1.00	0.25	8.38	14.9
3121	87.00	15.90	0	6.00	15.00	3.00	22.25	3.50	1.25	6.13	14.5
3121	67.75	16.43	0	6.25	13.50	1.00	17.25	1.75	0.50	5.03	14.1
3122	65.75	9.65	0	4.25	12.50	0.75	19.25	1.00	0.50	6.60	16.2
3122	71.50	9.30	0	3.75	14.25	3.00	22.25	2.50	1.00	8.20	17.1
3122	61.25	9.30	0	3.50	11.75	2.75	18.75	3.50	1.25	5.83	15.1
3123	73.50	7.40	0	3.00	13.25	1.50	17.50	1.50	0.75	6.10	17.1
3123	76.25	6.23	0	2.25	14.25	5.50	22.50	8.25	1.50	9.50	17.0
3123	65.00	11.05	0	4.00	12.00	0.00	17.00	0.00	0.00	5.00	16.4
3124	83.25	21.10	0	6.25	15.00	1.00	18.25	1.00	0.50	6.53	15.8
3124	85.50	23.38	0	6.25	15.00	0.00	18.50	0.00	0.00	7.10	17.4
3124	62.00	20.65	0	6.25	13.00	0.00	14.25	0.00	0.00	4.65	15.8

Table A 5 (cont'd.).

<u>TMC</u>	<u>PLHT</u>	<u>LNH</u>	<u>CHEND</u>	<u>LNN</u>	<u>MN</u>	<u>BN</u>	<u>MP</u>	<u>BP</u>	<u>BNR</u>	<u>SW</u>	<u>100 SW</u>
3211	86.40	8.94	0	3.60	15.40	2.40	32.00	4.60	0.80	9.72	14.8
3211	89.80	12.54	0	4.40	16.00	2.60	32.40	4.00	1.20	9.38	14.2
3211	74.80	10.16	0	4.00	14.20	7.00	22.60	9.60	2.80	9.40	15.0
3212	68.40	8.38	0	3.20	13.20	3.00	21.00	4.20	1.00	8.96	17.9
3212	66.00	9.76	0	3.00	12.80	2.20	16.00	3.00	0.80	6.86	19.4
3212	59.40	6.26	0	3.00	12.60	4.20	22.40	6.00	1.80	9.62	17.6
3213	75.00	7.30	0	3.00	13.80	4.20	25.40	5.20	1.40	9.90	16.1
3213	78.80	9.58	0	3.20	13.40	3.80	20.40	3.60	1.00	8.06	18.9
3213	68.20	8.44	0	3.40	13.80	1.20	18.20	1.60	0.60	7.00	19.2
3214	78.40	14.34	0	4.60	14.80	3.40	20.40	3.80	1.20	9.18	15.1
3214	87.60	14.20	0	4.80	15.40	2.20	21.80	2.00	0.80	10.66	16.8
3214	74.00	18.86	0	6.00	15.60	4.00	15.20	5.20	1.80	7.16	15.5
3221	77.57	11.19	0	4.14	14.71	2.71	21.43	3.00	1.00	6.49	14.9
3221	86.29	17.80	0	5.71	14.57	1.86	22.57	2.29	0.86	6.69	14.5
3221	66.86	14.61	0	4.71	13.43	1.86	17.00	2.14	0.86	4.63	13.6
3222	66.00	12.39	0	4.14	12.00	0.00	17.00	0.00	0.00	5.40	16.4
3222	77.00	9.07	0	3.14	14.00	3.14	23.00	3.71	1.29	8.77	17.3
3222	52.00	7.54	0	2.86	10.71	3.00	13.29	3.29	1.14	4.99	17.0
3223	66.14	12.96	0	4.00	10.71	0.57	13.00	0.57	0.29	4.77	17.6
3223	73.57	12.00	0	3.86	12.57	0.71	18.14	0.86	0.29	6.19	18.8
3223	61.80	10.20	0	4.00	13.60	2.00	22.20	2.00	0.80	5.64	15.9
3224	82.43	20.69	0	6.14	15.29	0.00	18.57	0.00	0.00	7.51	15.0
3224	84.43	24.90	0	6.14	13.14	0.00	14.71	0.00	0.00	5.71	15.8
3224	72.43	16.90	0	4.14	11.86	0.43	15.14	0.43	0.14	6.00	16.4
3311	87.25	13.45	0	4.50	15.00	4.13	23.63	5.00	1.75	8.81	15.4
3311	79.25	11.98	0	4.13	14.88	5.13	21.63	9.00	1.88	7.80	14.6
3311	71.88	16.19	0	5.00	13.25	2.13	16.63	2.88	1.00	5.21	15.0
3312	67.25	9.40	0	3.00	12.63	2.38	17.13	4.13	1.13	7.41	18.8
3312	69.63	10.99	0	3.50	12.50	2.38	19.13	2.75	1.25	7.50	16.4
3312	50.88	11.71	0	3.25	10.38	1.50	10.00	1.75	0.63	4.69	17.7
3313	70.75	12.25	0	3.63	12.13	1.38	18.00	1.88	0.63	6.56	18.4
3313	74.13	11.30	0	3.75	12.75	1.50	20.38	2.25	0.63	7.48	18.3
3313	66.38	12.76	0	4.00	12.38	0.75	19.25	0.88	0.25	6.49	16.5
3314	77.25	20.00	0	4.75	15.88	0.38	15.88	0.25	0.13	6.59	14.7
3314	81.75	12.63	0	4.25	14.63	3.50	19.63	3.25	1.00	9.56	16.2
3314	73.75	18.25	0	6.00	15.13	1.63	16.13	1.75	0.63	6.61	15.0
3321	81.70	15.21	0	4.40	13.30	0.20	21.00	0.40	0.10	5.80	14.7
3321	88.10	19.82	0	5.40	14.20	1.20	21.00	2.20	0.40	6.10	13.7
3321	75.80	13.60	0	4.50	12.20	1.40	18.60	1.80	0.70	5.85	15.4
3322	73.10	11.01	0	3.40	11.50	1.90	17.80	1.40	0.70	6.93	17.8
3322	67.70	15.50	0	4.40	12.00	1.80	14.50	3.00	1.00	5.43	17.7
3322	58.90	12.29	0	3.60	11.00	1.90	12.70	2.20	0.90	5.10	17.2

Table A 5 (cont'd.).

<u>TMC</u>	<u>PLHT</u>	<u>LNH</u>	<u>CHEHD</u>	<u>LNN</u>	<u>MN</u>	<u>BN</u>	<u>MP</u>	<u>BP</u>	<u>BNR</u>	<u>SW</u>	<u>100 SW</u>
3323	70.10	16.06	0	4.00	11.20	0.80	13.70	1.10	0.30	4.91	18.5
3323	78.00	17.66	0	5.00	12.60	1.20	16.70	1.50	0.60	5.83	16.9
3323	64.00	14.07	0	4.11	10.89	1.44	14.00	1.11	0.44	5.47	17.7
3324	74.50	24.23	0	5.00	11.80	0.20	12.60	0.20	0.10	5.40	15.5
3324	71.40	19.89	0	5.30	12.80	0.90	12.80	0.90	0.40	4.81	14.9
3324	72.60	22.38	0	5.60	12.70	0.00	12.60	0.00	0.00	4.51	15.2

Table A 6 . Raw data for 1979 Chesaning yield components including whole plant measurements.

<u>TMC</u>	<u>LNH</u>	<u>LNN</u>	<u>MN</u>	<u>BN</u>	<u>MP</u>	<u>BP</u>	<u>BNR</u>	<u>SW</u>	<u>PLHT</u> <u>(in)</u>	<u>100</u> <u>SW</u>
111	12.55	5.50	15.75	3.50	21.25	4.50	1.50	9.04	37	16.1
111	21.00	6.50	16.00	1.50	20.00	1.75	0.50	5.99	39	15.7
111	15.98	5.00	14.25	1.50	18.50	1.25	0.75	4.93	38	15.7
112	17.10	5.50	13.75	0.00	20.50	0.00	0.00	5.98	30	16.1
112	22.50	5.75	14.50	2.00	16.00	0.50	0.75	4.75	33	15.0
112	17.88	6.00	14.50	0.50	20.50	0.25	0.25	5.63	33	15.6
116	27.13	8.25	16.75	0.00	16.50	0.00	0.00	5.47	38	17.8
116	38.70	7.75	14.00	0.00	11.75	0.00	0.00	4.12	37	16.6
116	12.85	5.50	17.50	4.00	24.50	2.00	1.75	7.50	33	17.0
117	26.14	7.60	14.80	0.00	13.60	0.00	0.00	4.99	32	17.0
117	29.50	7.80	15.80	0.00	17.80	0.00	0.00	5.02	36	15.9
117	33.04	8.20	14.80	0.00	8.40	0.00	0.00	3.20	36	17.9
121	11.68	4.80	17.40	6.20	28.60	6.80	1.80	9.97	37	15.4
121	10.94	4.80	16.40	4.60	29.20	6.40	2.00	11.29	40	16.8
121	12.24	4.80	17.00	8.20	25.00	9.60	2.00	9.34	39	15.3
122	9.14	4.20	13.40	4.20	19.00	4.20	1.60	6.04	32	16.7
122	6.40	3.00	15.20	8.80	24.40	9.60	2.80	10.92	34	16.3
122	8.72	3.80	13.60	3.40	17.20	3.00	1.20	6.27	32	16.3
126	4.96	3.40	16.80	7.40	20.80	4.80	2.40	10.32	35	17.4
126	23.84	7.20	17.80	1.60	21.20	0.20	0.80	8.46	36	17.8
126	14.42	5.20	17.00	4.80	24.80	2.00	1.80	10.23	36	17.4
127	22.01	5.43	13.00	2.29	12.57	1.14	0.86	5.19	36	18.0
127	23.96	6.86	15.57	1.29	18.57	0.43	0.57	9.94	39	18.1
127	20.76	5.71	13.43	0.57	15.29	0.29	0.29	6.29	38	18.0
131	12.00	4.86	14.57	4.57	21.71	6.29	1.71	9.17	34	15.1
131	19.19	6.00	15.86	2.71	19.43	2.29	1.14	7.08	39	16.9
131	17.03	6.00	14.00	1.86	14.86	2.00	1.00	5.99	39	15.8
132	7.70	3.43	14.29	5.43	24.57	7.00	2.00	10.74	32	17.0
132	6.73	3.29	14.29	5.00	26.29	4.86	1.71	10.10	32	16.5
132	8.31	3.71	12.86	5.71	18.57	7.71	2.00	7.95	34	16.2
136	10.73	4.43	14.43	4.29	21.71	3.00	1.29	9.68	34	17.3
136	14.80	5.14	16.29	3.43	25.00	2.57	1.29	9.54	37	18.0
136	9.19	4.71	17.00	4.29	24.57	3.14	1.57	11.07	37	17.4
137	22.89	5.60	13.60	0.70	15.60	0.70	0.20	3.52	35	18.2
137	20.60	5.50	13.40	0.20	9.80	0.00	0.10	3.61	38	18.0
137	23.35	6.10	13.90	1.50	15.00	0.80	0.70	5.28	35	16.9
211	16.23	5.25	15.75	4.00	25.00	4.00	1.50	9.01	36	14.6
211	13.38	5.00	14.75	3.25	21.25	3.75	1.25	8.17	37	15.7
211	10.38	4.25	14.75	2.75	19.00	2.75	1.25	9.09	37	15.4
212	18.05	6.00	14.50	0.00	18.75	0.00	0.00	6.98	32	15.2
212	12.83	5.00	14.25	1.00	18.50	0.50	0.50	6.71	31	16.2
212	10.08	4.25	16.00	4.25	20.00	2.75	1.50	7.20	34	16.2
216	25.75	7.50	15.25	0.00	15.75	0.00	0.00	5.24	34	16.0
216	19.88	7.00	17.25	2.50	24.75	1.00	1.00	9.48	35	16.7
216	15.25	6.50	17.25	1.25	22.25	0.25	0.50	6.64	35	15.8

Table A 6 (cont'd.).

<u>TMC</u>	<u>LNH</u>	<u>LNN</u>	<u>MN</u>	<u>BN</u>	<u>MP</u>	<u>BP</u>	<u>BNR</u>	<u>SW</u>	<u>PLHT</u> <u>(in)</u>	<u>100</u> <u>SW</u>
217	16.84	6.00	15.00	0.00	19.40	0.00	0.00	6.84	33	17.0
217	29.00	7.00	15.00	0.00	16.40	0.00	0.00	5.73	36	15.4
217	30.98	8.20	15.80	0.00	15.20	0.00	0.00	5.13	36	16.1
221	11.58	4.60	14.80	1.60	19.40	1.60	0.60	7.06	36	16.0
221	12.56	4.80	15.40	4.00	24.00	3.60	1.20	9.38	36	15.3
221	11.94	4.60	15.80	5.00	24.60	4.40	1.80	7.54	36	16.1
222	9.76	4.00	13.20	3.20	21.60	4.60	1.20	7.80	30	15.6
222	8.90	3.60	14.00	5.20	21.80	5.00	1.80	8.22	30	15.5
222	7.90	3.60	15.20	4.80	25.60	5.00	1.60	10.58	32	16.0
226	12.88	5.20	16.20	2.00	22.00	0.80	0.80	8.38	34	17.3
226	19.06	6.60	15.60	1.40	22.60	0.80	0.60	7.97	34	16.2
226	20.96	7.00	16.60	1.20	28.60	0.40	0.60	9.84	34	16.3
227	14.37	5.14	14.14	1.71	16.71	0.71	0.71	6.31	30	15.4
227	18.31	6.14	16.14	0.57	20.00	0.57	0.29	7.62	35	16.4
227	23.43	6.14	15.14	0.00	18.29	0.00	0.00	7.10	35	17.0
231	8.17	4.00	15.43	7.14	25.14	8.29	2.00	10.29	34	16.2
231	9.53	4.14	15.86	9.14	27.29	10.86	2.43	10.84	39	16.5
231	9.87	4.14	16.71	6.71	30.29	7.14	2.00	11.36	37	15.7
232	6.73	3.00	14.43	6.57	23.29	7.57	2.29	9.99	33	16.2
232	10.27	4.14	13.57	3.71	19.14	4.57	1.29	7.03	32	16.3
232	13.86	4.29	12.71	2.14	18.43	2.00	0.86	6.41	34	16.5
236	16.41	5.57	16.43	4.29	27.71	2.43	1.57	11.54	36	16.5
236	13.44	5.29	16.43	4.14	22.86	4.00	1.71	8.46	31	17.0
236	17.66	5.57	15.86	2.86	21.71	0.86	1.00	8.37	34	16.7
237	18.85	5.60	14.70	1.10	19.20	1.80	0.50	7.54	33	16.1
237	22.39	5.80	13.90	0.60	16.20	0.40	0.30	5.76	35	16.5
237	22.43	6.20	13.10	0.20	13.40	0.20	0.10	4.62	33	16.5
311	11.68	4.00	15.00	4.25	25.75	5.00	1.75	7.47	32	17.1
311	19.85	6.50	11.25	0.00	8.00	0.00	0.00	1.41	26	13.2
311	21.88	6.00	14.25	0.00	20.50	0.00	0.00	4.36	34	12.9
312	8.33	3.25	13.25	5.25	19.50	4.00	2.25	7.10	29	12.6
312	15.80	5.25	13.50	1.00	20.75	0.75	0.50	5.72	27	12.9
312	12.93	4.50	13.00	2.50	20.75	1.50	1.25	4.74	30	12.0
316	20.08	6.75	14.25	0.00	19.00	0.00	0.00	5.33	28	17.2
316	15.00	6.00	15.25	0.00	22.50	0.00	0.00	5.80	26	13.9
316	20.23	6.25	14.00	0.50	17.00	0.50	0.25	2.21	30	11.0
317	15.40	5.40	13.60	0.00	17.80	0.00	0.00	4.43	30	12.3
317	17.60	6.00	13.80	0.00	16.20	0.00	0.00	4.19	29	13.0
317	33.12	7.80	12.40	0.00	8.40	0.00	0.00	1.47	31	11.8
321	8.38	3.40	14.40	7.60	22.60	9.00	2.80	8.59	30	13.4
321	14.16	5.20	16.00	5.20	25.20	6.00	1.80	7.31	34	13.3
321	11.40	4.40	12.40	6.20	19.80	4.40	2.60	5.80	31	17.7
322	10.20	3.40	13.60	3.20	20.80	2.60	1.40	6.01	31	13.1
322	10.46	3.80	13.80	5.60	20.40	4.60	2.00	7.28	30	14.7
322	11.26	4.20	14.20	5.60	20.20	4.40	1.80	6.12	30	12.9
326	8.58	3.60	15.80	7.40	25.60	6.00	3.00	8.16	29	13.0
326	13.94	4.60	14.20	4.00	20.60	2.40	1.60	6.77	31	13.7
326	14.42	5.00	15.20	3.20	23.20	3.20	1.20	6.51	30	13.2

Table A 6 (cont'd.).

<u>TMC</u>	<u>LNH</u>	<u>LNN</u>	<u>MN</u>	<u>BN</u>	<u>MP</u>	<u>BP</u>	<u>BNR</u>	<u>SW</u>	<u>PLHT</u> <u>(in)</u>	<u>100</u> <u>SW</u>
327	19.80	5.57	13.29	0.00	17.14	0.00	0.00	4.51	28	18.0
327	20.46	6.14	14.86	0.00	22.29	0.00	0.00	6.86	32	14.2
327	24.60	6.43	14.00	0.28	18.71	0.14	0.14	4.06	30	13.0
331	10.49	3.86	14.14	6.71	24.29	10.14	2.29	8.59	28	13.0
331	16.90	5.00	14.00	3.86	24.57	4.57	1.71	5.55	37	13.1
331	13.97	4.29	14.14	3.43	22.00	2.71	1.14	7.12	36	13.6
332	12.13	3.71	13.00	4.57	20.00	4.43	2.00	6.77	28	13.3
332	14.87	4.43	13.43	3.86	20.29	4.00	1.57	6.81	34	15.2
332	12.56	4.00	13.57	4.00	20.43	3.43	1.86	6.10	31	13.8
336	16.43	5.00	13.86	1.86	20.43	1.14	0.57	7.22	28	14.2
336	23.59	6.43	14.86	0.00	20.71	0.00	0.00	4.99	33	13.4
336	13.94	5.00	16.14	5.86	28.00	4.57	2.57	9.61	30	14.0
337	18.40	4.60	12.70	2.40	17.60	2.30	1.00	4.72	31	18.0
337	22.58	5.70	13.00	0.40	15.80	0.10	0.20	4.75	33	13.9
337	18.76	5.00	13.90	0.40	20.80	0.20	0.20	5.86	32	13.8

Table A 7. Raw data for 1979 Cheneaning yield components including measurements for one-third plant sections.

THC	LNH	LNN	NN-1	BN-1	MP-1	BP-1	BNR-1	SW-1	NN-2	BN-2	MP-2	BP-2	BNR-2	SW-2	NN-3	BN-3	MP-3	BP-3	BNR-3	SW-3	PLHT (in)	100 SW
113	10.58	4.75	5.75	1.25	1.75	1.00	1.00	1.06	5.00	3.00	10.25	4.00	0.50	5.41	4.50	0.00	5.25	0.00	0.00	1.71	38	17.0
113	12.00	4.75	5.50	0.75	0.75	0.50	1.50	0.45	5.50	5.00	15.50	7.00	0.00	7.44	5.00	0.50	5.00	0.25	0.25	0.92	36	15.9
113	9.30	4.50	5.75	1.00	1.00	0.50	1.50	0.30	5.25	6.75	13.50	5.50	1.00	5.93	4.50	0.00	9.00	0.00	0.00	2.05	35	17.8
114	23.88	7.75	7.00	2.25	0.50	0.00	1.50	0.17	5.75	1.75	10.50	2.25	0.25	4.93	4.75	0.00	5.25	0.00	0.00	1.41	39	15.0
114	19.30	6.50	6.50	1.50	0.50	0.00	0.50	0.07	5.75	0.75	7.50	1.00	0.00	2.59	5.50	0.00	5.75	0.00	0.00	2.12	40	13.1
114	20.80	7.00	6.00	0.00	0.00	0.00	0.00	0.00	4.75	0.00	6.50	0.00	0.00	1.77	4.75	0.00	5.00	0.00	0.00	1.48	38	14.9
115	20.30	7.25	6.25	1.00	0.00	0.00	0.75	0.00	6.25	1.50	6.25	0.00	0.00	2.27	5.75	0.00	7.00	0.00	0.00	1.82	40	18.9
115	18.30	7.00	6.00	0.00	0.00	0.00	0.00	0.00	6.00	5.00	8.00	0.00	0.00	3.42	5.75	0.00	4.00	0.00	0.00	1.50	39	18.0
115	20.25	7.25	6.25	0.50	0.00	0.00	0.75	0.00	6.75	0.00	9.50	0.00	0.00	3.83	5.25	0.00	6.00	0.00	0.00	2.01	38	17.8
123	11.84	4.80	5.20	1.20	0.80	0.60	1.40	0.32	5.00	4.00	9.80	3.60	1.40	4.48	4.00	0.00	6.00	0.00	0.00	1.80	37	16.4
123	7.44	4.00	5.80	1.80	1.20	0.60	2.20	0.61	5.80	7.80	16.00	10.40	0.60	8.79	4.80	0.40	10.60	0.40	0.00	3.61	37	18.1
123	10.50	4.40	4.80	0.60	0.80	0.40	0.80	0.50	5.00	1.80	11.20	2.00	0.40	5.41	4.80	0.00	6.40	0.00	0.00	1.87	34	17.2
124	8.33	4.00	6.20	1.80	0.20	0.80	1.40	0.25	5.80	3.40	10.80	2.20	1.00	4.73	5.80	0.00	9.40	0.00	0.00	3.31	40	15.4
124	15.28	5.60	6.40	2.40	0.20	0.40	1.80	0.15	6.40	7.00	12.60	6.40	0.80	8.05	6.00	0.00	10.00	0.00	0.00	4.08	42	16.1
124	20.12	7.00	6.80	2.40	0.00	0.20	2.40	0.08	6.20	4.00	13.40	2.60	0.75	6.46	5.60	0.00	9.80	0.00	0.00	3.64	40	16.0
125	15.96	5.20	5.80	2.40	0.60	0.20	2.00	0.26	5.80	2.20	9.40	0.40	0.00	4.22	5.40	0.40	7.60	0.00	0.00	2.16	35	19.1
125	21.38	6.80	6.80	3.60	0.60	0.40	2.40	0.52	6.00	4.20	12.20	2.80	0.00	6.48	4.80	0.00	5.40	0.00	0.00	1.46	36	19.1
125	24.42	7.80	6.80	2.20	0.00	0.00	2.40	0.00	6.40	4.60	15.60	3.00	0.00	9.58	5.80	0.80	6.00	0.20	0.00	2.48	39	20.7
133	8.09	3.14	5.29	1.29	2.43	1.29	1.71	0.86	5.00	7.29	14.86	8.57	1.00	7.28	5.14	0.29	9.14	0.43	0.00	2.97	35	18.0
133	10.90	4.57	5.14	0.57	1.43	0.14	1.14	0.44	5.14	5.71	13.00	5.14	1.00	5.76	4.43	0.43	7.29	0.43	0.00	2.07	37	17.3
133	12.64	4.86	5.29	0.86	0.71	0.57	1.57	0.44	4.86	7.14	12.29	5.86	1.00	5.69	5.57	0.00	8.43	0.00	0.00	2.52	36	17.5
134	17.14	5.57	6.14	4.14	0.29	1.57	2.29	0.77	5.86	4.57	11.86	4.57	0.71	7.14	5.57	0.00	8.57	0.00	0.00	3.63	44	16.1
134	18.79	6.29	6.57	2.00	0.00	0.43	1.71	0.11	6.14	1.29	10.43	1.57	0.00	4.98	5.86	0.00	7.00	0.00	0.00	3.28	42	15.1
134	18.71	6.14	6.00	2.00	0.14	0.57	1.71	0.19	5.57	3.57	10.00	3.14	0.50	5.14	5.57	0.00	8.29	0.00	0.00	3.30	43	16.8
135	19.53	5.86	6.00	1.57	0.14	1.14	1.29	0.51	5.71	2.71	13.71	1.29	0.29	6.86	5.00	0.00	7.14	0.00	0.00	2.72	39	20.8
135	21.04	7.00	6.43	1.57	0.14	0.43	1.86	0.23	6.14	3.57	9.57	1.29	0.71	4.13	5.86	0.86	8.71	0.43	0.00	2.63	38	18.7
135	13.43	4.86	6.00	1.57	0.00	0.57	1.57	0.18	5.86	3.57	10.86	2.14	0.29	5.80	4.86	0.00	5.86	0.00	0.00	2.04	36	18.7
213	14.25	5.75	5.25	1.00	0.00	0.25	1.75	0.09	5.00	3.25	12.50	2.75	0.00	5.68	5.25	0.00	8.25	0.00	0.00	2.49	34	16.0
213	11.65	4.50	5.50	1.75	1.75	1.00	1.50	0.93	5.25	1.25	15.00	1.25	0.00	6.76	5.00	0.00	7.25	0.00	0.00	2.07	35	17.2
213	9.08	3.75	5.50	1.25	2.00	1.25	1.75	1.10	5.25	3.50	14.50	2.25	0.00	5.60	4.75	0.00	7.50	0.00	0.00	2.13	36	15.5
214	19.63	7.00	6.25	1.25	0.00	0.25	1.00	0.03	5.75	0.50	11.00	0.00	0.25	4.85	4.75	0.00	6.25	0.00	0.00	2.35	38	14.0
214	20.15	7.00	6.75	3.00	1.00	0.50	1.50	0.34	6.25	0.00	10.75	0.00	0.00	4.65	5.50	0.00	11.00	0.00	0.00	3.21	39	13.8
214	17.98	6.75	5.75	0.00	0.00	0.00	0.00	0.00	5.50	0.00	10.00	0.00	0.00	3.81	5.00	0.00	6.50	0.00	0.00	2.14	39	15.1
215	17.20	6.50	5.50	0.00	0.00	0.00	0.00	0.00	5.50	1.00	9.00	1.00	0.50	4.34	5.25	0.00	5.00	0.00	0.00	1.80	35	17.4
215	22.75	8.00	7.00	1.75	0.00	0.00	1.25	0.00	6.00	0.50	12.25	0.25	0.25	5.55	5.25	0.00	7.50	0.00	0.00	2.33	37	18.6
215	23.25	7.50	6.50	0.25	0.00	0.00	0.50	0.00	6.00	0.00	6.75	0.00	0.00	2.78	5.25	0.00	6.25	0.00	0.00	1.34	37	17.4
223	8.36	3.40	5.00	1.60	1.40	1.60	2.20	0.92	5.00	5.60	13.60	4.20	0.00	6.22	4.80	0.00	9.00	0.00	0.00	2.95	34	17.2
223	10.26	4.00	5.00	1.00	1.00	0.80	1.20	0.70	4.80	1.40	11.40	1.00	0.00	4.89	4.40	0.00	5.80	0.00	0.00	1.74	35	16.8
223	8.60	4.00	5.60	1.40	1.40	1.00	1.80	0.76	5.00	3.00	14.20	4.20	0.00	6.43	5.40	0.00	8.40	0.00	0.00	2.47	36	16.8
224	16.80	6.20	5.60	1.20	0.40	0.00	0.60	0.05	5.40	0.40	10.00	0.20	0.00	3.67	5.20	0.00	7.00	0.00	0.00	2.03	37	15.0
224	18.40	6.40	6.20	2.20	0.80	0.40	1.40	0.56	6.00	0.00	16.00	0.00	0.00	6.84	5.60	0.00	9.40	0.00	0.00	2.83	37	14.3
224	19.96	7.20	6.40	1.60	0.40	0.00	1.20	0.21	6.40	1.80	14.00	1.00	0.00	7.02	5.60	0.00	9.40	0.00	0.00	3.58	40	15.0

Table A8. Analyses of variance of soybean yields (ql/ha) for both 1978 locations as influenced by replication (R), planting date (D), row width (W), plant density (P) and cultivar (C).

Source	df	Carleton Location		Chesaning Location	
		Mean Square	F	Mean Square	F
R	2	72.70	1.61	352.10	10.53*
D	2	828.86	18.39**	99.64	2.98
Error 1	4	45.08		33.44	
W	2	593.37	14.47***	217.94	21.43***
DxW	4	80.94	1.97	33.94	3.34*
Error 2	12	41.02		10.17	
P	1	4.21	0.59	5.10	1.17
DxP	2	15.00	2.10	12.26	2.80
WxP	2	1.93	0.27	1.75	0.40
DxWxP	4	25.43	3.56**	2.03	0.46
C	3	83.44	11.67***	81.02	18.54***
DxC	6	22.84	3.20**	19.11	4.37***
WxC	6	1.92	0.27	9.11	2.08*
DxWxC	12	8.34	1.17	6.57	1.50
PxC	3	11.64	1.63	11.42	2.61*
DxPxC	6	5.84	0.82	4.59	1.05
WxPxC	6	11.08	1.55	4.28	0.98
DxWxPxC	12	5.30	0.74	4.16	0.95
Error 3	126	7.15		4.37	

*** Denotes significance at the 0.001 probability level.

** Denotes significance at the 0.01 probability level.

* Denotes significance at the 0.05 probability level.

Table A9. Analysis of variance of soybean yields (q1/ha) for the combined 1978 locations as influenced by location (L), replication (R), planting date (D), row width (W), plant density (P), and cultivar (C).

<u>Source</u>	<u>df</u>	<u>Mean Square</u>	<u>F</u>
L	1	2788.07	71.01***
R(L)	4	212.40	5.41*
D	2	740.00	18.85***
LxD	2	188.51	4.80*
Error 1	8	39.26	
W	2	764.37	29.86***
LxW	2	46.94	1.83
DxW	4	85.84	3.35*
LxDxW	4	29.04	1.13
Error 2	24	25.59	
P	1	9.29	1.61
LxP	1	0.02	0.004
DxP	2	20.55	3.57*
LxDxP	2	6.70	1.16
WxP	2	1.19	0.21
LxWxP	2	2.48	0.43
DxWxP	4	9.74	1.69
LxDxWxP	4	17.72	3.08*
C	3	139.29	24.18***
LxC	3	25.17	4.37**
DxC	6	34.01	5.90***
LxDxC	6	7.95	1.38
WxC	6	2.36	0.41
LxWxC	6	8.67	1.51
DxWxC	12	4.90	0.85
PxC	3	5.25	0.91
LxPx C	3	17.81	3.09*
DxPx C	6	4.70	0.82
LxDxPx C	6	5.73	1.00
WxPx C	6	9.87	1.71
LxWxPx C	6	5.49	0.95
DxWxPx C	12	5.59	0.97
LxDxWxPx C	12	3.86	0.67
LxDxWxC	12	10.01	1.74*
Error 3	252	5.76	

*** Denotes significance at the 0.001 probability level

** Denotes significance at the 0.01 probability level

* Denotes significance at the 0.05 probability level

Table A10. Analyses of variance of soybean yields (q1/ha) for both 1979 locations as influenced by replication (R), planting date (D), row width (W) and cultivar (C).

Source	df	Chesaning Location		Dundee Location	
		Mean Square	F	Mean Square	F
R	2	1.28	0.06	7.40	0.22
D	2	508.77	22.14***	1147.64	34.66***
W	2	114.20	4.97*	596.88	18.03***
DxW	4	49.86	2.17	67.12	2.03
Error 1	16	22.98		33.11	
C	6	40.58	10.39***	146.92	14.68***
DxC	12	8.46	2.17*	21.21	2.12*
WxC	12	6.25	1.60	20.08	2.01*
DxWxC	24	4.73	1.21	11.68	1.17
Error 2	108	3.91		10.01	

*** Denotes significance at the 0.001 probability level.

* Denotes significance at the 0.05 probability level.

Table All. Analysis of variance of soybean yields (ql/ha) for the combined 1979 locations as influenced by location (L), replication (R), planting date (D), row width (W) and cultivar (C).

<u>Source</u>	<u>df</u>	<u>Mean Square</u>	<u>F</u>
L	1	13636.78	471.31***
R(L)	4	3.89	0.13
D	2	1524.23	52.68***
LxD	2	155.28	5.37**
W	2	505.32	17.46***
LxW	2	212.27	7.34**
DxW	4	11.27	0.39
LxDxW	4	99.86	3.45*
Error 1	32	28.93	
C	6	99.13	13.51***
LxC	6	105.49	14.38***
DxC	12	11.68	1.59
LxDxC	12	12.16	1.66
WxC	12	19.78	2.70**
LxWxC	12	5.08	0.69
DxWxC	24	11.04	1.50
LxDxWxC	24	7.21	0.98
Error 2	216	7.34	

*** Denotes significance at the 0.001 probability level.

** Denotes significance at the 0.01 probability level.

* Denotes significance at the 0.05 probability level.

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