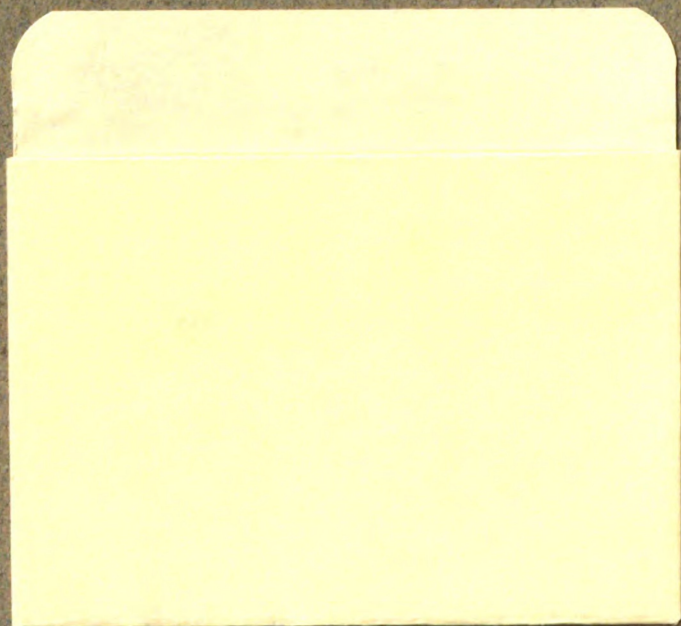


SOME OF THE FACTORS INFLUENCING
THE YIELD OF SOME VARIETIES
OF WHITE PEA BEANS IN MICHIGAN

THESIS FOR THE DEGREE OF M. S.
Judson A. Thompson
1930

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THESIS

Respectfully submitted in partial fulfillment

for the degree of Master of Science

at

Michigan State College of Agriculture

and Applied Science

Judson A. Thompson

1930

1945

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I. INTRODUCTION.

A. Importance of bean production in Michigan.

Since Michigan is the leading pea bean state in the United States, producing beans of high quality and flavor for use as dried beans, it is very important that a study of the factors influencing yield in this state be made. Michigan grows over 600,000 acres of pea beans annually and produces nearly 5,000,000 bushels of shelled beans each year. (Agricultural Year Book 1927). New York state is second in the production of pea beans and only produces about one tenth as many as Michigan, which ranks first in the production and acreage of all beans, including kidney beans, followed closely by California with her huge yields of lima beans.

B. Methods of harvesting used by farmers.

The early method of harvest used by farmers was to pull the mature bean plants by hand, cure in stack or pile in the field, and thresh with a flail.

At present the bean harvester is used, which greatly lessens the labor of bean pulling. This implement carries two knives or blades, which slip along under-ground just beneath the surface, pulling and throwing together two rows of beans at a time. The harvesting should be done when the plants are mature, and not delayed until the pods are too ripe, as

shattering results. After pulling, the beans are forked into piles, or, if the field is free from straw and trash, a side-delivery rake may be used for windrowing. After several hours' drying, the crop is forked into small cocks, built high and of narrow diameter at the bottom so as to allow rapid drying. When the beans are dry they are threshed or hauled from the field and stored in a dry place.

Growers with a large acreage of beans, increase the risk from weather damage by pulling the entire crop at once. It is a much safer practice, to pull units of four to five acres at a time, cure on the ground, and then store under roof or in stack. Beans on the standing plants are injured less by periods of wet weather than when the crop is rained on after pulling. When beans in the cock are rained on, they should be opened up and turned to stimulate the drying. (Cox and Pettigrove 1924).

Bad weather conditions during the harvest period materially influence the quality and quantity of beans threshed. Even with the greatest care the percentage of discolored beans increases rapidly with continued rains. The bean possesses a dehiscent pod and the handling increases the percentage of shelling thus decreasing the threshable amount.

Recently a method of harvesting designed and used by Mr. O. J. McNaughton of Mulliken, Michigan, to overcome some of the evils of the old system has been advanced by members of the Farm Crops Department. While the "McNaughton

Plate No. I.



A well made bean stack. "The McNaughton System of Curing Beans." (Courtesy of Mr. H. R. Pettigrove 1927).

System" should eventually prove of great success and value to the bean grower, only a few of the more progressive farmers are using it at the present time. (Plate No.I)(Pettigrove 1927).

C. Problem.

While the discussion so far has emphasized the importance of the method of harvesting, many other factors are also important. Several varieties of beans are grown in the state and usually two to three of them are grown in the same locality because of individual preference. A grower may believe his variety yields more, looks better, has a larger vine which holds its pods off the ground thereby reducing pick, shells less at harvest, or stands bad weather conditions with less discoloration than the other varieties in his locality. All of these points are vital to the ultimate returns that a grower receives from his crop, especially during a wet season.

There is practically no literature available on varietal factors influencing yield of white pea beans. To supply this need, the present experiment was outlined in 1926 by members of the Farm Crops Section of the Michigan Experiment Station, which aimed to study the question of yield, as influenced by size of vine, stand, quality (pick), and shelling from a variety standpoint.

The problem was carried on by Mr. R. B. Carr for the two-year period preceeding 1928, but he has not submit-

ted a report of his results as yet. The problem was continued by the author.

II. MATERIAL.

The material used was furnished by the Farm Crops Department of Michigan State College. Thirteen varieties were chosen as typical of those grown in the state.

A. Source.

The original sources of the varieties used in this experiment were as follows:

1. 1000-1. Sel. No. 325303, Ac 197.

Received in 1913 and entered the nursery that year. It is not known where the seed was secured.

2. Mexican Tree. Sel. No. 350205, Ac 210.

Received of George Wise of Hart, Mich., in 1913. Eight plants were received and the seed planted in the nursery in 1919.

3. Mexican Tree. Sel. No. 350206, Ac 210.

Received of George Wise of Hart, Mich., in 1913. Eight plants were received and the seed planted in the nursery in 1919.

4. Robust Selection. Sel. No. 350506, Ac 213.

Received as Early Wonder (reclassified and called Robust Selection) from Sebastian Greene of Hart, Mich., in 1913. Nine plants were received and

the seed planted in the nursery in 1919.

5. Greiner. Sel. No. 350604, Ac 214.

Received of Sebastian Greene of Hart, Mich., as a commercial navy bean in 1916. Five plants were received and the seed planted in 1919.

6. Canter. Sel. No. 351302, Ac 221.

Received of O. E. Canter, Shelby, Mich., as a commercial navy bean in 1913. Thirty-six plants were received and the seed planted in the nursery in 1919.

7. Early Wonder. Sel. No. 351503, Ac 223.

Received of Watson Billings of Davison, Mich., in 1918. Five plants were received and the seed planted in the nursery in 1919.

8. Pliter. Ac 254.

Received as a commercial navy bean from W. C. Pliter of Clio, Mich., and planted in variety series of 1921.

9. 1200-1. Sel. No. 318001, Ac 235.

Received of J. C. Walcott of St. Johns, Mich., and was planted in the nursery of 1922.

10. Alaska Parish. Ac 373.

Received of Frank Parish of East Lansing, Mich., in 1926, as Alaska Giant. Mr. Parish received his seed from William Stock of Standish, Mich., two years before.

11. Early Wonder. Ac 383.

Received of John Simms, County Agent of Tuscola County, May, 1926.

12. Vermont. Ac 385.

Received of H. R. Pettigrove of the Farm Crops Department Michigan State College in 1926.

13. Robust. Sel. No. 40520, Ac 13.

Selected in 1908 by Professor F. A. Spragg. The strain 40520 is a reselection made in 1914. This is the strain known as Improved Robust today. It was used as the check in these studies.

B. Variety abbreviations.

An abbreviation is given to each variety as shown in Table 1. in order to simplify reference to it and to economize in table space.

Table 1.

Table 1. gives the variety name, selection or accession number, and the simplified abbreviation.

Variety.	Sel. No.	Abbreviations.
1. 1000-1	323803	10
2. Mexican Tree	850205	M5
3. Mexican Tree	850206	M6
4. Robust Selection	850506	RS
5. Greiner	850604	Gr
6. Canter	851302	Cr
7. Early Wonder	851503	E2
8. Pliter	Ac 254	Pl
9. 1200-1	318001	12
10. Alaska Parish	Ac 373	AP
11. Early Wonder	Ac 383	E3
12. Vermont	Ac 385	Vt
13. Robust (Check)	40520	Ck
14. Total population		Tp
15. Correlations with means superimposed		S

Plate No. II.



General view of the plant breeding pea bean
area, 1929.

III. METHODS.

A. Methods used in the field.

1. Terminology.

In order to have a mutual understanding of the terms used, they are interpreted as follows:

a. First stand - the number of healthy plants per plot in the second leaf stage, about three weeks after planting.

b. Second stand - the number of plants producing pods per plot. The count was made when the pods were ripe a few days before harvest.

c. Yield - the weight in grams of threshed and fanned beans obtained from each plot.

d. Weight of vine - the weight in grams of the entire plot less the weight of the threshed beans grown on the same area.

e. Shelling - the actual number of beans that are shelled out and left on the ground in the field. Special pains were taken to carefully count all of the shelled beans, as this was one of the main objects of the experiment.

f. Pick - the per cent of discolored, moldy, unmarketable beans, not including split beans. This percentage was obtained by averaging the weight of discolored, moldy, unmarketable beans found in each of two 100-gram samples taken from the fanned beans of each plot. Split beans were not included

because they resulted from the type of small thresher used.

2. Planting.

The beans for planting were graded by discarding all beans that would not go through a $3/4 \times 15/64$ of an inch mesh sieve, and all that would go through a $3/4 \times 13/64$ of an inch mesh sieve. This did away with all under-sized and over-sized beans, and made a more uniform lot. It also made the number of beans planted in each replication about equal. All cracked and diseased beans were picked out. Equal amounts by weight (33 grams) of each variety were planted.

The soil was prepared in the usual way and nine 30 foot series of the varieties planted end to end in rows (28 inches apart), running north and south, with a check every fourth plot, as shown in the planting plan. This planting was repeated three times which caused each variety and the check to appear four and 17 times to a series or 36 and 153 times in all, respectively. Border effect was taken care of by either planting three rows of edge (Robust) or planting other variety experimental plots adjacent to the first and last checks of each series.

The plantings were made on June 2, 1928, and June 3, 1929. The beans were planted on different fields each year, but followed a crop of corn both years. Fertility was added the first year to the extent of 300 pounds of acid phosphate per acre and the second year there was added an application of 500 pounds of a complete fertilizer (4-16-4) per acre.

Planting Plan: A to I - the nine series. Varieties in the same order in each series as shown in A. The entire set of varieties and the necessary checks, as shown, appeared four times in each series. (The other three plantings not shown).

Variety.

Arrangement of Plots.

	A	B	C	D	E	F	G	H	I
0. Ck.	_____	_____	_____	_____	_____	_____	_____	_____	_____
1. 10.	_____	_____	_____	_____	_____	_____	_____	_____	_____
2. M5.	_____	_____	_____	_____	_____	_____	_____	_____	_____
3. M6.	_____	_____	_____	_____	_____	_____	_____	_____	_____
4. Ck.	_____	_____	_____	_____	_____	_____	_____	_____	_____
5. R3.	_____	_____	_____	_____	_____	_____	_____	_____	_____
6. Gr.	_____	_____	_____	_____	_____	_____	_____	_____	_____
7. Cr.	_____	_____	_____	_____	_____	_____	_____	_____	_____
8. Ck.	_____	_____	_____	_____	_____	_____	_____	_____	_____
9. E2.	_____	_____	_____	_____	_____	_____	_____	_____	_____
10. P1.	_____	_____	_____	_____	_____	_____	_____	_____	_____
11. 12.	_____	_____	_____	_____	_____	_____	_____	_____	_____
12. Ck.	_____	_____	_____	_____	_____	_____	_____	_____	_____
13. AP.	_____	_____	_____	_____	_____	_____	_____	_____	_____
14. E3.	_____	_____	_____	_____	_____	_____	_____	_____	_____
15. Vt.	_____	_____	_____	_____	_____	_____	_____	_____	_____
16. Ck.	_____	_____	_____	_____	_____	_____	_____	_____	_____

Key.

Plots 30 ft. long and single rows, 28 in. apart. Alley-way two ft. wide between series. a location of identification stakes.

2. The second section focuses on the role of communication in the organization. It highlights the importance of clear and concise communication channels, both internally and externally. The text suggests implementing regular meetings and reports to keep all stakeholders informed and engaged. It also discusses the benefits of using technology to facilitate communication, such as email, instant messaging, and video conferencing.

3. The third part of the document addresses the issue of resource management. It stresses the need to allocate resources effectively and efficiently to achieve the organization's goals. The text provides guidelines for budgeting, procurement, and personnel management. It also mentions the importance of monitoring and evaluating resource usage to identify areas for improvement and cost savings.

4. The fourth section discusses the importance of risk management. It outlines the various risks that an organization may face, including financial, operational, and reputational risks. The text provides a framework for identifying, assessing, and mitigating these risks. It also mentions the need for a risk management policy and the role of the board of directors in overseeing risk management activities.

3. Stand.

In 1923, only one stand count was taken which consisted of counting the number of healthy plants when about three weeks old. The purpose of this count was to find the relationship between stand and yield.

In 1928, it was noticed that many of the mature plants did not produce pods, so in 1929 a count was made of the pod producing plants, referred to as "second stand", to determine just how much of a factor this was. The second stand did not include plants that had been damaged by bald-head or bean maggots, or other non-productive plants as those attacked with mosaic or blight, therefore the second count was more representative of the plot than the first.

4. Harvesting.

The nine series were divided into five different treatments as follows:

Treatment.	Series.
I	A
II	B-C
III	D-E
IV	F-G
V	H-I

The treatments aimed to study the response of the varieties to different conditions of harvest. The first series was unweathered while the harvest of the remaining

series was delayed. A description of each treatment follows:

When the bean plots ~~were~~ ready for harvest each fall sufficient help was provided so that the first seven series (A-G) could be pulled the same day. This part of the harvest was done September 6th. in 1928, and September 16, in 1929. The remaining two series (H-I) were pulled and taken in three weeks later. Burlap bags were provided both years for each plot of beans.

Treatment I (A) was sacked and taken into the barn immediately in order to have a comparison between all the varieties in regard to pick and shelling uninfluenced by delayed harvest. The sacked beans were hung overhead in the field barn to dry.

Treatment II (B-C) remained in the field for a week before being taken to the barn and stored as treatment I. To prevent accidental mixing a systematic method of piling the varieties was used as shown in Plate No. III. These bunches were turned with a fork after each rain or every other day when it did not rain to prevent mold and discoloration. Another object of this procedure was to determine how many beans would be shelled out by this method.

Treatment III (D-E) was treated the same as treatment II, except that it remained in the field one week longer.

Treatment IV (F-G) was treated the same as treatment III, except that it remained in the field one week longer.

Treatment V (H-I) was ripe the same time as the

Plate No. III.



The diagonal method of arranging beans to avoid mixture. With this system, if the wind blows a bunch off the row, it can be told at once which pile has been moved.

other beans, but it was left standing for three weeks and then treated exactly as treatment I (A) had been treated three weeks before. The primary purpose of letting treatment V (H-I) stand was to study the influence of weathering upon the different varieties by delaying the harvest and to see whether it was more practical for the average bean grower to pull the beans and handle them as in treatments II-IV (B-G) or to let them stand until the weather and other conditions would permit their harvest.

5. Shelling.

Immediately after each series was sacked up a shelling count was made for each plot. To obtain the shelling count each bean that had shelled out and fallen to the ground was counted, also any pods left behind were shelled out and counted. This made the shelling count in actual number of shelled beans per plot. The counting was a long and laborious process but the shelling data were of great value, as ^{shelling} is a factor directly influencing yield. During harvest, special care was taken, when turning the bunches or placing them in their container, not to spread the beans onto an adjacent row. Care was taken not to walk near where the bunches had been located, because once the beans were tramped into the ground it was hard to make an accurate count.

6. Weight of vine.

This factor was obtained by subtracting the weight

of the threshed, cleaned, beans from the weight of the unthreshed vines grown on each plot. To reduce the amount of calculation all material was removed from its respective container for weighing.

7. Threshing and cleaning.

The beans were dried thoroughly in the field barn and were then ready for threshing. The bean thresher used was hand made, without any arrangement for wind cleaning. The machine breaks up the pods and vines. The beans with all dockage fall through a 1/2 inch screen and are then cleaned with a fanning mill. The thresher cylinder was rotated at the rate of about 900 R.P.M. Unfortunately the machine cracked quite a number of beans.

When the beans were cleaned care was taken to use a top screen large enough so that all beans would go through and a lower screen so small that only the dirt and very small pieces of cracked beans could escape. The wind was increased so that all pieces of chaff and broken pods were blown over.

8. Yield.

The yield was obtained in grams by the use of a Toledo no-springs gram balance. The beans were weighed as they were cleaned, before they were resacked. There was a great variation in yield throughout the field and between varieties both years. Plate No. IV. shows the very productive area (Series H-I), 1929. The yield was much above the

Plate No. IV.



The very productive area (Series H-I), 1929.
Notice how thickly the pods are set.

average in this area.

9. Pick.

This factor could only be obtained in 1923. The abnormally dry fall of 1929 was so favorable for harvest that no mold or discoloration appeared that year. Pick was obtained by averaging the weight of discolored, moldy, unmarketable beans, not including split beans, found in each of two 100-gram samples taken from the fanned beans from each plot.

B. Methods used in handling data.

1. Mean.

The arithmetic mean is used throughout the thesis, because it is the most usual mathematical constant obtained. All means were computed to three places beyond the decimal point and the last two places were disregarded, if less than .050. If equal to or greater than .050, it was considered as .100 and added to the mean.

In the different field treatments the varietal mean was obtained from four plots in treatment I and from eight plots in treatments II, III, IV, and V. The check mean in treatment I was obtained from 17 plots, while in the other treatments it was from 34 plots.

When the mean was computed on the basis of all the replications in the field it was taken from the correlation

surface, and computed from classes, (Hayes and Garber 1927) (Babcock and Clausen 1927) rather than from actual summation.

In 1928, due to the extreme soil variation in the northeast corner of the area, it was necessary to eliminate one entire replication for a part of the work. With one replication out of the first series it left only three plantings of each variety and 13 checks on which to base the mean in treatment I.

2. Probable errors.

All probable errors were computed in the usual manner, and these formulae may be found in any good book on elementary statistics. When N was less than 30 then N-1 was used in obtaining the standard deviations from which the probable errors were computed. All probable errors were computed three places beyond the decimal point and the last two places omitted when less than .050, but when equal to or greater than .050 it was considered as .100 and added.

The probable error of the difference was used to determine whether or not the difference between any two means was significant. When there is no correlation between a and b, $P.E. dif. = \pm(a^2 + b^2)^{\frac{1}{2}}$, and it was considered that there was no correlation between varietal means. If the difference is greater than 3.2 times its probable error, the difference is considered significant. (The odds are then over thirty to one that the difference is not due to chance. This limit is used very frequently and is quite reliable).

3. Correlations.

When dealing with those characters which are not perfectly correlated, it is necessary to know the degree of correlation which is actually shown. When there is a high degree of association, it can usually be estimated by inspection, but judgement is often faulty, and an exact statistical calculation of the amount of correlation is the only sure means by which we can definitely determine the amount of relationship. It may be interpreted as follows:

1. If "r" is less than the probable error there is no evidence of correlation.
2. In those cases in which "r" is less than 0.3 the correlation cannot be said to be at all marked.
3. If "r" is more than six times the probable error the correlation is a practical certainty.
4. If "r" is greater than 0.5 and greater than six times the probable error there is a decided correlation.

All correlation coefficients were computed to five places but only three are given for clearness and brevity.

a. The diagonal method.

The diagonal method of computing correlation coefficients as outlined by Crum and Patton (1925, p. 238) and modified by the plant breeding staff of the Farm Crops Department of Michigan State College was used for the correlation computations. In addition to the ordinary way of combining the varieties into one population, method b was used to ob-

tain the correlation surface, and the coefficient computed as in a.

b. Super-imposing-the-means-method.

The average value of relationship of the twelve varieties and the check was also determined by the super-imposing-the-means-method. This method was recently worked out by the plant breeding staff of the Farm Crops Department of Michigan State College, and in its application requires:

1. That the tables to be combined must involve the same characters and must give a logically homogeneous population.

2. That the mid-class values of the dependent variable in all of the populations combined must be equal or pertain to the same series, with a similar condition holding for the independent variable.

This method consists of combining two or more groups of data by transferring the frequencies from the different tables onto a single table by putting the classes containing the means at the same point and from the combined table computing the value of "r" in the usual manner.

c. Corrections.

Due to soil heterogeneity and other environmental factors some plots were not representative of the field. It was necessary to use some method to throw out any plots far

different from the average. This was accomplished by throwing out all the plots from the correlation surface that did not fall in the limits set by adding or subtracting from the mean 3.2 times the standard deviation. That is, any frequency that did not fall within the classes containing these limits would be discarded or omitted from the calculations.

In the correlation surface where a number is found in parenthesis as (1) it indicates that it is thrown out by the method just described. If a number is found, such as (3)¹, it indicates that in two varieties a frequency this far from the mean was thrown out, but in one case it was not, this was due to differences in size of means and standard deviations.

4. Coefficient of Yield.

This is known as the "P over C" method of comparing yields, when P equals the actual yield of the plot and C is the interpolated yield of the plot between the two nearest checks. "The coefficient of yield is the quotient obtained by dividing the yield of a variety by the calculated yield of the standard or check variety, growing on the same plot the same year. This is a ratio that becomes unity when the yield of the variety it represents equals that of the standard. It is greater or less than unity when the yield of the variety it represents is greater or less than the yield of the standard." Spragg 1920, p. 168.

IV. OBSTACLES ENCOUNTERED.

A. Weather.

One of the greatest obstacles encountered in this work was the variation in the weather conditions from year to year. The rainfall for the growing and harvest period of 1928 and 1929 (June 1st. to last harvest) may be found in Table 2. Rain during this period in 1928 made it possible to obtain a small pick. A large pick under Michigan conditions is not uncommon, but due to another extremely dry year in 1929 no pick could be obtained. This was very unfortunate because pick is a very important factor with Michigan producers.

B. Soil fertility and available moisture.

The natural fertility of the two areas where the beans were planted was about the same. Three hundred pounds per acre of acid phosphate were added in 1928 and 500 pounds of a 4-16-4 fertilizer in 1929. Because of weather conditions the results obtained were quite different.

A comparison of the field average on yield and weight of vine gives some idea of the influence of soil fertility and available moisture:

	1928.	1929.
Yield of beans in grams	503.2±4.8	415.9±4.0
Weight of vine in grams	333.6±3.3	420.5±2.8

It is interesting to note that in 1928 there was a

Table 2.

Daily precipitation during the summer months of 1923 and 1929. Data from local Weather Bureau Office, United States Department of Agriculture.

Precipitation.

Date	1923.				1929.				
	June	July	Aug.	Sept.	June	July	Aug.	Sept.	Oct.
1.	T	0	T	0	0	T	0	0	T
2.	T	T	.06	1.12	0	0	0	0	T
3.	0	T	.34	.04	0	.01	.06	0	.03
4.	.06	0	.13	0	0	.09	0	0	0
5.	.43	0	.02	0	.12	0	.03	0	.01
6.	.76	0	0	0	0	.09	0	.10	T
7.	0	0	T	0	0	.10	0	T	0
8.	.03	0	0	0	0	0	0	0	0
9.	0	.07	0	0	0	.01	0	.03	0
10.	0	0	.16	0	0	0	0	.03	0
11.	0	0	0	.24	.06	T	0	.02	0
12.	0	0	0	.02	.42	.12	0	0	0
13.	.02	.24	0	T	.24	.59	T	.11	0
14.	0	.11	0	.21	.03	0	T	T	0
15.	0	0	0	T	0	0	T	.07	0
16.	0	0	.01	.03	T	0	0	0	0
17.	.02	0	.03	.01	0	0	0	.04	0
18.	.63	.18	T	0	0	.63	0	.47	0
19.	0	.26	0	0	.12	0	0	0	0
20.	T	.01	.06	T	T	0	0	0	0
21.	0	T	.40	.02	0	0	0	0	0
22.	.43	.71	0	.03	0	0	.13	0	0
23.	0	0	.44	.13	.07	.17	T	0	0
24.	T	.06	0	.18	T	.04	0	0	0
25.	.10	0	0	.10	0	T	0	T	0
26.	.02	T	0	.01	.19	0	0	0	0
27.	0	.10	0	0	.55	T	0	0	0
28.	.43	.15	0	0	T	0	0	.06	0
29.	.14	0	.30	0	0	0	T	.30	0
30.	0	0	.84	0	.37	0	0	0	0
31.		0	0			0	0		
Total	3.12	1.89	2.79	2.14	2.17	1.90	.27	1.27	.04

Total for season.

9.94

5.61

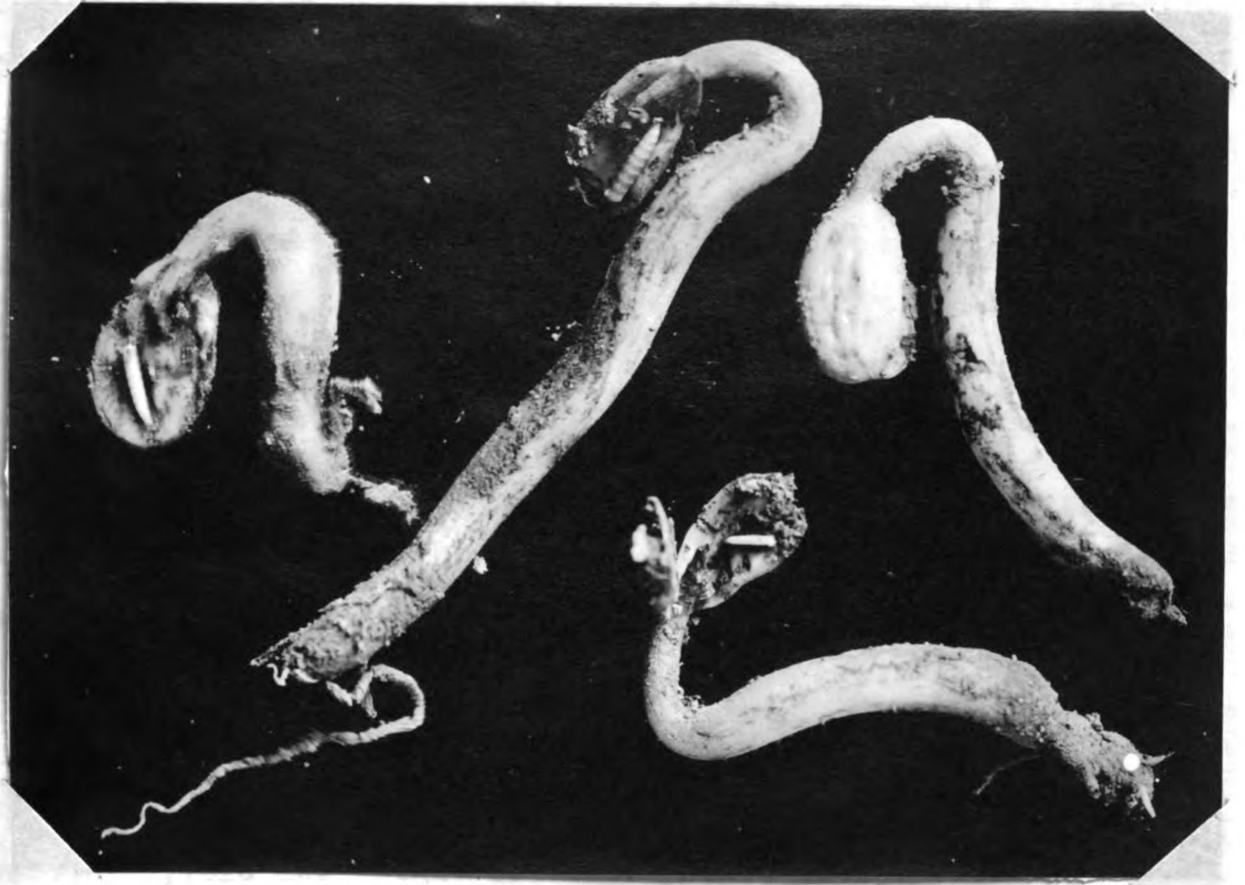
marked increase in yield over weight of vine, while in 1929 the weight of vine exceeded the yield. The greater yield of beans in 1928 was probably due to the greater supply of moisture during the month of August. The application of 500 pounds per acre of a 4-16-4 fertilizer was added hoping to increase the size of vine and net weight of beans. With this increased nitrogen in the soil and plenty of available moisture in the early part of the season a large vine was produced. This vine was so large that it apparently took most of the limited amount of moisture in the late growing season to maintain its growth, and only a moderate number of partially filled pods were produced.

C. Baldhead.

Baldhead of beans, sometimes called snakehead, for a number of years has attracted the attention of the seed growers and farmers. It shows up early in the season and as the other beans close in over the baldheads the farmer thinks the injured plants have recovered, but they only die or merely produce few or no normal pods. Experiments (Harter 1930) show that baldhead may be caused by insects, by thresher injury or by the crusting over of the soil just before the bean seedlings come through the ground.

In 1929, the bean maggot (Hylemyia cilicrura) was a very serious pest. This type of injury may be seen from plate No. V. (Pettit 1929). The weather was cold and damp after planting and the beans were slow to push above the surface of

Plate No. V.



The work of the bean maggot (Hylemyia cilicrura).
This injury was such a serious factor in 1929 that six series,
(D-I), had to be replanted. (Courtesy of Mr. R.H.Pettit, 1929).

the ground. The south side of the area was so seriously damaged that it was necessary to replant six series (D-I). Three series (A-C) were ripe several days before that part of the field where replanting was necessary (D-I), hence there was a greater shelling on these over-ripe beans than in the other series. With this condition in mind one should not place too much emphasis on the large shelling counts taken on treatment II in 1929.

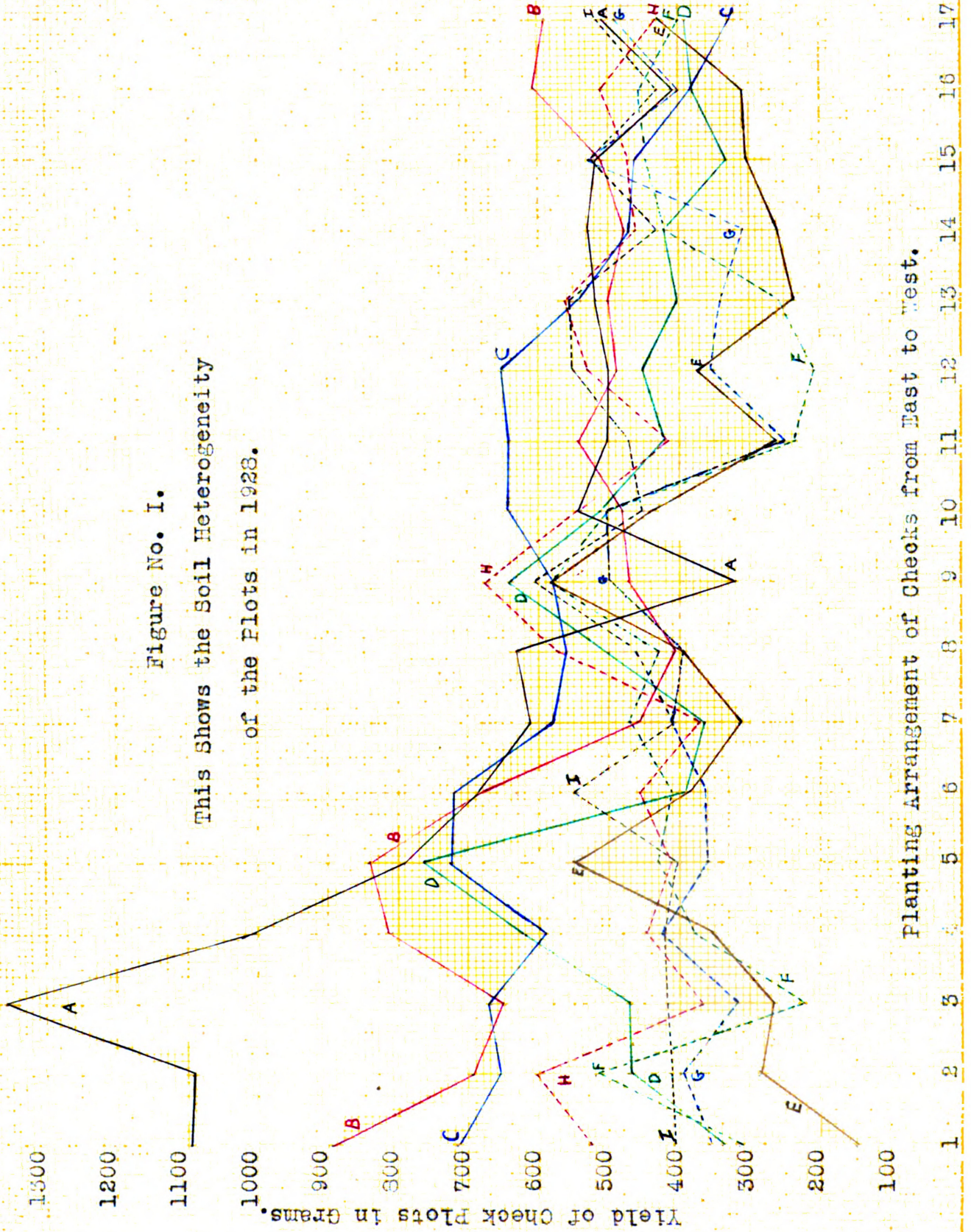
D. Soil.

The general classification of the soil in both areas is a fine sandy loam. Within these sections are small areas of heavier soils. Part of (A) series in 1928 and part of (I) series in 1929 are good examples of the heavier soils, and are noticeably different from the general area. (Figures No.I and No.II.) These extremely different areas made vast differences in yield and weight of vine. Since either yield or weight of vine was used in nearly all of the correlations computed extreme variations were omitted as described under corrections.

E. Other limiting factors.

Diseased and non-producing plants (Plate No. VI a, b) appeared in all the varieties and reduced the yield.

Figure No. I.
This Shows the Soil Heterogeneity
of the Plots in 1923.



Planting Arrangement of Checks from East to West.

Plate No. VI..



a. Diseased and non-productive area (H-I, 1929.



b. Late maturity may be due to disease.
The dark areas are the unripe vines.

V. RESULTS.

A. Factors influencing yield.

1. Variety yield.

The yield results are given in Tables 3 and 4. Table 3 gives the results as calculated by the coefficient of yield method. Table 4 gives the mean yield of each variety as calculated from the correlation surface. Robust Selection and Early Wonder (E2) are the only varieties that exceeded the check in yield both years. The significance of the yearly differences (calculated from the means and their probable errors) is shown in Table 5. Here we find the 1923 results of these two varieties (RS and E2) significantly different from the check but this is not true in 1929. This is easily seen in Table 3. Three varieties; 1000-1, Fliter, and 1200-1 averaged less than the check both years. The significance of their inferiority may be seen in Table 5.

2. Weight of Vine.

The weight of vine results are also shown in Table 4. This table shows that Mexican Tree (M6) had the heaviest vine in 1923 and was only exceeded by Mexican Tree (M5) in 1929. Early wonder (E2) and Robust Selection were much higher in 1923, comparatively, than in 1929. Greiner was lower both years than any other variety. The significance of the differences may be seen in Table 6.

Plate No. VII.



Varietal differences are noticed here in the size of vine, and in the number of adhering leaves.

Table 3.

Average coefficients of yield.

Variety	1923	1929	Two-year average
1. 10	.891	.913	.902
2. M5	1.067	.970	1.018
3. M6	1.094	.950	1.022
4. RS	1.392	1.077	1.200
5. Gr	1.033	.753	.933
6. Cr	1.133	.836	.985
7. E2	1.368	1.038	1.203
8. Pl	.903	.847	.875
9. 12	.994	.983	.983
10. AP	1.087	.892	.989
11. E3	1.044	.875	.959
12. Vt	1.077	.863	.970
13. Ck	1.000	1.000	1.000
14. Ave.	1.094	.913	1.004

Table 4: The means and probable errors for yield and weight of vine
1928 and 1929, and pick 1928.

Variety	Yield		Weight of vine		Pick	
	1928	1929	1928	1929	1928	1928
	Mean	PE.M	Mean	PE.M	Mean	PE.M
1. 10	442.8±15.2	412.5±12.2	337.1±14.6	402.8±10.0	.361±.025	
2. M5	521.4±15.1	416.7±12.1	440.0±13.3	456.9±10.3	.301±.017	
3. M6	548.7±13.6	418.0±11.0	453.6±13.2	454.2±10.9	.267±.023	
4. RS	645.7±10.9	452.3±15.1	435.7±15.1	425.1±10.6	.250±.018	
5. Gr	481.4±11.2	350.0±11.5	327.2±11.2	354.3± 9.2	.553±.041	
6. Cr	498.6±13.1	372.2±11.2	331.4± 9.7	430.6±10.5	.321±.019	
7. E2	587.1±12.6	453.3±13.8	447.1±12.5	431.9±12.0	.341±.021	
8. P1	400.6±10.6	373.6±13.2	371.4± 8.8	386.1±11.0	.544±.042	
9. 12	450.0±11.9	431.9±14.8	364.3±13.5	434.7±10.1	.279±.014	
10. AP	514.3±13.8	394.4±13.3	358.6±10.2	393.1± 9.1	.331±.026	
11. E3	504.3±12.9	392.1±10.2	387.2±11.1	415.3±10.2	.344±.027	
12. Vt	522.9±14.3	393.1±13.5	384.3±10.7	415.3±11.2	.493±.043	
13. Ck	480.9± 7.4	444.6± 7.6	380.2± 6.4	430.9± 6.2	.355±.013	
14. TP	503.2± 4.8	415.9± 4.0	333.6± 3.3	420.5± 2.8	.364±.007	

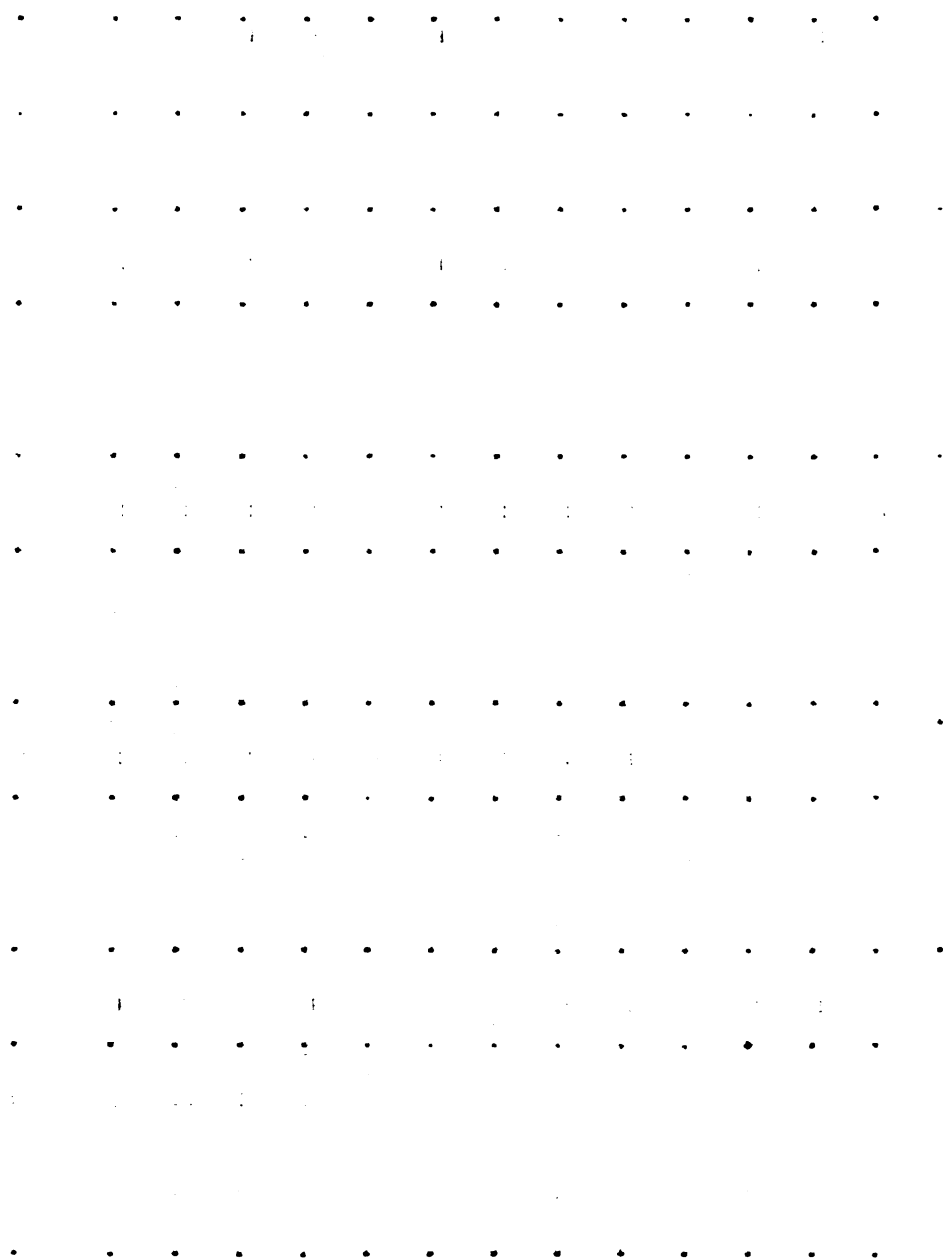


Table 5: The significance between varieties on the basis of yield in grams, 1923 results above diagonal, 1929 below.

	Ck	Vt	E3	AP	12	Pl	E2	Cr	Gr	RS	M6	M5	10
10	.	-s	-s	-s	.	.	-S	.	.	-S	-s	-s	.
M5	.	.	.	.	s	S	-S	.	.	-S	.	.	.
M6	s	.	.	.	S	S	.	.	s	-S	.	.	.
RS	S	S	S	S	S	S	s	S	S	.	.	.	.
Gr	.	.	.	.	.	S	-S	.	.	-S	-s	-s	-s
Cr	.	.	.	.	.	.	-S	.	.	-s	.	.	.
E2	S	s	S	s	S	S	.	s	S	.	.	.	.
Pl	.	-s	-S	-s	.	.	-s	.	.	-s	.	.	.
12	.	-s	.	-s	.	.	.	.	s	.	.	.	.
AP	.	.	.	.	.	.	-s	.	.	.	.	.	.
E3	.	.	.	.	.	.	-s	.	.	.	.	.	.
Vt	.	.	.	.	.	.	-s	.	.	.	.	.	.
Ck	.	.	.	.	.	s	.	s	S	.	.	.	.

S - significant by more than five times the P.E., s - significant by 3.2 to five times the P.E. . - no significance.

-s or -S indicate that the variety indicated in the left hand margin is significantly inferior to the corresponding variety above.

Example M5 is significantly inferior to E2, or E2 is significantly superior to M5.

M6 is significantly superior to 12 but inferior to RS.

Table 6. The significance between varieties on the basis of weight of vine in grams. The results above the line are for 1928, and below for 1929.

	Ck	Vt	E3	AP	l2	Pl	E2	Ca	Gr	RS	M6	M5	10
10	.	-s	-s	-s	.	.	-S	.	.	-S	-s	-s	.
M5	.	.	.	.	s	S	-s	.	.	-S	.	.	.
M6	s	.	.	.	S	S	.	.	s	-S	.	.	.
RS	S	S	S	S	S	S	s	S	S	.	.	.	.
Gr	.	.	.	.	.	S	-S	.	.	-S	-s	-s	-s
Cr	.	.	.	.	.	.	-S	.	.	-s	.	.	.
E2	S	s	S	s	S	S	.	s	S	.	.	.	.
Pl	.	-s	-S	-S	.	.	-s	.	.	-s	.	.	.
l2	.	-s	.	-s	.	.	.	.	s	.	.	.	.
AP	.	.	.	.	.	.	-s	.	.	.	.	.	.
E3	.	.	.	.	.	.	-s	.	.	.	.	.	.
Vt	.	.	.	.	.	.	-s	.	.	.	.	.	.
Ck	.	.	.	.	.	s	.	s	S	.	.	.	.

See notes for interpretation Table 5 p. 27.

3. Stand.

The data on stand may be seen in Table 7. This table gives the average stand for each variety in 1928 and 1929, and the average number of productive plants (second stand) in 1929. Figure No. III gives a good comparative picture of the average stand of each variety. This figure shows that Early Wonder (E2) and Robust Selection had the best stand in 1928 and were near the top in 1929. Table 4 and Figure No. III also show that while Alaska Parish, Greiner, and Fliter were quite low on the average of both years, 1000-1 was very low in 1928.

The significance of differences between varieties may be seen in Table 8. This table shows that in 1928, Early Wonder (E2) was significantly higher than all varieties but Robust Selection, and the latter ^{was} ~~were~~ significantly higher than all but Early Wonder (E2). The same year all varieties were significantly better than 1000-1. In 1929 Greiner was significantly poorer than all varieties except Fliter.

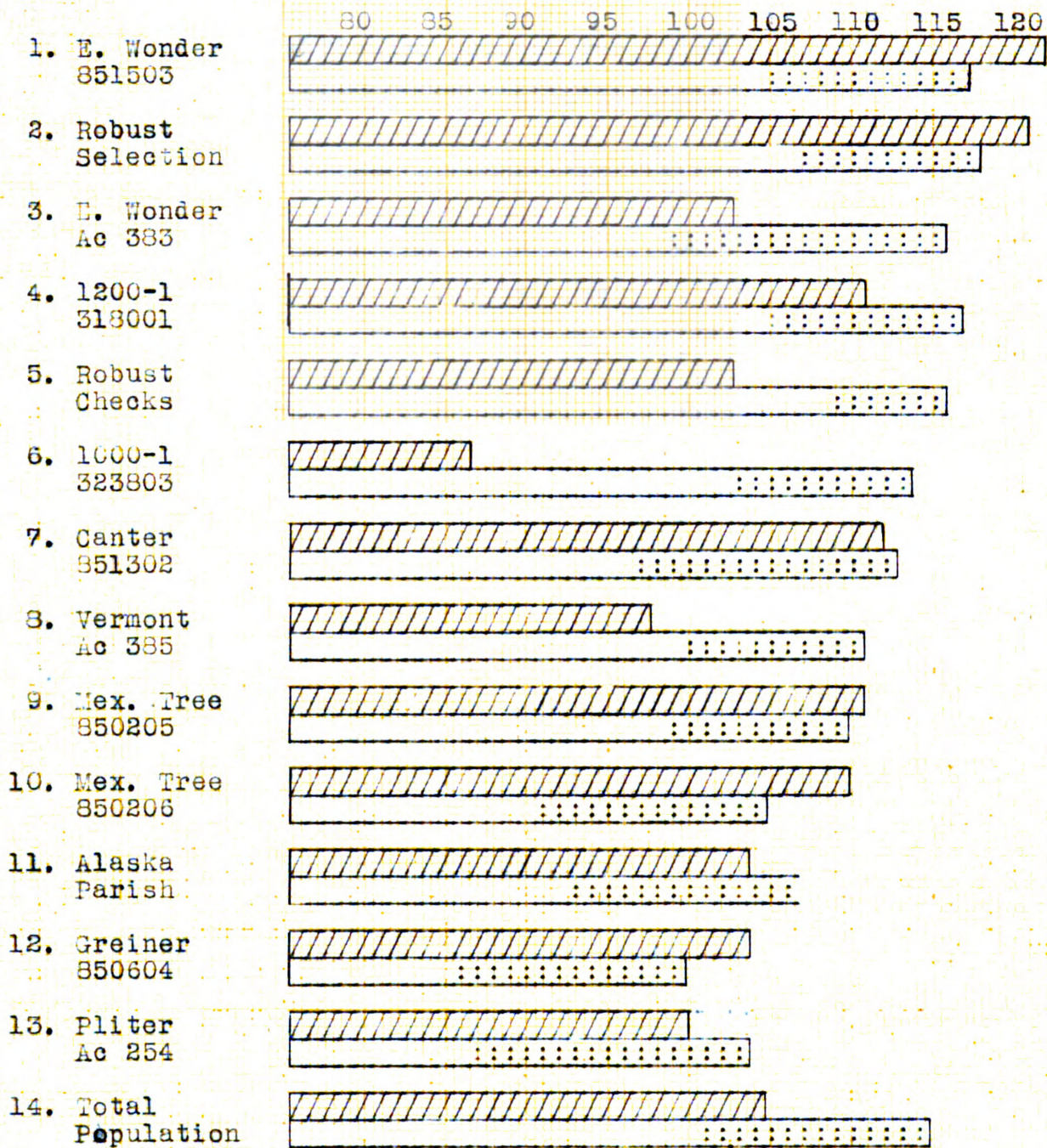
4. Shelling.

Table 7 also gives the average shelling of each variety for 1928 and 1929. This table for the 1928 results includes a little different average than the 1929 results because of a different outlook on Treatment V in 1928. Due to a wet fall some second growth occurred on the fifth treatment (H-I), and at harvest time there were several all green plants with a

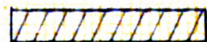
Table 7. The means and probable errors for shelling and stand 1928 and 1929, and second stand 1929.

Variety	Shelling			Stand			2nd. stand	
	1928	1929	1928	1929	1929	1929		
	Mean PE. _M	Mean PE. _M	Mean PE. _M	Mean PE. _M	Mean PE. _M	Mean PE. _M		
1. 10	36.8±3.3	94.4±4.1	88.0±1.7	114.2±1.7	103.1±1.5			
2. M5	47.7±4.4	162.2±7.6	112.1±1.6	110.8±1.7	99.0±1.5			
3. M6	34.0±2.8	52.5±3.2	111.0±1.5	104.3±1.9	92.1±1.4			
4. RS	36.7±2.3	47.2±3.0	121.9±1.4	118.1±2.0	106.8±1.5			
5. Gr	41.0±3.0	153.9±7.2	104.4±1.6	99.9±2.3	86.5±1.9			
6. Cr	35.9±2.9	48.3±2.8	112.4±1.7	113.2±2.1	96.8±1.5			
7. E2	39.1±3.5	61.1±3.7	122.3±1.1	116.9±1.6	105.0±1.1			
8. Pl.	36.9±2.9	74.4±4.6	99.3±1.4	101.5±1.4	89.7±1.2			
9. 12	31.1±2.9	89.4±4.7	108.7±1.4	117.1±1.8	105.3±1.5			
10. AP	45.9±4.1	95.0±4.8	105.0±1.2	107.5±1.7	93.6±1.5			
11. E3	46.0±4.4	80.6±4.6	104.7±1.6	117.4±1.7	101.4±1.5			
12. Vt	36.7±3.2	94.4±4.9	97.1±1.8	111.9±1.6	100.3±1.2			
13. Ck	36.6±1.6	50.5±1.6	102.1±.7	115.7±.8	108.9±.8			
14. TP	38.4±.8	78.2±1.5	105.8±.4	113.9±.5	101.0±.4			

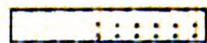
Mean Stand 1928 and 1929.



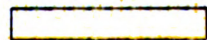
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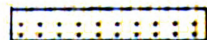
Stand 1928.



Stand 1929.



Productive Plants 1929.



Non-productive Plants 1929.

Non-productive plants were not counted in 1928.

Figure No. III.

Table 8. The significance between varieties on the basis of stand, 1923 results above diagonal, 1929 below.

	Ck	Vt	E3	AP	l2	Pl	E2	Ca	Gr	RS	M6	M5	10
10	-S	-S	-S	-S	-S	-S	-S	-S	-S	-S	-S	-S	.
M5	s	S	.	.	.	s	-s	.	s	-s	.	.	.
M6	s	S	.	.	.	s	-s	.	s	-s	.	-s	.
RS	s	S	s	s	s	s	.	s	S	.	S	s	s
Gr	.	s	.	.	.	.	-S	-s	.	-S	-s	-s	-S
Cr	s	s	s	.	.	s	-s	.	s	-s	-s	.	.
E2	S	S	S	S	S	S	.	.	S	.	-s	s	.
Pl	.	.	.	-s	-s	.	-S	-s	.	-S	.	-s	-s
l2	s	s	.	.	.	s	.	.	S	.	-S	s	.
AP	.	s	.	.	s	s	-s	-s	s	-s	.	.	-s
E3	.	s	.	s	.	S	.	.	S	.	-S	s	.
Vt	-s	.	-s	.	s	s	.	.	s	-s	-s	.	.
Ck	.	.	.	s	.	s	.	.	S	.	-s	.	.

See Table 5 (p.27) for interpretation.

few green pods on most plots. These plants were not harvested with the mature plants but the beans were shelled out by hand, counted, and added to the shelling counts. The first column of Table 7, and all of the shelling data for correlation coefficients for 1928 were computed on this basis. All data on the weathering (Tables 10, 11, and 12) are computed on the actual number of shelled beans. The difference is very small except that it made non-comparable values for Treatment V.

Table 7 shows that Mexican Tree (M5) shelled more both years than any other variety. It was not so much above the average in 1928, but in 1929 it and Greiner shelled very heavily. Table 9 gives the significance of differences between varieties. In 1929, Mexican Tree (M5) and Greiner are significantly different from all other varieties, but are not significantly different from each other.

Tables 10 and 11 show the effect of different field treatments on the amount of shelling. In Treatment I all the varieties shelled very little both years in comparison to the other plots, while in III and IV shelling counts were especially high. Table 12 gives the significance of differences between treatments. With some of the varieties Treatment I gave results that were quite significantly different from those obtained with the other treatments in 1928, but in 1929 it was significantly different from all the other treatments, except Treatment II with Robust Selection. The fourth treatment was not significantly superior to any other.

Table 9. The significance between varieties on the basis of shelling, 1929 results are given.

	12	M6	Cr	Ck	Vt	RS	10	Pl	E2	Gr	AP	E3	M5
M5													
E3													-S
AP												S	-S
Gr											S	.	.
E2										-S	-S	.	-S
Pl									.	-S	-s	.	-S
10								s	S	-S	.	.	-S
RS							-S	-s	.	-S	-S	.	-S
Vt						S	.	s	S	-S	.	.	-S
Ck					-S	.	-S	-S	.	-S	-S	.	-S
Cr				.	-S	.	-S	-S	.	-S	-S	.	-S
M6			.	.	-S	..	-S	-S	.	-S	-S	..	-S
12		S	S	S	.	S	.	.	s	-S	.	.	-S

There was no significance between varieties in 1928 on account of the low shelling counts.

See Table 5 (p. 27) for interpretation.

Table 10. Mean shelling of each variety under different field treatments, 1928.

Treatment I.		II.		III.		IV.		V.	
Series A.		B-C.		D-E.		F-G.		H-I.	
Variety	Mean PE. _M	Mean PE. _M		Mean PE. _M		Mean PE. _M		Mean PE. _M	
1. 10	21.5± 6.3	23.0±3.9		21.1±1.7		37.3±5.3		22.6±3.1	
2. M5	23.5± 6.7	13.5±1.2		43.0±8.6		57.9±6.2		32.1±6.0	
3. M6	17.3± 9.4	16.1±4.1		31.4±3.9		44.1±4.8		29.1±3.1	
4. RS	6.5± 3.3	26.6±2.3		38.5±3.0		58.5±7.5		28.9±4.0	
5. Gr	12.5± 6.3	23.0±2.6		41.0±4.0		67.3±6.7		28.8±5.5	
6. Ca	11.3± 3.1	17.0±2.5		34.6±4.8		46.1±4.2		38.1±5.5	
7. E2	29.3±12.0	36.9±7.6		36.1±4.3		61.8±10.4		24.0±2.7	
8. P1	33.0±19.8	18.3±3.3		24.3±2.6		50.3±6.6		23.1±2.7	
9. 12	17.3±10.7	13.5±2.6		37.0±4.6		45.1±9.0		24.5±5.6	
10. AP	6.8± 2.5	36.5±4.1		26.6±4.1		69.5±9.9		35.9±7.1	
11. E3	3.8± 1.4	22.9±5.7		37.0±3.7		67.4±5.2		24.4±4.1	
12. Vt	6.3± 1.5	17.8±3.9		41.4±5.0		37.6±6.1		21.9±3.4	
13. Ck	13.4± 2.4	26.3±2.3		29.7±2.2		52.8±3.1		23.9±1.7	
14. TP	12.1± 1.9	23.4± .9		33.5±1.0		53.4±1.6		26.8±1.0	

1. The first part of the paper discusses the importance of maintaining accurate records of all transactions.

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3. The third part of the paper discusses the importance of maintaining accurate records of all transactions.

4. The fourth part of the paper discusses the importance of maintaining accurate records of all transactions.

5. The fifth part of the paper discusses the importance of maintaining accurate records of all transactions.

6. The sixth part of the paper discusses the importance of maintaining accurate records of all transactions.

Table 11.

Mean shelling of each variety under different field treatments, 1929.

Treatment I.		II.		III.		IV.		V.	
Series A.		B-J.		D-E.		F-G.		H-I.	
Variety	Mean PE.M.	Mean PE.M.	Mean PE.M.	Mean PE.M.	Mean PE.M.	Mean PE.M.	Mean PE.M.	Mean PE.M.	Mean PE.M.
1. 10	38.0± 6.5	106.3± 6.5	88.5± 5.7	114.6± 7.8	95.0± 8.6				
2. M5	97.8±22.6	200.3±10.4	160.6± 9.8	194.8±15.0	127.0±14.5				
3. M6	14.0± 1.9	58.5± 6.3	42.1± 5.4	74.9± 4.0	54.8± 4.6				
4. RS	22.8± 1.6	34.6± 5.0	59.4± 7.5	64.0± 7.7	38.8± 4.1				
5. Gr	68.5± 8.1	129.6±12.1	152.9± 8.7	222.9±10.1	150.0±12.1				
6. Cr	15.5± 2.5	62.4± 5.4	44.5± 3.2	45.8± 4.9	49.5± 6.1				
7. E2	19.3± .4	51.5± 4.9	75.9± 7.6	82.9± 7.1	46.8± 5.1				
8. P1	24.5± .6	61.5± 6.5	75.8± 7.0	111.8±12.8	66.6± 7.4				
9. 12	17.0± 1.0	93.9± 7.4	70.6± 2.1	132.6± 7.9	97.4± 5.2				
10. AP	37.8± 3.5	97.0±12.5	109.6±12.4	112.4±11.1	83.1± 6.8				
11. E3	26.8± 1.6	70.3±10.4	79.1± 5.9	128.0±11.3	77.5± 5.2				
12. Vt	37.0± 3.6	93.5±10.9	94.9±13.0	120.2± 8.6	100.4± 6.3				
13. CK	25.0± 2.1	45.1± 2.6	51.3± 3.1	77.3± 3.6	41.4± 2.7				
14. TP	32.4± 1.4	77.8± 1.6	73.7± 1.8	106.3± 2.1	72.0± 1.7				

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Table 12. Shelling count significance between each field treatment.

Treatment.		I.		II.		III.		IV.		V.	
Series.		A.		B-C.		D-E.		F-G.		H-I.	
Variety :	1923	1929	1923	1929	1923	1923	1923	1923	1923	1923	1923
1. 10	: no	: all	: no	: no	: no	: no	: no	: no	: no	: no	: no
2. M5	: 4	: "	: 3,4	: "	: "	: "	: "	: "	: "	: 2,4	: 2,4
3. M6	: 4	: "	: 4	: "	: "	: 4	: "	: "	: "	: 4	: 4
4. R3	: all	: 3,4,5	: 4	: 4	: no	: no	: "	: "	: 4	: no	: no
5. Gr.	: 3,4	: all	: 4	: 4	: 4	: 4	: "	: "	: 4	: 4	: 4
6. Cr	: 3,4,5	: "	: 4	: no	: no	: no	: "	: "	: no	: no	: no
7. E2	: no	: "	: no	: 4	: "	: "	: "	: "	: 4	: 3,4	: 3,4
8. P1	: "	: "	: 4	: 4	: 4	: "	: "	: "	: 4	: 4	: 4
9. 12	: "	: "	: 3,4	: 4	: no	: 4	: "	: "	: no	: 4	: 4
10. AP	: all	: "	: 4	: no	: 3	: no	: "	: "	: "	: no	: no
11. E3	: "	: "	: 4	: 4	: 4	: 4	: "	: "	: 4	: 4	: 4
12. Vt	: 3,4,5	: "	: no	: no	: no	: 4	: "	: "	: no	: no	: no
13. Ck	: all	: "	: 4	: 4	: 4	: 4	: "	: "	: 4	: 4	: 4
14. TP	: all	: all	: 3,4,5	: 4	: 4	: 4	: no	: no	: 3,4	: 2,3,4	: 2,3,4

For explanation of this table see next page.

Description of symbols used in Tables 12 and 15.

The treatments represented by the numbers at the heads of the columns are considered to be superior (i.e., shelled less beans per plot) to the treatments whose numbers appear in the body of the table.

Thus: under I in 1928 for variety M5 is found a "4" (arabic numbers used for simplicity) and it is interpreted to mean that I shelled significantly less beans than IV but the differences with the other treatments were not significant. In 1929, under I for M5 is found "all" and it indicates that I shelled significantly less beans than all the other treatments. A "no" indicates that the treatment at the head of the column is not significantly superior (shelled less beans) to the other treatments.

Shelling counts may be interpreted in pounds per acre by considering that ten beans per plot is approximately 3.25 pounds per acre, or 100 beans per plot is approximately 32.5 pounds per acre. Then, the average (IP) loss under Treatment I in 1928 (Table 10) was 4.2 lbs. per acre, while in 1929, (Table 11, it was 10.5 lbs. Mexican Tree (M3) and Greiner lost 7.6 and 4.0 lbs., respectively, in 1928, and 31.8 and 22.3 lbs., respectively, in 1929, with the same treatment. The losses occurring in these two varieties under Treatments II, III, IV, V in 1929 were very high, while in Robust Selection, Mexican Tree (M3) and Early Wonder (E2) they were not very large. These differences are in all probability due to inherited varietal characteristics.

5. Pick.

Table 4 also shows the average pick of each variety for 1928. No pick was obtained in 1929 because of reasons already mentioned. This table shows that Greiner, Pliter, and Vermont picked much heavier than the other varieties. The significance of differences between varieties, on the percentage pick, may be seen in Table 13. Greiner, Pliter, and Vermont are significantly different from all other varieties, but are not significantly different from each other.

Table 14 gives the mean pick of each field treatment. The first three treatments picked much lower than the first two. Table 15 shows that the significance of differences between treatments. No variety in Treatment IV or V is significantly better than in any of the other treatments.

Table 13. The significance between varieties on the basis of
pick, 1928 results above diagonal, 1929 below.

	Ck	Vt	E3	Ap	12	Pl	E2	Cr	Gr	RS	M6	M5	10
10	.	-s	.	.	.	-s	.	.	-s	S	s	.	.
M5	.	-s	.	.	.	-s	.	.	-s	.	.	.	.
M6	.	-s	.	-s	.	-s	.	.	-s	.	.	.	-s
RS	-S	-S	-s	-s	.	-S	-s	-s	-S	.	s	.	.
Gr	s	.	s	s	s	.	s	s	.	-S	.	-s	-S
Cr	.	-s	.	.	.	-s	.	.	s	-s	.	.	.
E2	.	-s	.	.	.	-s	.	s	S	.	s	.	.
Pl	s	.	s	s	S	.	-s	.	.	-s	.	-s	.
12	.	-s	.	.	.	s	.	s	S	.	.	.	-s
AP	.	-s	.	.	s	.	-s	.	.	-s	.	.	.
E3	.	-s	.	s	.	s	.	.	s	.	s	.	.
Vt	s	.	.	s	.	s	.	.	s	.	s	.	.
Ck	.	s	s	s	.	s	.	s	s	.	s	s	.

See Table 5 (p. 27) for interpretation.

Table 14. The mean pick of each variety under different field treatments 1928.

Treatment	I.	II.	III.	IV.	V.
Series	A.	B-C.	D-E.	F-G.	H-I.
Variety	Mean PE. _M	Mean PE. _M	Mean PE. _M	Mean PE. _M	Mean PE. _M
1. 10	.255±.050	.119±.016	.205±.024	.625±.034	.400±.072
2. M5	.217±.057	.169±.026	.231±.040	.393±.048	.250±.046
3. M6	.067±.016	.119±.023	.183±.034	.406±.082	.306±.059
4. R3	.100±.039	.100±.031	.156±.025	.313±.049	.281±.030
5. Gr	.133±.065	.231±.063	.433±.068	.356±.107	.650±.078
6. Cr	.117±.049	.213±.067	.231±.030	.431±.030	.300±.014
7. E2	.167±.011	.150±.020	.230±.020	.394±.029	.551±.033
8. P1	.133±.021	.200±.033	.394±.077	.838±.074	.706±.150
9. 12	.200±.024	.138±.022	.219±.060	.356±.025	.250±.033
10. AP	.117±.036	.119±.030	.281±.022	.533±.060	.463±.042
11. E3	.150±.043	.150±.032	.294±.013	.533±.030	.306±.029
12. Vt	.350±.027	.106±.017	.353±.052	.663±.116	.600±.072
13. CK	.165±.026	.131±.007	.199±.015	.523±.025	.516±.039
14. TP	.171±.009	.153±.007	.253±.010	.537±.015	.447±.016

Table 15.

Table of significance between field treatments on the basis of percentage pick for each variety, 1923.

Treatment I.		II.	III.	IV.	V.
Series A.		B-C.	D-E.	F-G.	H-I.
Variety	1923	1923	1923	1923	1923
1. 10	4	4,5	4	no	no
2. M5	no	4	no	"	"
3. M6	3,4,5	4,5	"	"	"
4. RS	4,5	4,5	4	"	"
5. Gr	3,4,5	4,5	4	"	"
6. Cr	4,5	4	no	"	"
7. E2	4,5	4,5	4,5	"	"
8. P1	3,4,5	4,5	4,5	"	"
9. 12	4	4	no	"	"
10. AP	4,5	4,5	4	"	"
11. E3	4	4	4	"	"
12. Vt	4,5	1,3,4,5	4	"	"
13. Ck	4,5	4,5	4,5	no	no
14. TP	3,4,5	3,4,5	4,5	no	4

The weather was so dry in the fall of 1929 that it was impossible to obtain a percentage pick.

An example for interpretation of this table may be found with Table 12. (p.36a.)

B. Relationships.

L. General observations.

In general, the correlation surfaces were about the same both years. A few typical **scatter** surfaces have been selected from the large number actually computed in order to give some idea of the distributions obtained, and they are given along with the discussion of the characters concerned.

The superimposing-the-means method (Table 16) of combining all varieties to obtain a total population was used in all cases, because it was thought to be the more desirable method of obtaining combined results. It gives coefficients which are not significantly different from those obtained by combining the varieties by the ordinary method (Table 17), however as shown in Figures No. IV. and No. V., when the means of each variety are so different it may cause the reader to wonder whether such unlike groups of frequencies may be combined in the usual manner into a total population correlation. Both of the correlation coefficients may be found at the bottom of Tables 18, 22, 26, and 33 so that any one not fully convinced that the super-imposing method is a superior method for combining unlike populations may compare the two results and take either method for what it is worth.

All plots of a variety, unless omitted for soil variability as mentioned previously, regardless of treatment, were used to obtain the varietal correlations.

The correlation coefficients for the total population as obtained by the ordinary method of combining tables (TP) and by the super-imposing-the-means method (S) were not computed for the 1923 data in Tables 13, 26, and 33.

If no "r" values are found under the columns designated as "corrected, as described in text", in Tables 13, 22, 26, and 33, there was no change made in the "r" value over those coefficients found in the first column to the left of the one under consideration.

Table 16. Correlation between weight of vine (X) and yield (Y), 1929.

Total population by super-imposing the means.

Y	-5	-4	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	
X																
-4						1										1
-3	1	2	8	11	3		2	1								23
-2		3	16	23	16	13	6	1								33
-1			12	33	37	35	20	6	4							153
M		1	3	16	31	29	24	12	7	1		1				125
1		4	3	7	21	15	17	9	8	1	1					36
2			1	5	6	8	6	6	5	3	(2) ¹ (2)					42
3				3	1	5	2	6	5	4	4	(1)	1	(2) ¹		32
4						1		1	1	1	(1)	(1)	(2) ¹ (1)			9
5								1	1	(2) ¹ 2	1	(1)				3
6										1		2	(2) ¹ (1)			6
7														(1)	(1)	2
8								(1)			(1)			(1)		3
9										(1)	(1)					2
	1	10	44	103	115	111	83	42	23	11	12	9	6	6	3	1 535

$r = .6674 \pm .0155$ r (corrected) = .5736 $\pm .0189$

Table 17. Correlation between weight of vine (X) and yield (Y), 1929.

Total population by not super-imposing the means.

X	Y																
	175	225	275	325	375	425	475	525	575	625	675	725	775	825	875	925	
225	3			2													5
275	1	6	3	12	3	2											33
325		3	21	20	29	13	7	2									107
375	1	5	12	32	29	37	13	7	2								153
425		1	13	14	32	70	23	10	3	1	1						153
475	3		4	9	17	18	14	6	7	3							61
525			5	6	2	5	8	5	7	2	(2) ¹ (3) ²						43
575			1		2	5	3	2	4	3	(2) ¹	(1) ¹	1				24
625						1		1			4	1	(3) ¹				10
675								1	2		(1)	1	(1)	(2) ¹			3
725										1	1	1	1	1	(1)		6
775														(1)	(1)		2
825									(1)			(1)		(1)			3
875											(1)	(1)					2
	5	13	63	94	114	116	70	35	26	10	10	9	6	4	4	1	535

$r = .3735 \pm .0152$ r (corrected) = .5350 $\pm .0137$

2. Discussion of relations.

a. Shelling to weight of vine.

The relationship between shelling and weight of vine was not so strong as it possibly would be over a period of years. Table 13 gives the summary of the "r" values for 1928 and 1929. Typical surfaces are Tables 19, 20, and 21. The tendency was for a negative correlation, the greater the weight of vine the less the shelling, in 1928, but the following year the reverse was true. Unfortunately none of the correlations gave a significant coefficient. It is interesting to note that, if the points of intersection of the two means of each variety are plotted for shelling and weight of vine, there is a quite strong negative relationship in 1929. The smallness of the 1928 counts may explain the lack of correlation of these intersections in that year. (Figure No. IV, part 1).

If the four varieties (M5, M6, R3, and L2) which are apparently above the average weight of vine of all varieties (TP) both years are compared for shelling, it is noticed that with the exception of M5 they tend to be below the average (TP) in shelling, especially M6 and R3. If the four varieties (AP, 10, Gr and Fl) which are appreciably below the average weight of vine (TP) both years are compared for shelling, it is noticed that two of them (AP and Gr) shelled more both years than the average (TP) while the other two were not consistent in their reactions.

While 13 has a larger vine yet it is undesirable on account of its high shelling counts. To sum up the individual variety relationships and the inter-variety relationships the general tendency, with the exception of 13, is for the larger vines to have the smaller amount of shelling.

Table 13. Correlation values between shelling and weight of vine for 1928 (A,3,C) and 1929 (D,E). A and D-all plots included; B- one entire replication omitted on account of soil heterogeneity; C and E- corrected, as described in text.

Variety	A.		B.		C.		D.		E.	
	r	PE. _r	r	PE. _r	r	PE. _r	r	PE. _r	r	PE. _r
1. 10	-.138±.109		-.143±.112		.030±.116		.113±.111			
2. M5	-.134±.110		-.168±.111		-.290±.106		.130±.111			
3. M6	.069±.112		.008±.114				.273±.104			
4. RS	-.213±.107		-.200±.110				-.253±.105			
5. Gr	-.206±.108		-.281±.105				.197±.103			
6. Cr	.032±.112		.149±.112				.239±.107			
7. E2	.158±.110		-.009±.114		-.046±.115		-.060±.112		.047±.114	
8. P1	.254±.105		-.044±.114				.161±.110			
9. 12	.207±.108		.170±.111		.128±.114		.300±.102			
10. AP	-.005±.112		.022±.114				.046±.112			
11. F3	-.144±.110		-.129±.112		-.429±.095		.183±.109			
12. Vt	-.153±.110		-.191±.110				.281±.104			
13. CK	-.025±.054		.012±.055		-.027±.055		.160±.053		.199±.053	
14. TP			-.054±.029		-.072±.023		.039±.023		.070±.028	
15. S			-.053±.023		-.069±.023		.144±.023		.123±.027	

Table 19. Correlation between shelling (X) and weight of vine (Y), 1929.

Total population by super-imposing the means.

Y	-4	-3	-2	-1	M	1	2	3	4	5	6	7	8	9
X														
-7				1										1
-6		2												2
-5		1		2										3
-4			2	3	2	1	2							10
-3		2	6	8	4	5								25
-2		11	20	19	11	8	1	4		1		(1)		76
-1		5	22	41	33	19	7	5	1	3	2	(2)	(1)	141
M	1	5	16	26	26	15	15	9	4	1	1			119
1		3	7	21	29	11	13	5	2	2		(1)	(1)	95
2			13	12	10	6	2	3	1	2	3			52
3		3	6	12	6	4		2				(1)		34
4				2	5	3	2							12
5			1	2	1	3	1	1						9
6				1	2	1								4
7														
8					1									1
9				1										1
	1	32	93	151	130	76	43	29	8	9	6	2	3	535

$$r = .144 \pm .023$$

$$r \text{ (corrected)} = .123 \pm .027$$

Table 20.

Correlation between weight of vine (X) and Shelling (Y), in 1929,
on Robust (Check).

X	275	325	375	425	475	525	575	625	675	725	775	825	875	
Y														
10	3	5	5	1	2									16
30	2	8	17	16	5	1		1	1			(2)	(1)	54
50	1	5	6	9	2	6	3	3						35
70	1	1	5	6	7	2					(1)		(1)	24
90		5	2	3	1		2							13
110			3	1			1				(1)			6
130			1		2									3
150			1				1							2
	7	24	40	36	19	9	7	4	1	0	2	2	2	153

$r = .160 \pm .053$

$r \text{ (corrected)} = .199 \pm .053$

Table 21.

Correlation between weight of vine (X) and shelling (Y),
in 1929, on Early Wonder (E3).

X	225	275	325	375	425	475	525	575	625	675
Y										
10										
30			3	1	1	2				7
50		2	2							4
70				4	2	1	1		1	9
90				3	2	1	1	1		8
110			1				1	1		3
130			1							1
150					1					1
170					1		1			2
190			1							1
	2	8	8	8	7	4	4	2	0	1
										36

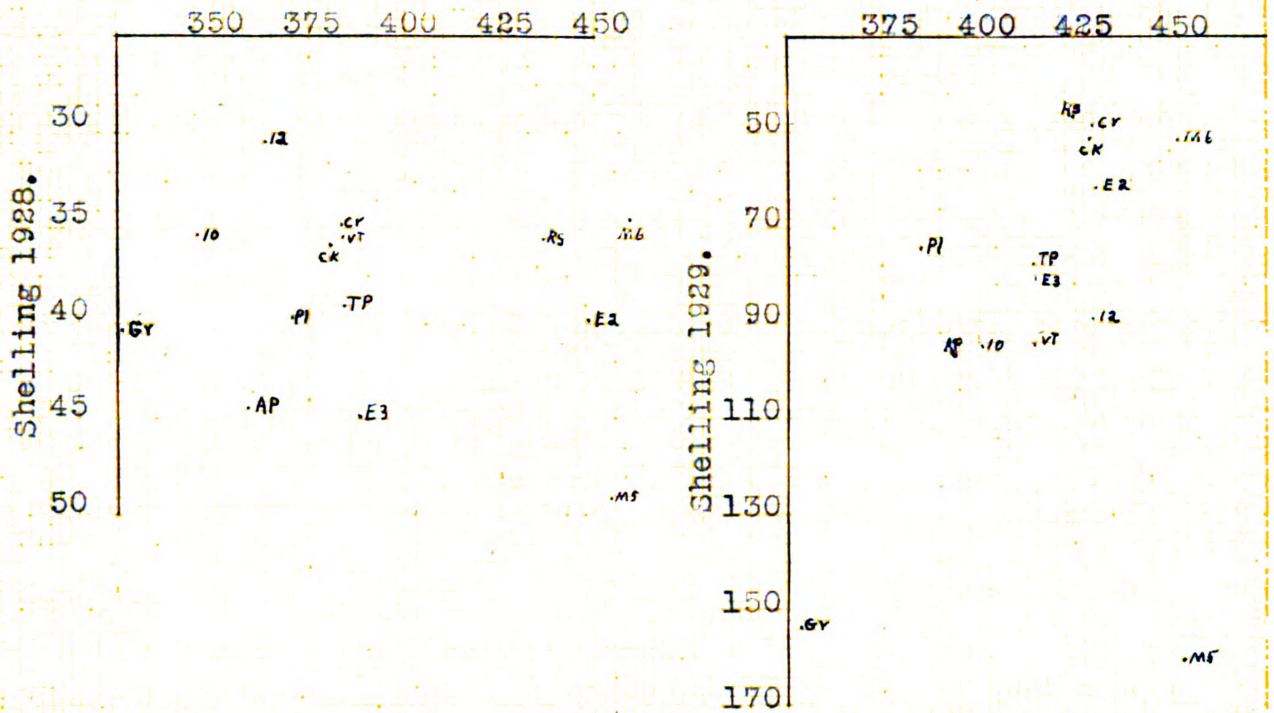
$r = .183 \pm .109$

b. Weight of vine to yield.

From the correlation studies on weight of vine to yield very significant relationships were observed for both years (Table 22), in spite of the differences in weather conditions.

The highest "r" obtained was on Early Wonder (E2) in 1929 (Table 22) and was .855-.030 which is 28 times its probable error. The smallest "r" was .433-.093 On Robust Selection in 1928. Tables 23, 24, and 25 tend to show the strong relationship of weight of vine to yield. When the Means of each variety were plotted as to weight of vine to yield there was also a noted tendency toward a positive relationship.(Figure No. IV., part 2). Therefore, there is not only a strong coefficient of correlation on each separate variety, but there is also a marked relationship between varieties, that is, a variety with a small vine will be expected to produce low yields, while a variety with a large vine will be expected to produce greater yields.

Weight of Vine 1929.



2. Weight of Vine to Yield 1928 and 1929.

Yield 1928.

Yield 1929.

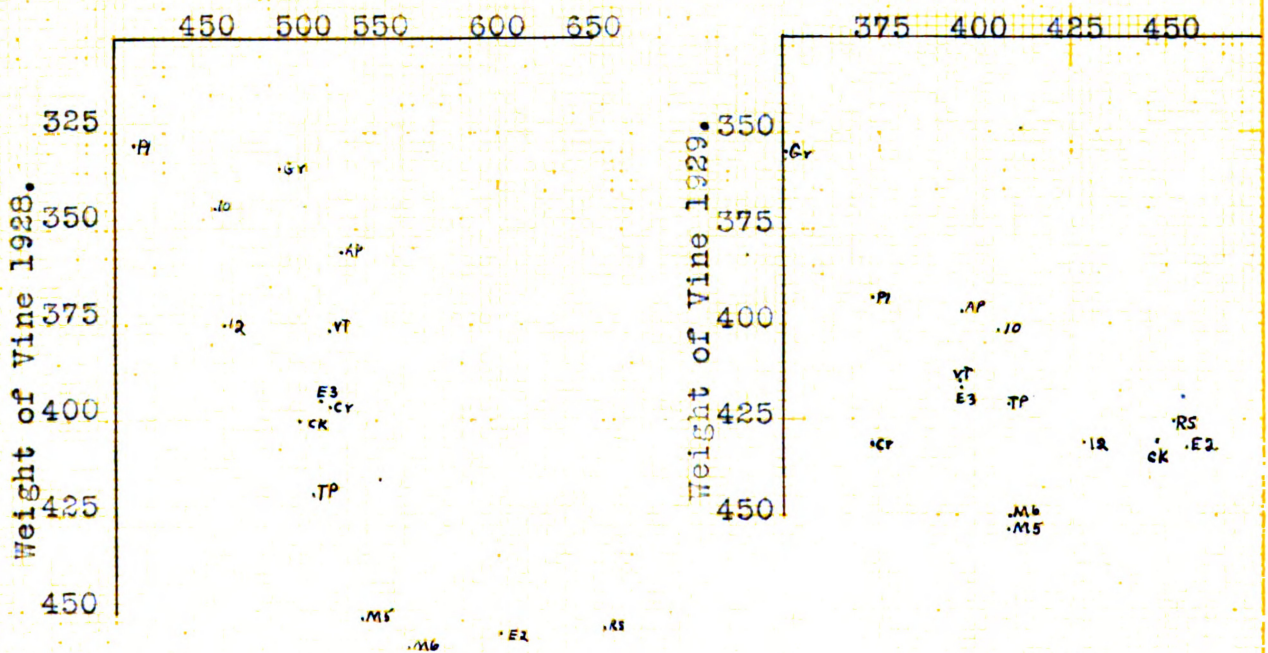


Table 22. Correlation values between weight of vine and yield 1928 (A,B) and 1929 (C,D). A - one entire replication omitted. C - all plots included; B and D - corrected, as described in the text. Correlations were not computed in 1928 for all replications present.

Variety	A.		B.		C.		D.	
	r	PE.r	r	PE.r	r	PE.r	r	PE.r
1. 10	.746±.051				.614±.070		.571±.098	
2. M5	.529±.082				.634±.067		.538±.081	
3. M6	.629±.069				.639±.059			
4. R5	.438±.093				.799±.041			
5. Cr	.630±.069				.623±.069			
6. Cr	.641±.067				.435±.086			
7. E2	.534±.075				.855±.030		.829±.036	
8. P1	.629±.069				.636±.059			
9. 12	.445±.091				.717±.055		.590±.075	
10. AP	.533±.073		.510±.086		.465±.083		.274±.106	
11. E3	.652±.066				.619±.069			
12. Vt	.590±.074				.538±.030			
13. Ck	.719±.027				.656±.031		.534±.041	
14. TP	.644±.017		.645±.017		.674±.015		.585±.019	
15. S	.616±.013		.612±.013		.579±.019		.637±.016	

Table 23.

Correlation between weight of vine (X) and Yield (Y), in 1929,
on Early Wonder, (E2).

X	275	325	375	425	475	525	575	625	675	725	775	825	
Y													
325	1	3	5										9
375			2	3	2	1							8
425		1	2	2		2							7
475				2	1	1	2						6
525					1	1							2
575							1			1			2
625													0
675												1	1
725													0
775													0
825											(1)		1
	1	4	9	7	4	5	3	0	0	1	1	1	36

$$r = .855 \pm .030$$

$$r \text{ (corrected)} = .829 \pm .036$$

This correlation is more than twenty times its
probable error and is very significant.

Table 24.

Correlation between yield (X) and weight of vine (Y),
in 1929, on Robust (Check).

X	175	225	275	325	375	425	475	525	575	625	675	725	775	825	875	925	
275	1	1		5												7	
325			2	8	7	7										24	
375				5	11	13	10	1								40	
425				1	10	12	8	4	1							36	
475			1	2	3	4	5	1	3							19	
525						1	2	2	1	(1)(2)						9	
575						2	2	1		(1)	(1)					7	
625						1		1		(1)(1)						4	
675										(1)						1	
725																0	
775														(1)(1)		2	
825								(1)						(1)		2	
875										(1)(1)						2	
	1	1	3	21	31	40	27	10	6	0	4	5	0	1	2	1	153

$$R = .656 \pm .031$$

$$r \text{ (corrected)} = .534 \pm .041$$

Table 25.

Correlation between yield (X) and weight of vine (Y),
in 1929, on 1000-1 (10).

X	225	275	325	375	425	475	525	575	625	675	725	775	825	
Y														
275	1	1	1	1										4
325		2	1	1	3		1							8
375			1	2			1	1						5
425			2	4	1	3			1					11
475			1	1	1									3
525			2					1						3
575									1					1
625														0
675												(1)		1
	1	3	8	9	5	3	2	2	2	0	0	0	1	36

$r = .614 \pm .070$

$r(\text{corrected}) = .371 \pm .098$

c. Stand to yield.

Due to the fact that Two years with diverse weather conditions were the basis of this work, very different results were obtained (Table 26). In 1928 the correlations were small but most of them indicated that the greater the stand the larger the yield. Vermont, in 1928, showed a $.410 \pm .094$ correlation, which is over four times its error, but all of the other correlations in this group are small and not significant. In 1929 most of the coefficients were negative. (Tables 28, 27, 26, and 29). This would tend to show that the fewer the plants, within limits, the greater the yield. Since but 0.27 of an inch of rain fell in August 1929, (Table 2), the fewer plants there were the greater was the yield because a plant required a larger area than in 1928 to obtain enough moisture to mature beans. In 1928, during the same month 2.79 inches of precipitation fell. (Table 2). These amounts of rainfall probably account for the positive correlations in 1928 and negative correlations in 1929. In 1929, it was noticed that many plants were unproductive. (Figure No. IV). The questions then arose, how much of a factor is this, and how much does it effect the relationships? The number of productive plants(second stand)was correlated with yield and but little relationship was noticed within the variety itself. (Tables 30, 31, and 32).

Although little relationship exists between stand and yield in a variety, when the means were plotted for each variety, a positive relationship is noted (Figure No. V. part 4). This shows that those varieties with the larger number of plants per row give the highest yield. This is emphasized still further when the second stand is considered. (Figure No. V. part 4).

Table 26. Correlation values between first stand and yield 1928 (A,B,C) and (D,E) 1929, also second stand and yield (F,G) 1929. A,D,F all plots included; B on entire replication omitted on account of soil heterogeneity; C,E,G corrected as described in the text.

Variety	A		B		C		D		E		F		G	
	r	PE.r	r	PE.r	r	PE.r	r	PE.r	r	PE.r	r	PE.r	r	PE.r
1. 10	.016†	.112	.293†	.104			-.211†	.107	-.419†	.094	-.166†	.109	-.294†	.104
2. M5	.093†	.112	.213†	.109			-.157†	.110	.197†	.110	.054†	.112	.033†	.114
3. M6	.104†	.111	.259†	.106			-.235†	.103			-.012†	.112		
4. RS	-.210†	.107	-.087†	.113			-.460†	.089			-.355†	.093		
5. Gr	.245†	.106	.399†	.096			-.031†	.112			..001†	.112		
6. Cr	.217†	.107	.313†	.103			-.334†	.096			-.097†	.111		
7. E2	.144†	.110	.217†	.109			-.240†	.106			-.163†	.109		
8. P1	-.091†	.112	-.079†	.113			-.308†	.102	-.527†	.102	-.214†	.107		
9. 12	.076†	.112	.095†	.114			-.275†	.104	-.393†	.096	-.200†	.108	-.245†	.107
10. AP	-.068†	.112	-.047†	.114	.114†	.114	.070†	.112	-.073†	.102	.245†	.106	.239†	.107
11. E3	-.067†	.112	-.049†	.114			-.265†	.105			-.109†	.111		
12. Vt	.410†	.094	.410†	.095			-.399†	.095			-.303†	.102	-.408†	.095
13. CK	.348†	.048	.216†	.053	.234†	.052	-.195†	.053	-.266†	.051	-.109†	.052	-.156†	.054
14. TP			.322†	.025	.337†	.025	-.131†	.027	-.170†	.027	.003†	.023	-.018†	.028
15. S			.118†	.027	.201†	.027	-.215†	.027	-.260†	.026	-.113†	.023	-.138†	.028



Table 27.

Correlation between yield (X) and first stand (Y), in 1929.

Vermont.

X	225	275	325	375	425	475	525	575	625	675	725	775	
Y													
85					2		1					3	
90					1							1	
95					1	1						2	
100				1	2							3	
105	1			1		1						3	
110			1		3	1	1					6	
115		1		1				1			1	4	
120	1	1	1		1	1			1			6	
125		2										2	
130	1	2	1									4	
135	1		1									2	
	4	6	4	3	10	4	2	1	1	0	0	1	36

$$r = .399 \pm .095$$

Table 23.

Correlation between yield (X) and first stand (Y) in 1939.

Total Population (S).

X	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	
Y																	
-13												1					1
-12														1			1
-11																	0
-10									2								2
-9						1	(1)	1	1		1						5
-8				2		1	1		1			1		(1)			7
-7			1	1	2	3	3	1	2	3							16
-6					1	3	4	1	1				1				11
-5		1	4	6	2	3	6	1	2	1							26
-4		1	3	5	5	5	4	5	3	1		1	2				35
-3			1	9	7	9	9	4	1	1	1	1					43
-2		1	6	9	12	10	10	7	6		3	1	1				66
-1		1	3	8	15	8	12	5	1			1	1	(1)			56
0			3	10	12	10	6	6	2	2	3	1	(1)	2			58
1		2	5	14	21	13	9	1		2	3	1		(1)			77
2		2	8	16	19	19	7	5	5		1	1					83
3	1	2	7	13	10	9	7	2	1	1				(2)	(1)		56
4			2	8	6	11	4	2						(1)			34
5				1	2	1		1									5
6			1		1												2
7				1													1
	1	10	44	103	115	111	83	42	28	11	12	9	6	6	3	1	585

$r = .215 \pm .027$

$r \text{ (corrected)} = .260 \pm .026$

Table 29.

Correlation between yield (X) and first stand (Y) in 1929.

Robust (Check)

	225		325		425		525		625		725		825		925		
X	175	275	375	475	575	675	775	875									
Y																	
70					1												1
75				1													1
80										1	(1)						2
85			1	1													2
90				1	1		1										3
95				1		3											4
100					1	1				1							3
105			1	1	2	1											5
110		1		2	4	3	2	2		1	1						16
115			1	1	2	2				1			(1)				8
120			3	2	3	2	2	1		2							15
125		1	3	8	6	4											23
130	1		5	9	10	5	2	2		1							35
135	1	1	6	2	4	6	2							(1)			23
140			1	3	7								(1)				12
	1	1	3	21	31	40	27	10	6	0	4	5	0	1	2	1	153
	r = .195 ± .053								r (corrected) = .266 ± .051								

Table 30.

Correlation between yield (X) and second stand (Y), in 1929.

Vermont

X	225	275	325	375	425	475	525	575	625	675	725	775	
Y													
80					1	1							2
85					3	1	1						5
90	1			1									2
95					3				1				4
100			1		2	1							4
105	2	4	1	1		1	1	1			(1)		12
110	1	1											2
115		1	1		1								3
120			1	1									2
	4	6	4	3	10	4	2	1	1	0	0	1	36

$r = .195 \pm .053$ r (corrected) $= .266 \pm .051$

Table 31.

Correlation between yield (X) and second stand (Y), in 1929.

Robust (Check).

	225		325		425		525		625		725		825		925	
X	175	275	375	475	575	675	775	875								
Y																
70			1		1		1	(1)								4
75																0
80			1	1	2	1										5
85																0
90	1			2	1	4	1			1						10
95			1	3	2	3	1			1						11
100		1	1	2	1	4	3	4		1						17
105			3	5	5	1	1	1					(1)	1	7	
110		1	4	5	4	2	1	1		3	1					22
115			8	3	5	3		2								16
120		1	4	6	9	6	2									28
125			2	4	8	1										15
130				1	1	2							(1)	(1)	6	
135			1							1						2
	1	1	3	21	31	40	27	10	6	0	4	1	0	1	2	153

$$r = -.110 \pm .052 \quad r \text{ (corrected)} = -.155 \pm .054$$

Table 32.

Correlation between yield (X) and second stand (Y), in 1929.

Total Population (S)

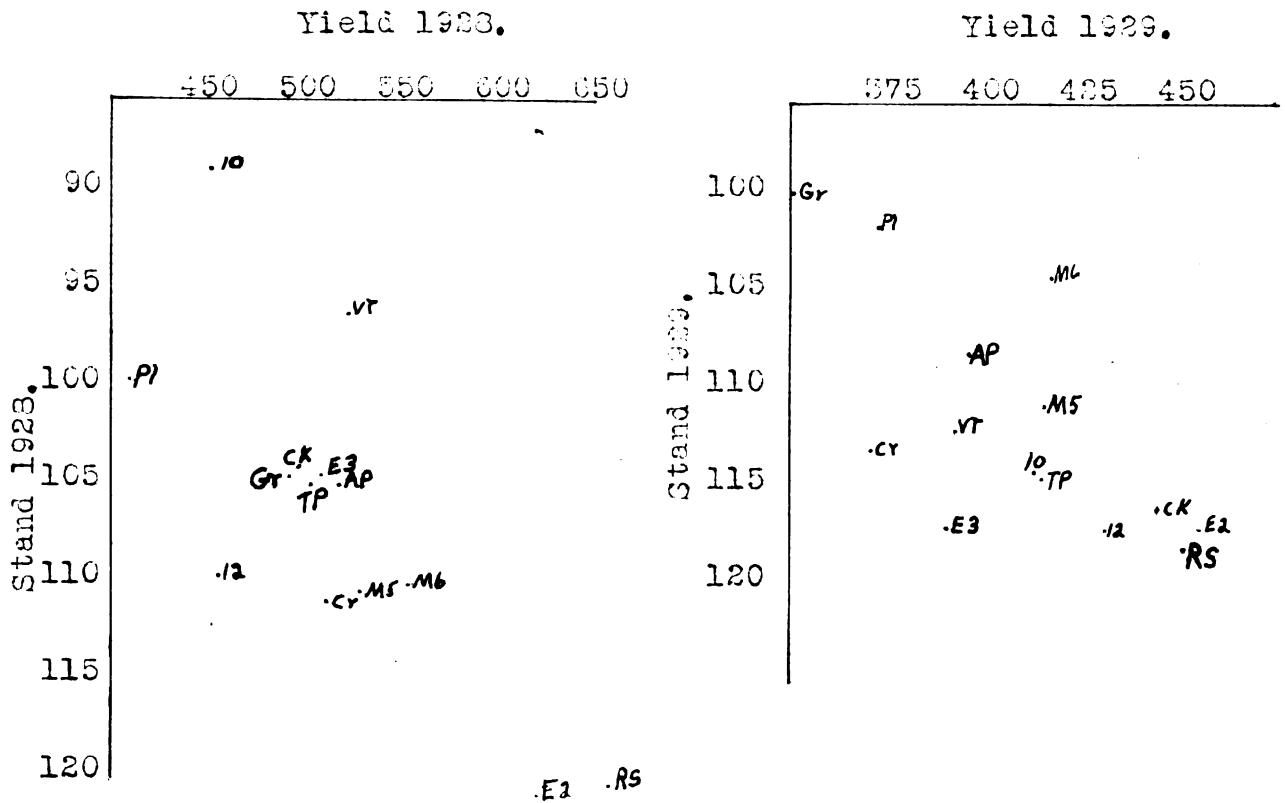
X	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10
Y																
-8					1			1				1		(1)		4
-7						1			1			1		1		4
-6				2		2	4	1	3							12
-5			2	2	2	1	3		3	1						14
-4	1		1	2	2	3	5	3	3	1		1	1			23
-3		2	4	7	7	6	8	3	4	1		1	2			45
-2		2	3	14	6	14	13	4		1	1					53
-1		1	6	11	13	10	11	8	3		2		1		(1)	67
0		2	9	17	22	15	7	3	3	3	4	2	(1)		(1)	94
1		2	10	17	18	16	8	5	3	2	2	1	1	(2)		87
2			6	13	21	16	12	5	2	2	1			(2) ¹		80
3		1	1	12	14	16	5	2	1		1	1				54
4			2	1	5	7	5	1	2		1				(1)(1)	26
5				3	4	1	2					1				11
6				2		3										5
7																0
8								1								1
	1	10	44	103	115	111	83	42	28	11	12	9	6	6	3	585

$$r = .109 \pm .052$$

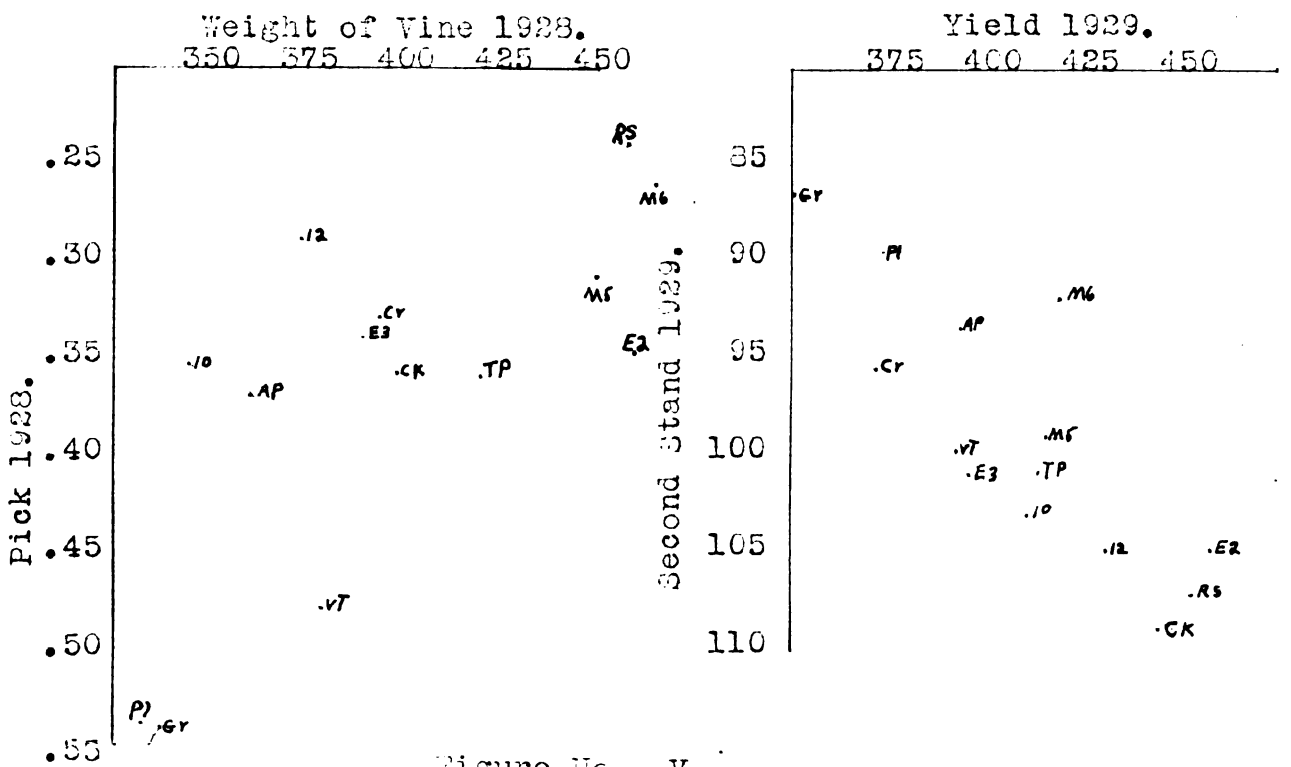
$$r \text{ (corrected)} = .156 \pm .054$$

Means Plotted.

3. Stand to Yield 1923 and 1929.



4. Other Relationships.



d. Pick to weight of vine.

Some interesting coefficients of correlation were computed in 1923 on pick to weight of vine. (Table 33). This relationship could only be secured in 1923 as there was no pick in 1929 due to small amounts of precipitation during harvest. On individual varieties all but two of the "r - values" were negative and some quite significant results were computed. This indicates that with an average amount of rainfall during harvest, varieties with large vines will have the less pick. Small vines are not so strong and the pods are more likely to be on the ground before and after pulling, whereas the large vines would tend to hold the pods up and prevent mold and discoloration. Three significant correlations all greater than four times their probable error, were obtained from 1000-1, Mexican Tree (M5) and Early Wonder (E3), as shown by Tables 34, 35, and 36, respectively. The r-values for the check and total population, although not significant, tend to show that a negative relationship is present. (Tables 37 and 38). When the means of each variety for the one year were plotted as to weight of vine and pick (Fig. No. V part 4) there is negative trend, which shows that a large vined variety is more capable of holding its pods off the ground, and the beans are cured freer of mold and discoloration. Such varieties, as Fliter, Greiner, and Vermont, had the highest pick, and they

had relatively small vines; while Robust Selection and Mexican Tree (M6) were among the large vined varieties and had the least pick.

Table 33 . Correlation values between pick and weight of vine 1928(A, B, C,) A-all plots included; B-one entire replication omitted on account of soil heterogeneity; C-corrected as described in the text.

Variety	A. r-PE. _r	B. r-PE. _r	C. r-PE. _r
1. 10	-.613 ₊ .070	-.630 ₊ .069	
2. M5	-.153 ₊ .110	-.442 ₊ .092	-.422 ₊ .094
3. M6	-.139 ₊ .110	-.220 ₊ .109	-.222 ₊ .108
4. RS	-.214 ₊ .107	-.034 ₊ .114	-.078 ₊ .113
5. Gr.	-.250 ₊ .105	-.244 ₊ .107	
6. Cx.	-.115 ₊ .111	-.341 ₊ .101	-.235 ₊ .105
7. E2	-.219 ₊ .107	-.060 ₊ .114	-.097 ₊ .113
8. P1	-.033 ₊ .112	-.040 ₊ .114	
9. 12	-.071 ₊ .112	-.334 ₊ .101	-.299 ₊ .104
10. AP	-.286 ₊ .103	-.317 ₊ .103	
11. E3	-.472 ₊ .087	-.473 ₊ .090	-.473 ₊ .089
12. Vt	-.247 ₊ .106	-.276 ₊ .106	-.305 ₊ .105
13. CK	-.102 ₊ .049	-.200 ₊ .053	-.188 ₊ .054
14. Tp		-.280 ₊ .026	-.286 ₊ .026
15. S.		-.224 ₊ .027	-.223 ₊ .027

Table 34.

Correlation between weight of vine (X) and pick (Y), in 1938.
1000-1.

X	50	100	150	200	250	300	350	400	450	500	550	
Y												
.05										2	1	3
.15						1	2	2		1		6
.25	1				2		2			1	2	8
.35						1	2	2		1		6
.45					2		1					3
.55			1	1	1							3
.65					1		1					2
.75			1			1						2
.85			2									2
	1	0	4	1	6	3	8	4	0	5	3	35

$$r = -.630 \pm .069$$

Table 35.

Correlation between weight of vine(X) and pick (Y), in 1928.

Mexican Tree (M5)

X	200	250	300	350	400	450	500	550	600	650	700	750	
Y													
.05		1										1	2
.15					1	3	3	2	1				10
.25					1	3	1	2		1			8
.35	2			2	3	1			1				9
.45	1			1		1							3
.55													0
.65				2		1							3
	3	1	0	5	5	9	4	4	2	1	0	1	35

$$r = -.442 \pm .092$$

$$r \text{ (corrected)} = -.432 \pm .094$$

Table 36.

Correlation between weight of vine (X) and pick (Y), in 1923.

Early Wonder (E3).

X	150	200	250	300	350	400	450	500	550	600
Y										
.05							2		1	3
.15				3		1	3	1	1	9
.25					2	1		1	1	5
.35					3	1	2			6
.45	1			1	2	1	1			6
.55									1	1
.65			2	1						3
.75				1						1
.85										1
.95										0
1.05										0
1.15										0
1.25				(1)						1
	1	0	2	7	7	4	8	2	4	35

$$r = -.473 - .090$$

$$r \text{ (corrected)} = -.478 \pm .039$$

Table 37.

Correlation between weight of vine (X) and pick (Y), in 1923
Robust (Check).

		150	250	350	450	550	650	750							
X	100	200	300	400	500	600	7000								
Y															
.05			1	2	1	3	2	1		3		13			
.15			2	5	1	8	8	6	4	1	1		1		37
.25	1		2	1	3	8	3	4	2	1	1		1		27
.35				3	3	2	2	1	1	2					14
.45			2	6	6	4	4	2	1	1					26
.55				1	4	3	3	2	2	1					16
.65				2	1										3
.75				3	1	1			1	1					7
.85					1					1					2
.95				1											1
1.05								1							1
1.15															0
1.25															0
1.35				(1)											1
1.45								(1)							1
	1	0	6	24	22	27	23	19	12	8	2	0	4	1	149

$$r = -.200-.053$$

$$r \text{ (corrected)} = -.183\pm.054$$

Table 38.

Correlation between weight of vine (X) and pick (Y), in 1923.

Total Population (S).

X	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	1
Y															
-5							1								14
-4				1	1	4	2	4	1		1		3		37
-3				2	3	9	5	7	2	5	1				104
-2	1		3	6	9	17	21	22	11	5	4	2	2	1	117
-1	2	1	3	5	13	26	23	16	15	5	7		1		92
0	1		2	4	12	17	17	26	13	8	4	4	1		92
1		5	5	8	14	23	13	3	5	1	2				40
2		1	3	3	10	4	5	8	4	2					23
3				5	6	4	3		4	1					19
4			2	3	6	2	3		2	1					12
5			3	2	2	1	1		2	1					6
6			1	1	1	2					1				3
7				1			1	1							2
8			1		1										3
9				1	(1)		1	1							1
10				(1)											1
11								(1)							1
12															0
13															0
14						(1)									1
	4	7	23	42	78	110	105	86	52	29	19	6	7	1	569

$$r = -.224 \pm .027$$

$$r \text{ (corrected)} = -.228 \pm .027$$

VII CONCLUSIONS

1. Since Michigan leads in the production and acreage of white pea beans, any information that contributes to the general knowledge of the factors influencing yield is of importance.

2. An investigation was outlined to determine some of the varietal factors influencing yield of white pea beans in Michigan.

3. Thirteen varieties were chosen as representative of those grown in the state.

4. The factors dealt with in this investigation were variety, stand, weight of vine, shelling, pick, disease, soil, fertility, and precipitation.

5. Such obstacles as weather, soil fertility, and bean maggot, made it very inconvenient to put the two year's data on an equal basis and were found to have quite an effect on the characters studied.

6. Only two of these varieties Robust Selection and Early Wonder (351503) were better in yield, both by B/C method and in average number of grams per plot than the check, both years. The average difference between these two was not statistically significant. Three varieties were statistically poorer, 1000-1, Fliter, and 1200-1.

7. The stand of beans per plot varied considerably. No relation was found between stand and yield within a variety, however those varieties with the larger number of plants per plot gave the higher yields.

8. The second stand (number of productive plants) was not as variable and is more closely related to yield than the first stand.

9. When it is necessary to leave beans in the field more than two weeks after they are ripe, less pick and shelling will result, if they are left standing until they can be harvested.

10. It was found that some varieties, Griener and Mexican Tree(M3), shelled many more beans than the other varieties in the test while others, Robust Selection, Canter, and Early Wonder(E2), shelled comparatively few beans, irrespective of the treatment used although treatments I and V gave the least counts.

11. It was found that varieties with larger weights of vine gave the greater yields.

12. Correlations showed that large vined varieties tended to have less pick than the smaller vined sorts, and also that within a variety the plots with the larger vines had the smaller pick percentages.

13. Shelling had a tendency to be less on the larger vined varieties, with the exception of Mexican Tree (850205), and on those plots with large vines.

14. In order to increase yield it is necessary, in addition to having as good environmental conditions as possible, to obtain a variety which has a large proportion of productive plants, a large vine, a low shelling count and a low percentage pick together with the intrinsic characters for high yield.

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