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SEPARATUM

VARIATION OF SEED SETTING IN A LUCERNE POLYCROSS

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The polycross breeding method (TYSDAL et al., 1942) is probably the most widely used concept for the genetical improvement of forage yield in lucerne. The procedure centers around the polycross and the polycross progeny test. In the polycross, propagules of selected clones are planted in such a way that a complete intercrossing of all components is most likely to occur. Various planting designs have been proposed for this purpose (WRIGHT, 1962). Ideally, any clone is pollinated by a random pollen mixture of all other clones. If this is true, the progeny of each clone would consist of approximately 50 % maternal germplasm and of approximately 50 % paternal germplasm. Differences detected between progenies in the polycross progeny test would then be due to the maternal genotype. In practice, however, a number of internal and external factors may cause deviations from random pollination and by this way impair the validity of the progeny test's result. In the case of self-fertility, for instance, the proportion of the maternal germplasm would considerably exceed the anticipated 50 %, and a loss of vigour would be expected. Pollinating insects may prefer certain clones to others (KEHR, 1973). When the polycross seed is harvested in bulk as for the production of the syn 1-generation of a synthetic cultivar, differential pollination may lead to differential seed setting and subsequently to varying proportions of the progenies of the contributing clones. This may affect the performance and trueness to type of the synthetic.

MATERIAL AND METHODS

A polycross was established at an experimental field in Freising-Weihenstephan in 1960. The polycross plan represented an 8 times replicated 7x7 balanced lattice design as described by COCHRAN and COX (1957) (figure 1). Each plot consisted of 4 plants of a clone which were square planted 50 cm apart. Two sets of the plan were planted in such a way that replications with odd numbers were directed to the south and replications with even numbers were directed to the north. The numbering proceeded from west to east. The situation is shown in figure 2. There were 49 lucerne clones. Seeds of 48 clones were harvested in 1961 and 1962. Seed yields were determined for plots of 4 plants each.

RESULTS

Highly significant differences exist with decreasing order of mean squares among years, positions, clones, and replications, and interactions are also highly significant (table 1).

Table 1. Analysis of variance of lucerne polycross seed set

Source of Variation	DF	SQ	MQ
Replications	7	26722	3815 ***
Position (north, south)	1	17754	17754 ***
Years	1	43194	43194 ***
Clones	47	32640	694 ***
Position x Years	1	8011	8011 ***
Position x Clones	47	10057	213 **
Years x Clones	47	18352	390 ***
Position x Years x Clones	47	42197	897 ***
Error	1328	182032	137

** = P 0.01; *** = P 0.001.

The seed yields of the clones are shown in figure 3. They range from 3 g to 34 g in the first harvest year and from less than 1 g to 11 g in the second harvest year. An average of 15 g seed per plot was obtained in the first harvest year (table 2). This figure dropped to about 30 % in the second harvest year.

Table 2. Mean seed yield (g) per plot in lucerne polycross

Replicate		1961			1962		
S	N	S	N	x̄	S	N	x̄
W							
1	2	10.1	13.0	11.6	2.9	2.8	2.9
3	4	7.8	23.9	15.8	2.5	3.8	3.2
5	6	6.1	28.3	17.2	2.0	5.1	3.5
7	8	5.3	12.9	9.1	2.6	6.2	4.4
9	10	6.8	13.5	10.1	3.4	4.7	4.0
11	12	8.7	13.5	11.1	3.5	5.6	4.5
13	14	9.5	23.9	16.7	3.4	6.9	5.2
15	16	20.4	36.8	28.6	5.8	9.0	7.4
E							
x̄	x̄	9.3	20.7	15.0	3.3	5.5	4.4

The coefficients of variation (cv) were calculated for each clone in each harvest year. The pertinent figures which are not shown here in detail reveal a tremendeous variation of seed set within clones. The cv of clones range from 34 to 139 in the first harvest year and from 30 to 132 in the second harvest year. These results indicate considerable variation of seed yields between replications. The interaction of seed yields of clones and harvest years can also be seen in figure 3. For example, clone no. 44 ranked 6 in 1961 but only 44 in 1962. In contrast, clone no. 5 ranked next to last in the first harvest year but was 7th in the second harvest year. Therefore, the contribution of each clone to the total seed produced is very different depending on the year of harvest. Furthermore, selection of clones for superior seed yield would lead to quite different results in the two harvest years.

The average seed yields of replications are given in table 2. The information gained from this table is threefold. Firstly it confirms the large variation between replications. The average figures range from 5 g (rep. 7) to 36 g (rep. 16) in 1961 and from 2 g (rep. 5) to 9 g (rep. 16) in 1962. The coefficients of variation for the two harvest years are 59 and 42, respectively. Secondly, if adjacent northern and southern replications are compared, the northern reps. yield consistently more seed than the southern ones. The corresponding figures are 9.3 g to 20.7 g in the first harvest year and 3.3 g to 5.5 g in the second harvest year. The coefficients of linear regression b_{yx} are 1.23 and 1.22, respectively. Thirdly, an additional position effect is

Table 3. Contribution (%) of sum of clones no. 36, 37, 43, 44 to total seed yield in certain replications of lucerne polycross

FIRST HARVEST YEAR

Rep. No. South	%	Rep. No. North	%
	West		
1	10.8	2	14.9
7	19.1	8	11.4
9	16.6	10	12.3
15	9.0	16	7.0
	East		

Expected
assuming equal seed set of all clones $= \frac{4 \cdot 100}{48} = 8.3$ %
according to actual contribution of respective clones to total polycross seed $\frac{1149 \cdot 100}{7951} = 14.5$ %

SECOND HARVEST YEAR

Rep. No. South	%	Rep. No. North	%
	West		
1	10.9	2	13.0
7	9.8	8	9.6
9	18.2	10	17.6
15	7.5	16	7.3
	East		

Expected
assuming equal seed set of all clones $= \frac{4 \cdot 100}{48} = 8.3$ %
according to actual contribution of respective clones to total polycross seed $\frac{342 \cdot 100}{2117} = 16.2$ %

Rep. 1

Block							
(1)	1	2	3	4	5	6	7
(2)	8	9	10	11	12	13	14
(3)	15	16	17	18	19	20	21
(4)	22	23	24	25	26	27	28
(5)	29	30	31	32	33	34	35
(6)	36	37	38	39	40	41	42
(7)	43	44	45	46	47	48	49

Rep. 2

(8)	1	8	15	22	29	36	43
(9)	2	9	16	23	30	37	44
(10)	3	10	17	24	31	38	45
(11)	4	11	18	25	32	39	46
(12)	5	12	19	26	33	40	47
(13)	6	13	20	27	34	41	48
(14)	7	14	21	28	35	42	49

Rep. 3

(15)	1	9	17	25	33	41	49
(16)	43	2	10	18	26	34	42
(17)	36	44	3	11	19	27	35
(18)	29	37	45	4	12	20	28
(19)	22	30	38	46	5	13	21
(20)	15	23	31	39	47	6	14
(21)	8	16	24	32	40	48	7

Rep. 4

(22)	1	37	24	11	47	34	21
(23)	15	2	38	25	12	48	35
(24)	29	16	3	39	26	13	49
(25)	43	30	17	4	40	27	14
(26)	8	44	31	18	5	41	28
(27)	22	9	45	32	19	6	42
(28)	36	23	10	46	33	20	7

Rep. 5

(29)	1	30	10	39	19	48	28
(30)	22	2	31	11	40	20	49
(31)	43	23	3	32	12	41	21
(32)	15	44	24	4	33	13	42
(33)	36	16	45	25	5	34	14
(34)	8	37	17	46	26	6	35
(35)	29	9	38	18	47	27	7

Rep. 6

(36)	1	23	45	18	40	13	35
(37)	29	2	24	46	19	41	14
(38)	8	30	3	25	47	20	42
(39)	36	9	31	4	26	48	21
(40)	15	37	10	32	5	27	49
(41)	43	16	38	11	33	6	28
(42)	22	44	17	39	12	34	7

Rep. 7

(43)	1	16	31	46	12	27	42
(44)	36	2	17	32	47	13	28
(45)	22	37	3	18	33	48	14
(46)	8	23	38	4	19	34	49
(47)	43	9	24	39	5	20	35
(48)	29	44	10	25	40	6	21
(49)	15	30	45	11	26	41	7

Rep. 8

(50)	1	44	38	32	26	20	14
(51)	8	2	45	39	33	27	21
(52)	15	9	3	46	40	34	28
(53)	22	16	10	4	47	41	35
(54)	29	23	17	11	5	48	42
(55)	36	30	24	18	12	6	49
(56)	43	37	31	25	19	13	7

Figure 1 : 7 x 7 balanced lattice polycross design (COCHRAN & COX, 1957)

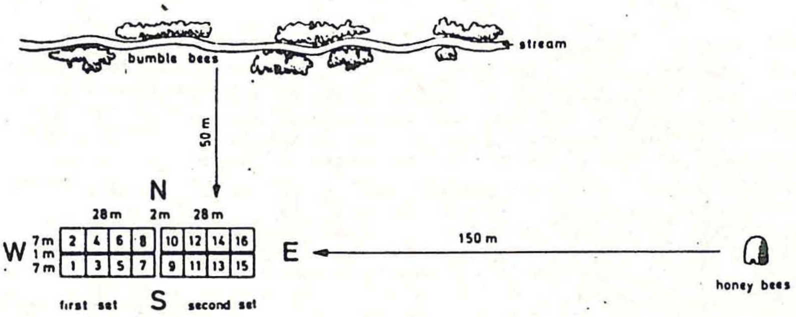

Figure 2 : Polycross plan and environment

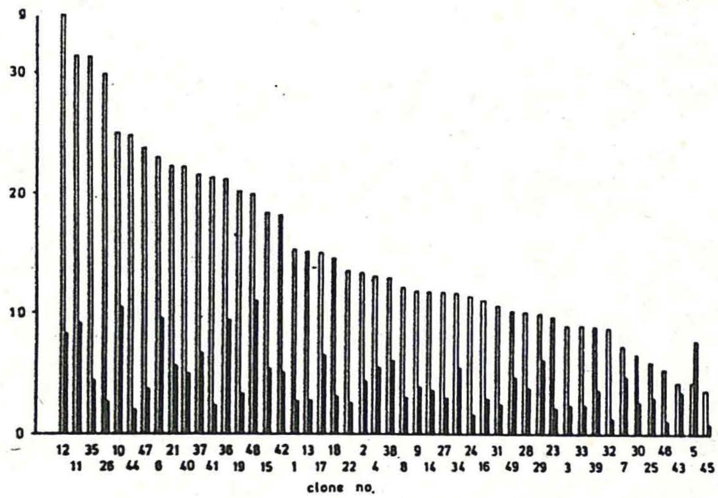

Figure 3 : Ranking of seed yields of lucerne clones in first (□) and second (■) harvest year

noticeable: There is a general increase of seed yields from west to east. The corresponding regression coefficients are 0.33 and 1.16. Obviously, the direction and distance of the housing sites of the pollinating insects had a significant effect on seed yields. Seed yields decrease with increasing distance of plants from nesting sites of bees. This position effect cannot be verified for individual clones within replications. An example using the adjacent clones no. 36, 37, 43 and 44 is given in table 3. In addition, considerable variation in the contribution of these clones to the total seed yield in the selected replications becomes apparent. In this particular case it ranges from 7 % in rep. 16 to 19 % in rep.7 in the first harvest year and from 7 % to 18 % in the second harvest year.

SUMMARY

The variation of seed setting within a 49 clone lucerne polycross was analysed. Higly significant differences were found between clones, replications, position of replications, and years. Interactions of position of replications x year, position of replications x clones, years x clones, and position of replications x years x clones were also highly significant. Apparently seed yields decrease with increasing distance of plants from nesting sites of bees. The contribution of individual clones to the total seed yields varies considerably.

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