THE CORRELATION BETWEEN STAND AND YIELD OF ALFALFA AND SWEETCLOVER [1]

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INTRODUCTION

There is a decided lack of exact data on the relation between stand and yield of forage crops which are sown broadcast. They are, to be sure, a considerable number of rate-of-planting tests with most forage crops, but these experiments usually do not report quantitatively the stand actually secured. A general relation between stand and yield is obvious to the most casual observer, but beyond that little is known.

A considerable amount of experimental work with forage crops has been done by the Ohio Agricultural Experiment Station at, and in cooperation with, the Ohio State University, in which yields of tops and roots have been determined by harvesting square-yard samples. In each instance the number of plants in the square yard has been counted. In many instances two or more square yards have been harvested from the same plot, or plots which had been treated alike. These replicated samples have actually differed in both yield and stand, and so furnished an opportunity to determine the extent to which the variations in yield of these small areas of forage crops were correlated with variations in stand.

EXPERIMENTAL RESULTS

Altogether, from 1923 to 1929, data were secured from 520 samples of alfalfa and 421 samples of sweetclover, two to five samples being taken from the same or comparable plots. These samples were distributed in 228 and 160 means, respectively. The yield of tops, the yield of roots, and the stand of each square yard included in each mean were expressed as percentages of that mean yield or stand. Correlations between yield of tops, yield of roots, and stand were then determined. The correlation figures are given in Tables 1 to 6. The divisions between the classes were made on the even 10 per cent; e. g., the class 100 to 109 contains all percentages from 100.00 to 109.99, inclusive. Sheppard's correction has been used in all computations. The constants secured are summarized in Table 7.

In calculating the standard deviations given in Table 7, n was reduced by the number of means around which the samples varied, or, specifically, $\sigma = \sqrt{\frac{\Sigma \text{ dev.}^2}{520-228}}$ and $\sigma = \sqrt{\frac{\Sigma \text{ dev.}^2}{421-160}}$, for alfalfa and sweetclover, respectively.

In addition to the standard deviations and correlation and regression coefficients, the standard deviations of the yields of tops and roots with stand held constant, or with the influence of variation due

[1] Received for publication Apr. 8, 1931; issued September, 1931. Contribution from the Department of Agronomy, Ohio Agricultural Experiment Station.

to stand removed, ${}_s\sigma_t$ and ${}_s\sigma_r$, respectively, were calculated from the formula ${}_s\sigma_t = \sigma_t \sqrt{1-r^2_{st}}$. The term $\sqrt{1-r^2_{st}} \times 100$ gives the percentages of the total variation that would remain if the observed yields were corrected for regression on stand by the coefficients secured in these experiments. These percentages are also reported in Table 7.

TABLE 1.—*Data for determining statistical correlation constants between yield of alfalfa tops and stand*

Stand (per cent of mean)	Number of samples of tops falling into percentage yield class indicated											Total
	Below 60	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130–139	140–149	Above 150	
Above 150										1		1
140–149									1			1
130–139					4	1	2		1			8
120–129				2	4	9	7	2				24
110–119			2	13	22	33	18	5	4	1		98
100–109		5	9	12	33	43	20	8	1	1	1	133
90–99	2		7	21	40	31	13	8	5			127
80–89	1	4	4	16	31	23	9	2	1			91
70–79			1	8	10	4	3		1			27
60–69		1	1	2		4						8
Below 60		2										2
Total	3	12	24	74	144	148	72	25	14	3	1	520

TABLE 2.—*Data for determining statistical correlation constants between yield of alfalfa roots and stand*

Stand (per cent of mean)	Number of samples of roots falling into percentage yield class indicated											Total
	Below 60	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130–139	140–149	Above 150	
Above 150									1			1
140–149									1			1
130–139						3	2	2	1			8
120–129					1	9	12	2				24
110–119				2	25	43	22	4	2			98
100–109	1		1	11	45	52	18	4	1			133
90–99		1	6	15	48	47	8	1		1		127
80–89		2	2	20	37	26	4					91
70–79		1	3	10	9	4						27
60–69		1	4	1	2							8
Below 60	1	1										2
Total	2	6	16	59	167	184	66	13	6	1		520

TABLE 3.—*Data for determining statistical correlation constants between yield of alfalfa tops and yield of roots*

Yield of alfalfa roots (per cent of mean)	Number of samples of tops falling into percentage yield class indicated											Total
	Below 60	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130–139	140–149	Above 150	
Above 150												
140–149					1							1
130–139			1	1		1			2	1		6
120–129					4	2	4	3				13
110–119				5	11	19	19	8	3	1		66
100–109		1	5	21	52	68	23	6	6	1	1	184
90–99	2	4	8	24	57	45	19	7	1			167
80–89	1	4	5	18	15	9	6		1			59
70–79			5	5	2	3			1			16
60–69		2			2		1	1				6
Below 60		1				1						2
Total	3	12	24	74	144	148	72	25	14	3	1	520

TABLE 4.—*Data for determining statistical correlation constants between yield of sweetclover tops and stand*

Stand (per cent of mean)	Number of samples of tops falling into percentage yield class indicated											Total
	Below 60	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130–139	140–149	Above 150	
Above 150			1		2	1	1	1				6
140–149					3		1	1	1	1		7
130–139				2	2	9	7	3	4		1	28
120–129	1			2	3	7	8	1	1			23
110–119			2	11	12	18	8	5	1			57
100–109			2	8	16	35	12	2	2		1	78
90–99	2	2	7	18	23	21	11	4	1	1		90
80–89		4	6	11	17	10	13	3				64
70–79	1	1	3	9	11	9	4	1	1	1		41
60–69		4	2	4	4	3	1	1				19
Below 60		1	1	1	2	2		1				8
Total	4	12	24	66	95	115	66	23	11	3	2	421

TABLE 5.—*Data for determining statistical correlation constants between yield of sweetclover roots and stand*

Stand (per cent of mean)	Number of samples of roots falling into percentage yield class indicated											Total
	Below 60	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130–139	140–149	Above 150	
Above 150				2			2	2				6
140–149				1	1		2		2		1	7
130–139			1	1	1	9	7	4	5			28
120–129				2	2	4	6	8	1			23
110–119		1	4	7	11	15	14	3	2			57
100–109		2		7	21	28	16	1	2	1		78
90–99	1	1	5	16	28	26	7	2	4			90
80–89	4	3	4	8	23	11	8	3				64
70–79		3	6	12	7	10	2	1				41
60–69		2	2	9	4	1	1					19
Below 60		1	1	5	1							8
Total	5	13	23	70	99	104	65	24	16	1	1	421

TABLE 6.—*Data for determining statistical correlation constants between yield of sweetclover tops and yield of roots*

Yield of sweetclover roots (per cent of mean)	Number of samples of tops falling into percentage yield class indicated											Total
	Below 60	60–69	70–79	80–89	90–99	100–109	110–119	120–129	130–139	140–149	Above 150	
Above 150								1				1
140–149											1	1
130–139	1					3	2	2	6	1	1	16
120–129	1			1	4	4	6	6	2			24
110–119			3	1	8	23	19	9	1	1		65
100–109		1		6	28	39	26	3	1			104
90–99		2	3	26	29	28	11					99
80–89		1	10	18	24	15	1	1				70
70–79		3	5	10		2		1	1	1		23
60–69	1	3	3	3	2		1					13
Below 60	1	2		1		1						5
Total	4	12	24	66	95	115	66	23	11	3	2	421

TABLE 7.—*Statistical constants obtained from the data in Tables 1 to 6*

Subscripts: t=Tops, r=roots, s=stand.

Constant	Alfalfa	Sweetclover	Constant	Alfalfa	Sweetclover
				Per cent	*Per cent*
r_{st}	0.28±0.04	0.29±0.04	σ_t	20.1	20.8
r_{sr}	.55± .03	.45± .03	σ_r	16.1	21.0
r_{tr}	.36± .03	.59± .03	σ_s	19.4	26.1
			reg.$_{t.s}$	0.29±0.04	0.23±0.04
			reg.$_{r.s}$	.45± .03	.36± .03
			$_s\sigma_t$[a]	19.3	19.9
			$_s\sigma_r$[b]	13.4	18.7

[a] $_s\sigma_t$=95.9 per cent of σ_t for alfalfa tops, $_s\sigma_t$= 95.7 per cent of σ_t for sweetclover tops.
[b] $_s\sigma_r$=83.4 per cent of σ_r for alfalfa roots; $_s\sigma_r$=89 per cent of σ_r for sweetclover roots.

CONCLUSIONS

For alfalfa and sweetclover, the correlation between the yields of tops and the stand, 0.28 and 0.29, respectively, is very low. Variations in stand accounted for less than 5 per cent of the total variation in yield of tops as measured by the standard deviation.

The correlations between the stand and the yield of roots are much higher than those for the yield of tops, in both alfalfa and sweetclover, being 0.55 and 0.45, respectively. In these samples, variations in stand accounted for approximately 11 per cent of the variation in the yield of sweetclover roots, and nearly 17 per cent of the variation in the yield of alfalfa roots.

The regression of yield on stand is 0.29 per cent and 0.23 per cent for yield of tops, and 0.45 per cent and 0.37 per cent for yield of roots, of alfalfa and sweetclover, respectively, for each 1 per cent change in stand. Despite this definite relation, other errors of random sampling would cause a variability 83 to 96 per cent as great as the uncorrected figures, when or if the original figures were corrected for stand. This reduction is probably not sufficient to justify the correction, especially since the only remedy for other errors of random sampling, replication, will also reduce variations due to stand.

The correlation between the yield of tops and the yield of roots is much lower in alfalfa than in sweetclover, but is surprisingly low in both, 0.36 and 0.59, respectively. Evidently, it is decidedly unsafe to predict the yield of roots from the yield of tops. Since these low correlations were obtained from samples intended to be uniform, they indicate that within very small areas there are important variations in the factors affecting the relative proportion of roots and tops.

The probable error of a single square-yard sample in these experiments has been ±13.6 per cent and ±14.0 per cent of the yield of the tops, and ±10.9 per cent and ±14.2 per cent of the yield of the roots, for alfalfa and sweetclover, respectively.