THE YIELD OF TOMATOES, CUCUMBERS, AND SWEET CORN WITH ALFALFA HAY APPLIED AS A SIDEDRESSING

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ABSTRACT

THE YIELD OF TOMATOES, CUCUMBERS, AND

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By

George Damian Morris

Air dried alfalfa hay (Medicago sativa L. cv. 'Vernal') was shredded and evenly applied at planting in a band beside and below vegetable seed in field experiments. Tomato (Lycopersicon esculentum L. cv. 'Campbell 1327') and cucumber (Cucumis sativa L. cv. 'Green Star') tests were conducted at two locations. Sweet corn (Zea mays L. cv. 'Spring Gold') was tested at one location. One hundred to 400 kilograms per hectare of alfalfa hay did not increase yields of these crops when compared to controls receiving equal levels of mineral fertilizer. Supplemental nitrogen applications increased the yield of tomatoes and sweet corn at one location. Tomatoes treated with alfalfa hay had equivalent yields to treatments receiving starter solution at planting. On a medium fertility soil, tomato yields of both the 200 kilogram per hectare of alfalfa hay plus starter and the starter solution treatments were as high as supplemental nitrogen treatments receiving starter fertilizer solution.

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INTRODUCTION

The incorporation of existing crop residues and the broadcast application and incorporation of added organic materials at high rates may improve the physical properties of soils. The effect of band applications of organic matter in crop production and their potential physiological consequences have not been established. Ries et al. (1976) reported that band applications of alfalfa hay at rates as low as 234 kilograms per hectare increased the early yields of direct seeded tomatoes and cucumbers. This could not be explained on the basis of the nitrogen available from the hay. Nath and Suryanarayana (1927) increased seedling growth of wheat, tomatoes, and other plants by adding yeast at two milligrams per kilogram of sand in sand culture and Ruiz and Etchevers (1975) improved the physical properties of a soil by adding seaweed at the rate of about two metric tons per hectare in container experiments. These additions of organic matter may have marked effects on early plant growth, resulting in yield increases. Band applications of organic matter with a gradual release of nutrients and organic substances in the root zone of seedlings could maximize the effects. The purpose of this study was to evaluate the merits of alfalfa hay applied as a band sidedressing in the production of several vegetable crops.

LITERATURE REVIEW

Stimulation of plant growth by organic matter, especially prior to 1940, was frequently confused by the lack of micronutrients in controls and poor control of microorganisms. It was difficult to determine if the cause of the stimulation was the organic matter or microbial decomposition products (Swaby 1942). In conducting research with soils and organic matter, no reaction that may occur in the soil should be ignored until it is proven unimportant for the system under study (Patrick et al. 1964). Although plants can have optimum growth with only inorganic nutrients (Patrick et al. 1964), plants grown in a microbe-free system are usually smaller than plants grown in contaminated systems (Lindsey 1967). The lack of some plant requirement in the microbe-free system and the production of growth regulators by saprophytic microorganisms were suggested as possible explanations for larger plants in microbe-contaminated systems (Lindsey 1967).

Comprehensive reviews have been written on soil microorganisms and plant growth substances (Schmidt 1951), rhizosphere relations (Starkey 1958), and phytotoxic substances from soil microorganisms and crop residues (McCalla and Haskins 1964; Patrick et al. 1964).

Organic matter affects soil fertility by improving soil structure, increasing water holding capacity, increasing buffering and exchange capacity, and supplying nutrients (Bremner 1956). The fertility of coastal plain soils is largely determined by the organic matter content of the soil (Hester and Shelton 1937).

Organic matter additions to soils may increase carbon dioxide levels in the soil and the availability of soil phosphorus (Stanford and Pierre 1953). Water extracts of decomposing organic matter may also increase phosphorus availability. Increased microbial levels from organic supplements may produce additional anions that can replace soil phosphates. Organic supplements can also decrease the capacity of soils to fix added phosphorus (Hester and Shelton 1937; Stanford and Pierre 1953).

The quantity of nutrients released from organic matter is the sum of mobilization and immobilization. Mobilization or mineralization of nutrients from materials occurs only if the nutrient is in excess of that needed for microbial growth in the decomposition process. Materials with 1.2 to 2.6 percent nitrogen content, and carbon to phosphorus ratios of less than 200 tend to mineralize readily (Black 1968). Alfalfa, usually high in nitrogen, phosphorus, and organic substrates mineralizes its nutrients rapidly. Nitrogen released from alfalfa hay was found to be 63 percent as efficient as ammonium nitrate applied at the rate of 31 kilograms of nitrogen per hectare (Fribourg and Bartholomew 1956). Shaw and Robinson (1960) found that the best nitrogen utilization from added soybean hay resulted with shallow soil incorporations.

Plant materials usually have about two thirds of their phosphorus content in the organic form (Black 1968). Organic phosphorus has a greater extended mobility in soils than inorganic phosphorus (Renner 1965; Black 1968). This supports the idea that the biologically effective quantity of each form may not be the same (Wier and Black 1968). In phosphorus uptake studies, Fuller and Hannapel (1958) showed that uptake from added plant residues is greater on soils low in phosphorus than soils high in phosphorus demonstrating that organic matter additions can be important on low fertility soils.

Other nutrients may also be more available in soils where organic matter additions are made. Potassium may be more available due to increased mobility of potassium from clover (Locatusu 1975) and organic matter additions (Aslander and Armolik 1964). Alfalfa amended soils have increased release of soil copper (Hurwitz 1948), iron and manganese (Elliot and Blaylock 1975).

Although the organic matter content of cultivated soils is reported to remain constant (Joffe 1955), numerous short term effects of adding organic matter to the soil have been documented. The addition of ryegrass (Broadbent 1948) and alfalfa (Bingeman et al. 1953) are reported to increase the decomposition of soil organic matter. This increase in decomposition of soil organic matter by added organic matter has been termed the 'priming action'. The priming effect lasts longer in soils low in organic matter (Sauerbeck 1966). Organic matter high in nitrogen causes an accumulation of ammonium inducing an increase in pH which can increase soil microbial activity (Barrow 1960). Microbial activity increases the production of carbon dioxide, sulfate, and the mineralization of nitrogen from the soil organic matter. In contrast, Mortenson (1963) reported that increased additions of organic matter decreased the breakdown of soil organic matter. These conflicting results in soil organic matter studies may be due to variability of soils or the procedures used by each experimenter.

Plant residues are known to contain substances toxic to other plants. Detrimental effects to plant growth have been reported from plant toxins (Bonner 1950), plant extracts (Le Tourneau et al. 1956), water soluble extracts of straw (Guenzi and McCalla 1962; Kimber 1967, 1973a, 1973b), alfalfa extracts (Nielson et al. 1960), and alfalfa saponins (Pederson 1965; Shany et al. 1970). Extracts from one variety of wheat straw decomposed for two days stimulated wheat root growth by 40 percent (Kimber 1967). With increasing decomposition times, the toxicity of plant residues usually decreases. After one month of decomposition, stimulatory effects were observed from plant residues (Patrick et al. 1963). Generally, substances that inhibit germination have stimulatory effects on germination at more suitable concentrations (McCalla and Haskins 1964).

Added organic materials can exert unique effects on soil microorganisms. Soybean meal in a 0.5 percent mixture with soil stimulated actidione (antifungal antibiotic) production while alfalfa caused no effect at the same rate (Gottlieb et al. 1952). Alfalfa juice which is rich in protein, carbohydrates, vitamins, and minerals was shown to increase *Bacillus subtilis* growth (Bickoff et al. 1968). Volatile substances from fresh cut and dried alfalfa hay can increase microbial respiration (Menzies and Gilbert 1967). Methanol and several aldehydes were identified as the volatile compounds from alfalfa hay residues that stimulate germination and decrease the survival of *Sclerotium rolfsii*. Alfalfa saponins were shown to arrest the growth of *S. rolfsii* (Gestetner et al. 1971). Volatile aldehydes and alcohols from other plants were found to change the composition and activity of soil microflora (Owens et al. 1969) indicating the complex relationship between organic matter and biological systems.

Organic amendments may also affect disease incidence caused by soil-borne pathogens by increasing the biological buffering capacity of the soil, reducing the pathogen numbers during anaerobic decomposition of organic matter, and by affecting nitrification (Huber and Watson 1970). Alfalfa additions increased nitrification and tended to reduce the incidence of fusarium and rhizoctonia root rot in Phaseolus sp. (Huber et al. 1965). Organic matter additions have been used to stimulate plant pathogen antagonists, but the results are unpredictable (Baker and Cook 1974).

Additions of soil microbial isolates to sterile cultures of intact higher plants have accelerated the growth of young plants. Of the 2.4 percent (81 total) of the isolates that accelerated growth, many increased growth 50 percent over control treatments (Hata 1962). Antibiotics, such as Penicillin G and Bacitracin, have stimulated the growth of Lemna minor in aseptic culture tests (Nickell and Findlay 1954). Penicillium urticae 'Bainer', frequently associated with straw decomposition in soils, produces a phytotoxic substance (patulin) which at 75 ppm inhibited wheat shoot growth in soil cultures by 50 percent and at 0.01-10.00 ppm acted as an auxin synergist (Norstadt and McCalla 1963).

Associations of growth regulators with the soil and organic materials are currently of great interest in agricultural research. Gross (1975) discussed natural growth regulators which are involved in plant growth, but apparently do not show specific action or function. Aliphatic hydroxycarboxylic acids, neutral lipids, tannins, dihydroconiferyl alcohol, and Strigol stimulate plant growth, most of which have been shown to interact directly with plant hormones. Kampert et al. (1972) stated that added organic matter could slow down auxin decomposition in soils enough to be ecologically significant for plant growth. Less optimistic views are reported by Audus (1963) after reviewing earlier literature. On a well fertilized soil it is unlikely that vitamins or auxins from added organic matter would stimulate plant growth unless stimulation occurred from some presently unidentified substance or by direct effects from microfloral associations with plant roots (Audus 1963).

Organic matter additions to soils with the formation of humus substances are an important factor in the maintenance of soil fertility. Kononova (1966) reviewed the history, formation, and the significance of these substances. Humus substances are formed mainly from the decomposition products of plant and animal residues. They consist of a heterogeneous mixture of molecules which can be extracted from soils by alkaline solutions. Humic acids are precipitated from the alkaline extract upon acidification. The other main fraction of humus substances, fulvic acids, remain in solution upon this acidification. Increased tomato yields by foliar sprays of sodium humate at 10 ppm (Varshney and Gaur 1974) and earlier flowering of tomatoes from humic acid root dips of seedlings (Stanchev 1972) have been reported. Other beneficial effects attributed to humus substances are: the inhibition of phosphorus fixation (Hashimoto et al. 1969), increased phosphorus utilization (Jelenić et al. 1963), increased root growth (Ivanova 1965), and improved crop growth under non-optimal conditions (Niggeman 1965; Guminska and Gracz-Nalepka 1972). Early explanations of humic acid growth promotion were centered mainly on its chelating effects (Burk et al. 1932, De Kock 1955). Recent studies have shown increased plant growth and the movement of small quantities of labeled humic acids into plants (Führ and Sauerbeck 1966). Humic acids improved growth of wheat plants in sterile solution culture systems. This established that humic acids enter the plant and have direct physiological effects (Vaughan and Linehan 1976).

Several other plant stimulating substances related to the organic matter discussion are naphthenic acids and triacontanol. Naphthenic acids or petroleum growth substances are a complex mixture of acids prepared from petroleum that have been shown to cause a general stimulation of plant biochemical processes and increase crop yields. It appears that an increased photosynthetic efficiency results upon foliar application resulting in increased yields of many crops (Wort 1976). Triacontanol, isolated from alfalfa hay, has been shown to stimulate plant growth by applications to the foliage or roots (Ries et al. 1977). The literature reviewed here indicates that organic matter additions may have significant roles in crop production due to factors recently considered unimportant.

MATERIALS AND METHODS

Direct seeded 'Campbell 1327' tomatoes and 'Green Star' cucumbers were planted at Sodus and East Lansing on Oshtemo loamy sand (0.96% organic matter) and Spinks loamy sand (1.47% organic matter) soils respectively. Soil tests indicated that experimental sites at both locations required supplemental fertilization (Table 1). Soil micronutrient levels were considered satisfactory based on past cropping histories, pH ranges of soils (6.4-6.7), and soil tests for manganese and zinc at East Lansing.

At Sodus, sudan grass was grown the previous season at the tomato test location and a vegetable crop grown previously at the cucumber site. Both sites were fall-seeded with rye, broadcasted with 78 kg/ha of nitrogen as urea in the early spring, then plowed before planting. Vegetables were grown previously at the tomato test location and the land was fallow prior to the cucumber test conducted at East Lansing. Forty kg/ha of nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) was broadcast and disked into the soil on April 15 at the East Lansing site.

A randomized complete block design with four blocks in each experiment was used with the exception of the tomato test at East Lansing,

Table 1. Available Nutrients and Recommended Fertilizer Application Rates for Sodus and East Lansing in 1976.[1]

LOCATION	CROP SITE	SOIL TEST (PPM)		RECOMMENDED FERTILIZER APPLICATION - RATE[2] (kg/ha)	
		P	K	P_2O_5	K_2O
SODUS[3]	TOMATO	47	156	168	56
	CUCUMBER	92	192	28	--
EAST LANSING[4]	TOMATO	36	44	168	336
	CUCUMBER	36	44	56	224
	SWEET CORN	36	44	56	224

[1]Soils tested by the Michigan State University Soil Testing Laboratory. Available soil phosphorus determined by Bray P_1 extraction. Available soil potassium determined by 1.0 N neutral ammonium acetate extraction.

[2]Commercial Vegetable Recommendations for Michigan, Cooperative Extension Service, Michigan State University, April 1970.

[3]Soil test samples taken in the fall of 1975.

[4]Soil test samples taken in the spring of 1976.

where a factorial experiment in a split plot design was used. The main plots were 40 kg/ha of P_2O_5 and K_2O versus 80 kg/ha of P_2O_5 and K_2O. Each experiment had seven or eight treatments. Row spacings, plot lengths, and harvested plot lengths are listed in Table 2.

Table 2. Plot Dimensions and Cultural Practices Utilized in Growing Direct Seeded Tomatoes and Cucumbers at Sodus and East Lansing.

PLOT DIMENSIONS (METERS)	TOMATOES		CUCUMBERS	
	SODUS	E.L.	SODUS	E.L.
Row Spacing	1.50	1.50	1.20	1.20
In-Row Spacing	0.46	0.46	0.38	0.20-0.30
Plot Length	7.60	7.60	7.60	6.10
Harvested Plot Length	7.60	7.00	7.50	5.50
PRACTICE AND DATE PERFORMED				
Planting	5/12	5/20	5/27	6/3
Planting Time N	5/27	6/5		
Thinning	6/23 6/28	6/14	6/28	6/14
Sidedressing	7/19	7/8		
Sidedressing N Supplement		7/12		7/15
Harvest(s)	8/30	8/26 9/10	7/22 7/27 8/3	7/21 7/26 7/31

Bales of second cutting 'Vernal' alfalfa hay harvested in 1975 containing 2.82% nitrogen (as determined by micro-Kjeldahl analysis) were used for alfalfa applications. Alfalfa was shredded as an air dry hay with a Wiley mill without a seive screen. This texture accommodated manual band applications of 100-400 kg/ha of alfalfa hay. Agricultural grade alfalfa meal, alfalfa pellets, and soybean meal containing 2.7, 2.7, and 7.68% nitrogen respectively, were sidedressed in cucumber tests but not tomato tests. Placement of the band applications beside and below the seed was achieved by spreading the organic materials by hand in a trench (5 to 7.5 cm deep) previously dug to the side of the marked row, covering the trench, and seeding with a planter. The tomato and cucumber rows were seeded approximately 2.5 and 5 cm respectively to the side of the band of organic supplements. Seeding depth was 2.0 cm for tomatoes and 2.5 to 3.5 cm for cucumbers.

Direct seeded tomatoes received a pre-emergence spray of diphenamid at 4.48 kg/ha within one day after seeding followed by an application of 1.5 cm of water by overhead irrigation to incorporate the herbicide and enhance uniform germination. Cucumbers at Sodus were sprayed with 2.24 kg/ha of chloramben methyl ester immediately after planting, followed by overhead irrigation. No herbicide was applied to the cucumbers at East Lansing. The crops were irrigated, weeded, cultivated, and protected from pests.

Tomatoes were planted with a Dahlman clump planter adjusted to drop about 6 seeds as a group 23 cm apart in the row. Starter solution was sprayed on the seeds in the row just prior to soil covering of the seed by the planter. Nitrogen at 2.2 kg/ha and P_2O_5 at 7.5 kg/ha were applied in the starter solution at both locations. An additional 1.9 kg/ha of K_2O was applied at East Lansing in the starter solution. At East Lansing, a loose starter hose connection during planting required that two blocks be sprayed with the starter on the soil surface on top of the row. No attempt was made to thin seeded clumps allowing the establishment of 3 to 12 plants per clump. About two weeks after seeding urea was applied, at 56 kg/ha, 2.5 cm deep and 25 cm to the side of designated rows. In mid-June, experiments were thinned to every other clump leaving 46 cm between clumps. Due to heavy rains in late June, an additional 20 kg/ha of N as ammonium nitrate was sidedressed on all treatments in East Lansing. Tomatoes were harvested at the breaker stage. One harvest was made at Sodus and two harvests were made at East Lansing (Table 2). The total number and weight of fruit greater than 3.5 cm were recorded from each plot.

Cucumbers were planted at the rate of 10 to 15 seeds per meter of row with a V-belt planter at Sodus and a cone planter at East Lansing. The cucumbers at Sodus were thinned to 20 plants per plot due to poor emergence. They were thinned to 20 to 30 cm between plants at East Lansing. Fifty kg/ha of N as ammonium nitrate was applied as a side-dressing to all cucumbers treatments in East Lansing due to the appearance of nitrogen dificiency symptoms. Three harvests of fruit greater than 2.5 cm long were made at each location (Table 2). The harvested fruit from each plot were sized into four standard grades and the total number and weight of fruit for each grade was recorded. Grades were assigned values based on research standards.

'Spring Gold' sweet corn was planted at East Lansing to examine the effects of sidedressed alfalfa applications, broadcasted nitrogen, and broadcasted phosphorus and potassium on the early yield of sweet corn. Vegetables were grown the previous season and radishes were harvested and disked down prior to the planting of sweet corn at this site.

The same main plots and subplots of the preceding radish experiment were used for the sweet corn experiment in a split-split plot design. The same sub-subplots of alfalfa treatments in the previous four block radish experiment were not utilized due to the wider sweet corn row spacing. An additional 40 kg/ha of N as urea was broadcasted and incorporated to the high N main plots. With this application, the total applied fertilizer for the season to the two main plots was 40 or 120 kg/ha of N and the two subplots received both P_2O_5 and K_2O at the rate of 40 or 140 kg/ha. Row spacings of 0.9 meters and plot lengths of 7.3 meters were used for the sweet corn planting. Sub-subplots consisted of three rates of alfalfa hay (0, 100, and 300 kg/ha) which were banded 2.5 to 7.5 cm to the side and 2.5 to 5.0 cm below the expected seed placement. On June 18, the sweet corn was planted 5 cm deep at the rate of 10 to 15 seeds per meter of row with a cone planter. A post emergence spray of 0.6 kg/ha of atrazine was applied for weed control. A week later the plants were thinned to 20 to 25 cm apart. One main harvest was taken on August 25 with the weight (unhusked) and number of horticulturally mature ears recorded from 6.4 meter sections of each plot.

RESULTS AND DISCUSSION

At Sodus, early seedling growth of tomatoes was curtailed by a severe wind storm. One harvest of tomatoes was made at Sodus to examine early yield; no treatment response could be detected (Table 3). Early growth of tomatoes at East Lansing was excellent. A nitrogen deficiency developed after heavy rains in late June in treatments not

Table 3. Response of Direct Seeded 'Campbell 1327' Tomatoes to Band Applications of Alfalfa Hay at Sodus and East Lansing.

TREATMENT (kg/ha)					YIELD (metric tons/ha)	
PLANTING TIME			SIDEDRESSING		SODUS	EAST LANSING
STARTER	ALFALFA	N	ALFALFA	N		
+	---	56	---	28	20.2	43.9
+	---	--	---	--	16.7	38.3
+	200	--	---	--	19.2	41.9
+	---	--	200	--	21.6	36.7
+	200	--	200	--	18.0	43.2
+	400	--	---	--	18.4	37.2
+	400	56	---	28	22.3	46.4
-	400	--	---	--	19.0	35.2
L.S.D. at 0.05 level					N.S.	6.3
L.S.D. at 0.01 level					N.S.	8.7

scheduled for nitrogen applications. Two harvests of tomatoes were made at East Lansing. Highly significant yield increases (based on the individual F tests) were obtained by nitrogen applications (56 kg/ha of N after planting and 28 kg/ha of N at flowering) compared to other treatments receiving starter solutions (Table 3). A nitrogen response was expected on this sandy soil. The yield of the alfalfa band treatment (400 kg/ha at planting) with N applications was the same as from the N applications alone. The alfalfa treatment without starter or nitrogen applications yielded as well as the starter fertilizer control; however, the alfalfa treatment with starter solution also yielded the same as the starter fertilizer control. This indicates that the addition of alfalfa had no effect on yield if starter was applied at planting.

No interaction occurred between the treatments and fertilizer levels (main plot) in the tomato test at East Lansing (Table 4). Clearly, at the low fertility, only the N applications without alfalfa increased tomato yields. This implies that alfalfa at 400 kg/ha may have had detrimental effects on tomatoes in the low fertility soil. Another explanation may be that a nutrient imbalance occurred due to an excess of nitrogen with respect to a low potassium level in the soil resulting in a decreased yield (Paterson 1974).

Results obtained in 1976 with 'Campbell 1327' tomatoes contradict findings reported with 'Heinz 1350' tomatoes in 1975 (Ries et al. 1976). In the studies reported here, increased early plant growth was not observed and no increase in early yield was obtained from alfalfa sidedressings. Improved nitrogen (Qureshi et al. 1972) and phosphorus supplies (Murphy 1964) are known to increase plant height of tomatoes and may explain the increased height of alfalfa treatments noted in 1975. There were no observed differences in vigor or height in 1976. A nutrient effect from alfalfa is further suggested by work of Ogle et al. (1964) where additions of nitrogen and phosphorus (P_2O_5) up to 112 kg/ha increased tomato yields on a similarly low fertility soil; in 1975 (Ries et al. 1976) applied only 36 kg/ha of N, P_2O_5, and K_2O. The following reasons are suggested for the lack of response to alfalfa band applications in 1976 compared to 1975: the use of starter fertilizer; heavy rains earlier in the growing season; use of different

Table 4. Response of 'Campbell 1327' Tomatoes to Band Applications of Alfalfa on Two Soil Fertility Levels at East Lansing.[1]

TREATMENT (kg/ha)					YIELD (metric tons/ha)	
PLANTING TIME			SIDEDRESSING		SOIL FERTILITY LEVEL	
STARTER	ALFALFA	N	ALFALFA	N	LOW	MEDIUM
+	---	56	---	28	45.5	43.9
+	---	--	---	--	33.8	38.3
+	200	--	---	--	37.4	41.9
+	---	--	200	--	37.8	36.7
+	200	--	200	--	34.0	43.2
+	400	--	---	--	33.4	37.2
+	400	56	---	28	34.9	46.4
-	400	--	---	--	34.9	35.2
L.S.D. at 0.05 level					6.9	6.3
L.S.D. at 0.01 level					9.4	8.7

[1]The low fertility level soil received a base fertilizer application of 40 kg/ha of N, P_2O_5, and K_2O. The medium fertility level soil received the base level application plus an additional 40 kg/ha of P_2O_5 and K_2O.

cultivars of tomato and alfalfa; and the use of clump planting rather than thinning to single plant stands.

Application of high phosphorus starter solutions to tomatoes at transplanting has been shown to increase early yields of tomatoes (Sayre 1938); Jones and Warren 1954) with the response rapidly decreased as phosphorus additions to soils are increased (Arnold 1953). The ready availability of phosphorus stimulated early growth of tomatoes which results in the development of a greater number of flowers earlier by speeding up flower differentiation (Yamashita and Yoshiak 1963; Takahashi et al. 1973). This increased early growth leads to a higher yield and earlier maturity (Hepler 1922). Banded phosphorus applied 5 to 7.5 cm below tomato seed was seven times as efficient as broadcasted phosphorus on direct seeded tomatoes in a field situation (Hipp 1970). The benefits from these phosphorus applications are similar to those obtained from alfalfa additions on tomatoes in 1975 without banded starter fertilizer. Starter fertilizer solutions used in the 1976 tomato tests clarified this point showing that alfalfa additions did not improve yields above that of starter solution.

Heavy rains (5 cm) on June 30 in 1976, caused a premature nitrogen stress on tomatoes at East Lansing about two months earlier than noted in 1975. This deficiency was corrected by a nitrogen application to all treatments. This stress or the leaching of substances from the alfalfa treatments may also explain the difference in results between 1975 and 1976.

The toxicity of alfalfa extracts may vary with the year and cutting of alfalfa (Guenzi et al. 1964) and alfalfa constituents as saponins may vary between alfalfa varieties (Hanson et al. 1963). Differences between alfalfa cultivars with respect to plant growth response in the field were not studied. It has been determined by Chibnall (1933) that alfalfa contains approximately 100 ppm triacontanol on a dry weight basis. At this concentration, 100 kg/ha of alfalfa hay contains 10 gm of triacontanol. This level is far in excess (1000 fold - based upon

1000 ℓ/ha of 10 μg/ℓ of triacontanol) of the amount found to increase plant growth from both nutrient and foliar applications (Ries et al. 1977). No field tests were designed specifically to test tomato cultivar differences based on the marked responses obtained in 1975 field tests, greenhouse tests, and the apparent general nature of the sidedressing study.

Clump planted tomatoes, with two to four seeds per clump, yield the same and have a more concentrated fruit set than tomatoes which are thinned to one plant at a given plant spacing (Purdue University 1966). Clumps of over six plants at each within the row plant spacing were common at East Lansing. The possibility of altered nutrient requirements and other growth response patterns in relation to alfalfa additions in 1976 from this plant competition deserves consideration.

'Green Star' cucumbers did not respond to sidedressings of alfalfa hay, commercial alfalfa products, or soybean meal at Sodus or East Lansing when compared to controls (Table 5). Despite poor seedling emergence at Sodus, good foliage development and yields were obtained. At East Lansing, emergence was excellent; nevertheless, poor growth occurred throughout the season indicating a nutrient deficiency. Noting these problems, a late planting of 'Green Star' cucumbers was made at East Lansing on July 12 (data not presented). In this planting band treatments of 100 and 200 kg/ha of 'Vernal' alfalfa were spread directly on top of a mineral fertilizer band (40 kg/ha of N, P_2O_5, and K_2O) that was beside and below planted cucumber seeds. Although excellent emergence and growth occurred in this late planting, no yield benefits resulted from alfalfa treatments with fertilizer when compared to fertilizer controls. Banded applications of phosphorus are

Table 5. Yield in Dollars per Hectare of 'Green Star' Cucumbers at Sodus and East Lansing Following Organic Matter Additions at Planting (three harvests were made at each location).

TREATMENT	RATE	YIELD ($/ha)	
	(kg/ha)	SODUS	EAST LANSING
CONTROL	---	1018	349
UREA	56 N	----	340
ALFALFA HAY	100	1080	378
" "	200	1023	408
" "	400	1010	375
ALFALFA MEAL	200	1040	359
ALFALFA PELLETS	200	1085	339
SOYBEAN MEAL	60	1048	361
F RATIO		N.S.	N.S.
C.V. (%)		11.3	14.3

more efficient than broadcast applications in supplying phosphorus (Baker and Mortenson 1965) and may explain the early yield response of 'Earlipik' cucumbers reported by Ries et al. (1976) from alfalfa additions.

'Spring Gold' sweet corn at East Lansing developed nitrogen deficiencies as the season progressed. No additional nitrogen was applied in order to observe treatment effects. Sweet corn sidedressed with alfalfa hay at 100 or 300 kg/ha had equivalent yields to controls receiving no alfalfa (Table 6). No interactions occurred between the nitrogen, phosphorus and potassium, or alfalfa levels. The high level of nitrogen (120 kg/ha of N) gave a 31% increase in fresh weight yield of unhusked ears over the low nitrogen level (40 kg/ha of N). Alfalfa additions did not supply sufficient nitrogen to show a nitrogen yield response but they did appear to improve the early growth of sweet corn plants.

Fourteen other field experiments were conducted with 'Vernal' alfalfa hay applied as a sidedressing on other vegetable crops and field corn, but are not reported here. Sidedressed applications of alfalfa did not increase yields or visually improve growth in these tests. In greenhouse and controlled environmental conditions plant responses to alfalfa additions were variable with beneficial responses occurring more frequently on lower fertility soils.

Applications of alfalfa hay at low rates as a sidedressing do not consistently produce beneficial responses under field conditions when the nutritional status is conducive for plant growth. In retrospect, studies of organic matter additions with regards to alfalfa hay may best be studied by examining components of alfalfa on whole plant or plant part systems and as suggested by Patrick et al. (1964), research with microenvironments should be emphasized if organic matter additions are made to soils.

Table 6. Response of 'Spring Gold' Sweet Corn to Band Applications of Alfalfa Hay and Broadcasted Fertilizers at East Lansing.

SPLIT	TREATMENT	RATE	FRESH WEIGHT (unhusked ears)
		(kg/ha)	(metric tons/ha)
MAIN PLOT	N	40	6.8
		120	8.9
	L.S.D. at 0.05 level		0.8
	L.S.D. at 0.01 level		1.6
SUBPLOT	$P_2O_5 + K_2O$	40	8.2
		140	7.3
	F RATIO		N.S.
	C.V. (%)		17.3
SUB-SUBPLOT	ALFALFA	0	7.7
		100	7.7
		300	8.0
	F RATIO		N.S.
	C.V. (%)		14.1

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