



West Virginia Agricultural and Forestry Experiment
Station Bulletins

Davis College of Agriculture, Natural Resources
And Design

1-1-1926

Cultural Experiments with Sunflowers and Their Relative Value as a Silage Crop

T. E. Odland

H. O. Henderson

Follow this and additional works at: [https://researchrepository.wvu.edu/
wv_agricultural_and_forestry_experiment_station_bulletins](https://researchrepository.wvu.edu/wv_agricultural_and_forestry_experiment_station_bulletins)

Digital Commons Citation

Odland, T. E. and Henderson, H. O., "Cultural Experiments with Sunflowers and Their Relative Value as a Silage Crop" (1926). *West Virginia Agricultural and Forestry Experiment Station Bulletins*. 204.
https://researchrepository.wvu.edu/wv_agricultural_and_forestry_experiment_station_bulletins/204

This Bulletin is brought to you for free and open access by the Davis College of Agriculture, Natural Resources And Design at The Research Repository @ WVU. It has been accepted for inclusion in West Virginia Agricultural and Forestry Experiment Station Bulletins by an authorized administrator of The Research Repository @ WVU. For more information, please contact ian.harmon@mail.wvu.edu.

West Virginia University Libraries

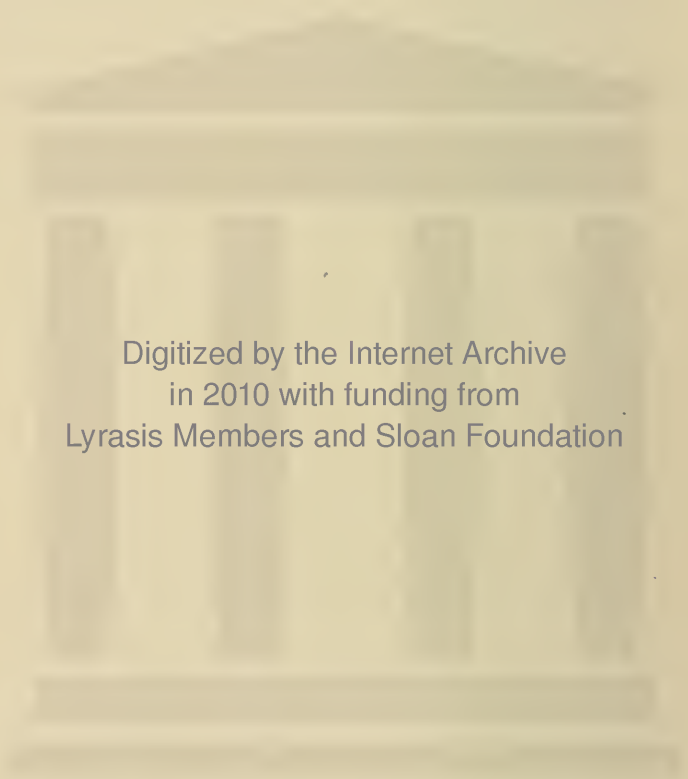


3 0802 100663713 5

EVANSDALE LIBRARY
WEST VIRGINIA
UNIVERSITY

**Restricted
Circulation Only**

--	--	--



Digitized by the Internet Archive
in 2010 with funding from
Lyrasis Members and Sloan Foundation

Agricultural Experiment Station

College of Agriculture, West Virginia University

HENRY G. KNIGHT, Director

Morgantown

Cultural Experiments With Sunflowers and Their Relative Value As A Silage Crop



Field of Sunflowers on the Agronomy Farm, West Virginia Agricultural Experiment Station, Morgantown.

By

T. E. ODLAND and H. O. HENDERSON

duct more detailed studies with sunflowers as a silage crop. Experiments were accordingly started on both the Agronomy and Dairy farms in 1921 and 1922. The results obtained in these experiments are reported in this bulletin.

EXPERIMENTAL WORK

Methods Used

In the spring of 1922 a series of forty four plots was laid out on the Dairy farm for the purpose of securing more information in regard to the relative value of sunflowers and corn for silage produced under local conditions. The experiment was also planned with a view to finding the best cultural methods to use in growing sunflowers. This test included Cocke's Prolific, a variety of corn representing the late or silage type, and Leaming, a variety representing the type of corn generally grown for grain. Two mixtures of corn and sunflowers were used. In one mixture one sunflower plant alternated with two of corn and in the other mixture there were equal numbers of corn and sunflower plants. All corn and sunflowers were planted in rows 3 1-2 feet apart. The corn alone and the corn and sunflower mixtures were thinned to one plant every fourteen inches. The sunflowers alone were thinned to various spacings in the row ranging from a plant every three inches to a plant every twenty-one inches. The seed was sown thickly and the plants later thinned to the desired stands. Two later plantings of sunflowers were also made in 1922 and 1923. One planting was made each of these years on June 1 and another on June 10. In 1924 no later plantings were made due to the lateness of the season.

Each plot was repeated three times so that there were four plots each year of each treatment or crop. The plots were eight rods in length and four rows wide. An ordinary two-row corn planter was used for planting both the corn and sunflowers. At harvest time the entire four rows were cut and then weighed on a platform scale at the barn before being put through the silage cutter. A sample of about fifteen pounds was taken from each different series of four plots at the time of cutting for the purpose of determining the moisture content and for making a chemical analysis. This sample was weighed at the time it was taken and again after drying. The sample was dried in an artificially heated drying house where it was left until thoroughly dry. It was then taken out and allowed to hang in a shed until it had attained a relatively constant weight when it was again weighed to determine the amount of air dry material.

The samples contained on an average from 7 to 10 per cent of moisture at the time of taking the air dry weights. By taking care to do this weighing after several days of dry weather it was found that the percentage of moisture in the samples became uniform enough to reduce the error resulting from the fluctuation in moisture content of the air within narrow limits. From the dry weights thus obtained the air dry yields per acre were calculated.

After the air dry weights had been obtained the samples were used for making a chemical analysis.*

The plots were cut at only two different times in order to make the work fit into the regular silo filling operations on the farm. It would have been more desirable if several cuttings had been possible so that each series of plots could have been cut when they had reached the proper stage. The first cutting was made at the time the sunflowers planted first were nearly all in full bloom and some of the seeds had reached the light dough stage. At this time the various plots of sunflowers planted alone were cut. In 1922 and 1923 the mixtures of sunflowers and corn were also cut at this time. In 1924 the mixtures were left until the second cutting on account of the very immature condition of the corn.

The second cutting was made when the silos were being filled from the other corn grown on the farm. This corresponded in the two first years with the time the Leaming in the test was ready to cut for silage. In 1924 both varieties of corn were immature when put into the silo. At this time the later plantings of sunflowers were also cut.

In the spring of 1922 an experiment with different rates of planting sunflowers was started on the Agronomy Farm. In this test the same rates of planting were used as on the Dairy Farm. The different plots were repeated in the same way as in the other experiment so that there were four plots of each rate of planting every year.

Mammoth Russian sunflowers were used in all the experiments both on the Dairy and Agronomy farms. The two varieties of corn used in the experiment on the Dairy Farm and also sunflowers were included in the regular corn variety test which was conducted on the Agronomy Farm. The plots here were in triplicate. The corn and sunflowers were planted in rows three and a half feet apart and with plants fifteen inches apart in the rows. Yield determinations

*The authors wish to acknowledge their indebtedness to T. J. Cochrane and T. B. Leith of the Agricultural Chemistry Department for making the chemical analyses.

were made as in the other tests but based only on the two central rows of the plot. The corn was cut when it had reached the glazed stage and the sunflowers when they were nearly all in full bloom.

In making the calculations for yields of the different plots the probable errors of the experiment were also determined*. In experimental work this is necessary in order to determine whether differences obtained between different plots are large enough to be significant. The probable errors of the different experiments are shown in the appendix.

Experiments on the Dairy Farm

Table I shows the average yield of sunflowers and corn obtained on the Dairy Farm. Both the average yield of green corn and air dry material per acre are given. The date of planting, of harvesting, and the number of days in the growing period are shown.

The three-year period over which this test extended included two years (1922 and 1923) which represented more or less normal seasons while the other year (1924) was a very abnormal season with a late wet spring and a cool growing season. It was impossible to get the field prepared and the planting done until June 11 or approximately three weeks later than usual. The results obtained should therefore be considered with these facts in mind.

In considering the yield in green forage per acre of the different plots for 1922 as shown in Table I, it is apparent that with the exception of the later plantings made on June 1 and June 10, the sunflowers planted alone out-yielded both varieties of corn. However when the yield on an air dry basis is considered the above order is reversed. The reason for this is due to the higher moisture content of the sunflowers as compared with corn. From the yields of green and air dry material it may be seen that the moisture content of the sunflowers varied considerably between the different rates and dates of planting. It is difficult therefore to draw any conclusions as to the yield of dry matter per acre as based on the green weights without taking the moisture percentage into consideration.

In 1923 the yield of green corn was somewhat higher than in 1922 while the yield of green sunflowers was less than the previous year. The yields on an air dry basis however did not show a very great difference for the various plots for the two years. Again this shows the necessity of taking the moisture content of the green material into consideration.

*The authors are indebted to B. L. Wad3, a graduate assistant, for aid in making the calculations.

1922

Nature of Plot	Spacing of Plants in Rows (inches)	Date Planted	Date Cut	Days Growing Period	Yield in Tons per Acre		Average Yield in Tons per Acre	
					Green	Air Dry	Green	Air Dry
Cocke's Prolific Corn.....	14	5/20	9/13	116	11.96	3.42		
Leaming Corn	14	5/20	9/13	116	8.75	3.10		
Corn 1/2, Sunflowers 1/2.....	14	5/20	8/30	103	14.38	2.57		
Corn 3/4, Sunflowers 1/4 -	14	5/20	8/30	103	13.20	2.19		
Sunflowers alone	3	5/20	8/30	103	18.00	2.32		
Sunflowers alone	7	5/20	8/30	103	17.35	2.38		
Sunflowers alone	10	5/20	8/30	103	17.09	2.36		
Sunflowers alone	14	5/20	8/30	103	15.32	2.47		
Sunflowers alone	21	5/20	8/30	103	14.44	2.14		
Sunflowers alone	7	6/1	9/13	105	12.33	2.65		
Sunflowers alone	7	6/10	9/13	95	8.78	1.83		

1923

Nature of Plot	Spacing of Plants in Rows (inches)	Date Planted	Date Cut	Days Growing Period	Yield in Tons per Acre		Average Yield in Tons per Acre	
					Green	Air Dry	Green	Air Dry
Cocke's Prolific Corn.....	14	5/23	9/14	114	14.85	3.68	13.41	3.55
Leaming Corn	14	5/23	9/14	114	11.08	3.12	9.92	3.11
Corn 1/2, Sunflowers 1/2.....	14	5/23	9/7	107	11.72	2.54	13.05	2.56
Corn 3/4, Sunflowers 1/4 -	14	5/23	9/7	107	11.59	2.67	12.40	2.43
Sunflowers alone	3	5/23	9/7	107	12.99	2.48	15.50	2.40
Sunflowers alone	7	5/23	9/7	107	12.32	2.32	14.84	2.35
Sunflowers alone	10	5/23	9/7	107	12.32	2.11	14.71	2.24
Sunflowers alone	14	5/23	9/7	107	11.87	2.15	13.60	2.31
Sunflowers alone	21	5/23	9/7	107	11.08	1.98	12.76	2.06
Sunflowers alone	7	6/1	9/14	106	7.67	1.53	10.00	2.09
Sunflowers alone	7	6/10	9/14	96	11.63	2.11	10.21	1.97

1924

Nature of Plot	Spacing of Plants in Rows (inches)	Date Planted	Date Cut	Days Growing Period	Yield in Tons per Acre		Average Yield in Tons per Acre	
					Green	Air Dry	Green	Air Dry
Cocke's Prolific Corn.....	14	6/11	9/22	103	8.56	1.63	11.79	2.91
Leaming Corn	14	6/11	9/22	103	7.12	1.49	8.98	2.57
Corn 1/2, Sunflowers 1/2.....	14	6/11	9/22	103	11.15	2.19	12.42	2.43
Corn 3/4, Sunflowers 1/4 -	14	6/11	9/22	103	10.37	1.91	11.12	2.26
Sunflowers alone	3	6/11	9/6	87	11.87	1.66	14.29	2.15
Sunflowers alone	7	6/11	9/6	87	11.98	1.87	13.88	2.19
Sunflowers alone	10	6/11	9/6	87	12.13	1.76	13.85	2.03
Sunflowers alone	14	6/11	9/6	87	12.32	1.73	13.17	2.12
Sunflowers alone	21	6/11	9/6	87	11.48	1.56	12.33	1.89
Sunflowers alone	7						10.00*	2.09*
Sunflowers alone	7						10.21*	1.97*

1922-23-24

*Two-year average only, for 1922 and 1923.

In 1924 as in 1922 the yields of green sunflowers were somewhat higher on the average than the corn. When the air dry weights were considered the difference was not proportionately as large as in case of the green weights. The mixture of corn and sunflowers as compared with the two crops grown separately, produced a higher yield in 1924 than in the other two years.

Comparing the two types of corn very little difference in yield of air dry material per acre was found when the two varieties were planted and cut at the same time. Cocke's Prolific averaged 2.91 tons of air dry material per acre and Leaming 2.57 tons as an average of the three years. The Cocke's Prolific corn had not reached the same degree of maturity as the Leaming and therefore contained a higher moisture content.

The average yield of green material per acre for the three years with corn and sunflowers growing in a mixture was 12.42 tons where equal numbers of each were grown, and 11.72 tons where two stalks of corn alternated with one of sunflowers. This is a difference of only .70 of a ton per acre. In air dry weights there was a difference of only .17 of a ton. These differences are not large enough to be considered significant. The sunflowers were ready to cut for silage about two weeks before the corn. This made it difficult to determine at what time to cut the mixture for best results.

Considering the various distances at which the sunflowers were spaced in the row there was no significant difference in yield of air dry material per acre for the different spacings. The yields varied from 1.89 tons per acre for the twenty-one inch spacings to 2.19 tons for the plots where the plants were spaced seven inches apart in the row. In green material per acre the yields ranged from 12.33 tons for the twenty-one inch spacing to 14.29 tons for the three-inch spacing. In the three-inch spacing the plants became too spindly. This caused considerable lodging of plants and resulted in much difficulty in cutting. The same was true but to a less extent where the plants were spaced seven inches apart in the row. In the four-ten and twenty-one-inch spacings and particularly in the latter the plants became too large and coarse to make the best silage. The large heads made the plants top heavy and more difficult to handle. The ten-inch spacing gave on the whole the most satisfactory plants for handling.

The two later plantings gave varying results in the two years they were made. The first year the sunflowers planted on June 1 yielded as well on the air dry basis as the earlier plantings. The yield obtained from the June 10 planting was somewhat less on both the green and air dry basis. In the second year these results were reversed. Apparently the seasonal influences were of more importance than the time of planting.

Experiments on the Agronomy Farm

Table II shows the yields obtained with the various rates of planting on the Agronomy Farm.

The thicker plantings, where plants were spaced three and seven inches apart in the rows, produced a little larger tonnage per acre than did the thinner plantings. The difference in yield between the ten, fourteen, and twenty-one-inch spacings were so small that they come within the range of experimental error. The ten-inch spacings produced plants that proved to be the most satisfactory for handling. The three and seven-inch plantings produced plants with stems too small and weak, while the plants in the twenty-one-inch spacing grew too coarse. The plants also had a tendency to become too coarse when spaced fourteen inches apart.

The soil on which the sunflowers were grown on the Agronomy Farm was somewhat lower in fertility than the soil where they were grown on the Dairy Farm. This may explain the somewhat higher yields on the latter farm and may also account for the slightly different results obtained for the various rates of planting.

Table III shows the yields obtained for the four year period, 1921-1924, in which the two varieties of corn and sunflowers were grown in comparison in the regular variety test on the Agronomy Farm.

The average yield of green forage of Cocke's Prolific Corn was only approximately one ton more per acre than the Leaming. The sunflowers outyielded Cocke's Prolific and Leaming corn on the basis of green material by 1.49 and 2.64 tons per acre, respectively. On the air dry basis Cocke's Prolific outyielded Leaming by .53 of a ton per acre and sunflowers by 1.48 tons. The Leaming corn outyielded sunflowers on this basis by .95 of a ton. Expressed in percentages on an air dry basis the yield of Cocke's Prolific showed

TABLE II.—Comparison of Different Rates of Planting Sunflowers for Silage on the Agronomy Farm.

No. of Plants in Rows (inches)	1922				1923				1924				1922-23-24	
	Days Growing Period	Yield in Tons per Acre		Days Growing Period	Yield in Tons per Acre		Days Growing Period	Yield in Tons per Acre		Days Growing Period	Yield in Tons per Acre		Ave. Yield in Tons per Acre	
		Green	Air Dry		Green	Air Dry		Green	Air Dry		Green	Air Dry	Green	Air Dry
3	109	7.49	1.61	104	10.98	1.97	96	11.74	2.25	96	11.74	2.25	10.07	1.94
7	109	7.44	1.41	104	11.00	1.94	96	12.40	2.34	96	12.40	2.34	10.28	1.90
10	109	7.17	1.44	104	9.41	1.58	96	11.87	1.90	96	11.87	1.90	9.48	1.64
14	109	7.05	1.20	104	9.86	1.70	96	10.63	1.84	96	10.63	1.84	9.18	1.58
21	109	6.09	1.09	104	9.53	1.50	96	11.61	1.89	96	11.61	1.89	9.08	1.49

an increase of 55.2 per cent over sunflowers and an increase of 29.5 per cent over Leaming.

Where the corn varieties were allowed to reach the stage of maturity considered best for silage they outyielded sunflowers by a considerable margin in dry matter per acre.

TABLE III.—Yield of Corn and Sunflowers for Silage on Agronomy Farm 1921-24.

Variety	Year	Days Growing Period	Yield in Tons per Acre	
			Green	Air Dry
Cocke's Prolific	1921	135	9.29	3.19
Leaming		123	6.63	2.63
Sunflowers		107	10.51	2.29
Cocke's Prolific	1922	135	15.72	5.45
Leaming		123	14.24	4.51
Sunflowers		113	18.23	2.91
Cocke's Prolific	1923	142	10.35	3.07
Leaming		130	11.26	3.04
Sunflowers		107	10.33	1.82
Cocke's Prolific	1924	151	9.63	3.30
Leaming		134	8.28	2.71
Sunflowers		106	11.90	2.05
Cocke's Prolific	Average 1921-24	141	11.25	3.75
Leaming		128	10.10	3.22
Sunflowers		108	12.74	2.27

COMPOSITION OF CORN AND SUNFLOWER SILAGE

In 1922 and 1923 chemical analyses were made of samples taken at the time of cutting. The analyses did not differ greatly in the two years for the various plots.

Table IV shows the average composition for these two years. The data show that the average water content of the Cocke's Prolific corn when cut was approximately 75 per cent, of the Leaming 70 per cent, and of the sunflowers 84 per cent. The more immature condition of the Cocke's Prolific corn accounts for its higher moisture content as compared with Leaming. The high moisture content of sunflowers explains why this crop outyielded the corn in some years in green tonnage per acre but yielded less on a dry matter basis.

TABLE IV.—Average Composition of Corn and Sunflowers Cut for Silage on the Dairy Farm 1922 and 1923.

Kind of Silage	Spacing of Plants in Rows (Inches)	Constituents (Per Cent)						
		Water	Ash	Protein	Fat	Fiber	Carbo-hydrates	
Cocke's Prolific	14	75.16	1.13	1.24	0.38	7.63	22.10	
Leaming	14	70.59	1.28	2.07	0.82	5.88	25.25	
Corn ½, Sunflowers ½	14	81.96	1.47	1.47	0.58	5.80	14.54	
Corn ¾, Sunflowers ¼	14	81.76	1.65	1.26	0.62	6.36	14.72	
Sunflowers	3	85.05	1.54	1.22	0.65	5.48	11.55	
Sunflowers	7	85.03	1.39	1.31	0.71	5.37	11.58	
Sunflowers	10	85.87	1.35	1.37	0.54	5.29	10.88	
Sunflowers	14	84.28	1.37	1.13	0.57	6.26	12.66	
Sunflowers	21	84.91	1.47	1.41	0.75	5.53	11.46	
Sunflowers (June 1st)	7	81.00	1.79	1.49	1.43	6.74	14.30	
Sunflowers (June 10th)	7	82.28	1.51	1.39	0.85	6.11	13.98	
Average Corn		72.88	1.21	1.65	0.60	6.76	23.67	
Average Corn and Sunflowers		81.86	1.56	1.37	0.60	6.08	14.63	
Average Sunflowers		84.06	1.49	1.33	0.79	5.83	12.34	

The corn averaged a little higher in protein and fiber content than the sunflowers but the latter averaged slightly higher than the corn in ash and fat content. The carbohydrate content of corn was considerably higher in all cases than the sunflowers. With the exception of fat content the mixtures of corn and sunflowers were intermediate between the two crops.

Similar analyses were also made of the samples taken from the variety test on the Agronomy Farm. Here the moisture content of the two corn varieties were more nearly alike since they were allowed to reach the same stage of maturity. The moisture content of Cocks's Prolific corn was 69.5 per cent, of Leaming 72.7 per cent and of sunflowers 84.5 per cent. Here as in the analyses on the Dairy Farm the sunflowers showed a high moisture content. In the other constituents the analyses showed percentages very much the same as were obtained in analyzing the samples taken on the Dairy Farm.

DISCUSSION OF RESULTS

In considering the different experiments reported in this bulletin it would seem that where the growing season is normally as long as at Morgantown, 135 to 145 days, a variety of corn that can make use of this length of growing season can ordinarily be depended upon to produce as large a tonnage of green material for silage as sunflowers and a considerably heavier yield of dry matter per acre.

Where the growing season is considerably shorter, as in some of the higher altitudes of the state, so that only an early type of corn will ordinarily mature, sunflowers will probably produce a heavier tonnage of green material per acre and possibly a greater yield on a dry matter basis than corn. Tests should be made with sunflowers for silage under such conditions.

SUGGESTIONS ON SUNFLOWER CULTURE

The following suggestions for growing sunflowers are offered:

Sunflowers should be planted about the time corn is generally planted or a little earlier. Drilling in rows from thirty-eight to forty-two inches apart with plants ten to twelve inches apart in the row will be found satisfactory. Either a regular two-row corn planter or a grain drill with some of the holes closed is well suited for

this work. Approximately five pounds of seed per acre will be required.

The crop should be cultivated the same as corn. Sunflowers shade the ground more completely than corn so that weeds do not thrive as well with this crop as with corn. Where both corn and sunflowers are given the same amount of cultivation the sunflowers are always more free from weeds when the crops are harvested.

For harvesting sunflowers the corn binder is usually satisfactory. Cutting by hand is sometimes necessary where the plants have become lodged.

Sunflowers should be cut before the seeds have reached the hard dough stage. The best guide for determining when to cut sunflowers is probably the time of flowering. The crop should be cut for silage when from 60 to 75 per cent of the plants are in bloom.

SUMMARY

1.—Sunflowers and corn were compared for silage in experiments on the Agronomy and Dairy farms at the West Virginia Agricultural Experiment Station. Different rates and dates of planting of sunflowers were also included. Both silage and grain types of corn were included in the test.

2.—Under the conditions of the experiment on the Dairy Farm, the silage corn and the sunflowers yielded approximately the same average tonnage of green material per acre for the two normal seasons. They both outyielded the grain type of corn on this basis. Both types of corn outyielded sunflowers considerably on the air dry basis, and on this basis there was also a small difference in favor of the silage corn as compared to the grain type. In the short growing season of 1924 the sunflowers outyielded both varieties of corn on the green material basis and also slightly on the air dry basis.

3.—On the Agronomy Farm where both corn varieties were permitted to reach the right stage for silage each year, the sunflowers averaged a little heavier green tonnage per acre but both corn varieties far outyielded them on an air dry basis.

4.—Spacing the sunflowers ten inches apart in the rows gave the best results when both ease of handling and yield were considered.

5.—Leaming corn and sunflowers did not prove a satisfactory mixture, chiefly because they do not mature at the same time.

6.—Sunflowers planted at later dates did not give as uniformly good yields as when planted at the same time as corn.

7.—Sunflowers had a considerably higher moisture content than corn. The corn was much higher than the sunflowers in carbohydrate content. The analyses showed only relatively small differences between the two crops in protein, ash, fat, and fiber contents.

APPENDIX

In field experiments such as the ones reported in this bulletin each yield is subject to a probable error. It is recognized therefore that a difference in yield between two plots must be of a certain magnitude before it is safe to consider this difference as significant. The magnitude of the required difference will depend upon the degree of variation among the plots receiving the same treatment. Probable errors were computed for the yields reported in this bulletin in order to determine whether the differences obtained were significant or not.

The method of computing probable errors based on the yield of varieties under test as described by Hayes was used.*

To obtain the probable error of the mean yield of the four plots of each treatment the probable error of a single plot was divided by $\sqrt{4}$. In order to be considered significant a difference should be at least three times its probable error. To obtain a number representing the least significant difference the probable error of the mean was multiplied by $3\sqrt{2}$.

In Table V the probable errors calculated on this basis are shown for each year on the Dairy Farm and for the rate of planting experiment on the Agronomy Farm.

*Hayes, H. K. Controlling experimental error in nursery trials. Jour. Amer. Soc. Agro. 15:177-192. 1923.

TABLE V.—The Probable Error in Percentages for Sunflower Experiments on the Dairy and Agronomy Farms as Measured by the Deviation of Each Plot From the Mean Yield of Each Treatment.

Experiment	Year Grown	Number of Plots	Probable Error in Per Cent	
			Single Determination	Mean
Sunflowers and Corn on Dairy Farm	1922	44	12.1	6.1
	1923	44	9.8	4.9
	1924	36	10.8	5.4
Sunflowers—rate of seeding on Agronomy Farm	1922	20	13.0	6.5
	1923	20	8.4	4.2
	1924	20	8.3	4.2

Student's method was used to determine the significance of the differences obtained in the variety tests on the Agronomy Farm.† When this method is used it is found that the odds are 28 to 1 that the difference in yield between Cocke's Prolific and Leaming corn on the air dry basis is significant. It is usually considered safe to assume that a difference is significant if the odds are as high as 30 to 1.

In the same way the odds are 46 to 1 that the difference in air dry yield between Leaming corn and sunflowers is a real difference. The odds are 77 to 1 that the difference between the air dry yield of Cocke's Prolific corn and sunflowers is significant. In determining the odds the values as given by Love were used.‡

†Student. Probable error of a mean. *Biometrika* 6:1-25. 1908.

‡Love, H. H. A modification of Student's tables for use in interpreting experimental results. *Jour. Amer. Soc. Agro.* 16:68-73. 1924.

HECKMAN
BINDERY INC.



JUNE 99

Bound-To-Pleas[®] N. MANCHESTER,
INDIANA 46962

