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GENETIC STUDIES IN INTERSPECIFIC CROSSES OF SOYBEAN *GLYCINE MAX* (L.) MERILL. x *GLYCINE FORMOSONA*. III. SELECTION INDICES

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ABSTRACT

The selection indices by discriminant function analysis were constructed based on the data of a population of 1600 F_2 plants developed by crossing a wild species, *Glycine formosona*, with five cultivars of *G. max*. Majority of selection indices were found to be more efficient than straight selection based on yield alone. The selection index consisting of seed yield, pods/plant, seed weight, and oil content gave the highest relative efficiency, followed by the index consisting of seed yield, pods/plant and seed weight. Inclusion of pods/plant in selection index appears to increase its relative efficiency. The efficiency of the index improved with increase in the number of characters up to four, after which it decreased.

Key words: Interspecific crosses, *Glycine formosona*, *Glycine max*, selection indices.

The cultivated varieties of *G. max* in India have the problem of low productivity due to various reasons, and the inherent poor yielding ability of the present varieties is one of them. Interspecific hybridization provides greater opportunities of enhancing soybean productivity as they possess genes for resistance to different biotic stresses as well as for some yield components that are found lacking in the cultivated species. Among the related species, *G. formosona* exhibits desirable features of plant height, primary branches, pods/plant, protein content, etc. When two species, genetically diverse for a number of important yield traits, are crossed, the F_2 population is expected to release enormous variability transcending even the limits of the parents for different yield traits. In such a situation, it becomes all the more important yield, through a mutiple trait selection scheme by utilizing information obtained on all the yield influencing traits. Hence, this study has worked out selection indices in a pooled F_2 population of interspecific hybridization involving 5 varieties of *G. max* crossed with *G. formosona*.

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MATERIALS AND METHODS

Five cultivars of soybean (*G. max*) viz., KHSb-2, SL117, Progeny-1, Monatta, and PK 308, were crossed with a wild species (*G. formosona*). The parents, F_1s and F_2 populations were grown at the spacing of 60 cm between rows and 30 cm within rows in randomised block design with four replications in 1988. The phenotypic and genotypic variances and covariances were computed by using 1600 F_2 plants belonging to these five interspecific crosses based on individual plant observations on days to maturity (X_1), primary branches (X_2), pods per plant (X_3), yield per plant (X_4), 100-seed weight (X_5), and oil content (X_6). The environmental variances and covariances were estimated using the data of nonsegregating populations [1]. These phenotypic and genotypic variances and covariances were used for computing discriminant functions as per [2–4]. Proper weightage was given to each character using the product of square root of heritability of the trait [x] with its genotypic correlation ($a=h_x r_{Gxy}$) with seed yield [y].

In order to determine relative efficiency (%) of various selection indices, the expected genetic advances of these indices were expressed as per cent of genetic advance expected from selection on the basis of yield alone.

RESULTS AND DISCUSSION

Selection indices for yield were constructed using different character combinations in an attempt to identify the combinations that could prove more efficient than direct selection for yield. The following points emerge from a critical look at the results presented in Table 1.

It is interesting to note that the selection efficiency improved with increase in the number of characters in combinations with yield. This trend of rising efficiency was limited to four characters, after which the relative efficiency declined. This is clearly evident from Table 2.

The highest efficiency was observed with two character combinations. But the selection efficiency dropped to less than 100% in respect of selection indices with five and six characters. Selection indices with two characters, therefore, appear to be more useful, since they are not only highly efficient over straight selection than other combinations but are also less cumbersome to use in the selection exercise. Some of the selection indices with high relative efficiency are listed in Table 3. It can be seen that pods/plant (X_3) was one character which was commonly involved. Grain yield (X_4), 100-grain weight (X_5), and oil content (X_6) were the characters with no adverse effect on the relative efficiency of the index when used in combination with pods/plant.

Table 1. Expected genetic advance and relative efficiency (theoretical) of different selection indices in pooled F_2 populations of soybean

Selection functions	Genetic advance	Relative efficiency, %
Seed yield x_4	6.53	100
$-1.892\ x_1$	36.86	564
$1.937\ x_2$	99.29	1520
$23.892\ x_3$	841.28	12883
$0.969\ x_5$	2.04	31
$0.237\ x_6$	1.10	17
$-2.181\ x_1 + 1.978\ x_2$	34.16	523
$-1.918\ x_1 + 5.317\ x_3$	1.19	18
$-2.448\ x_1 + 6.519\ x_4$	22.6	339
$-1.885\ x_1 + 0.971\ x_5$	36.61	561
$-1.888\ x_1 + 0.228\ x_6$	36.76	563
$1.690\ x_2 + 6.542\ x_4$	3.91	45
$2.224\ x_2 + 1.008\ x_5$	14.18	217
$1.948\ x_2 + 0.285\ x_6$	14.10	216
$8.895\ x_3 + 6.850\ x_4$	826.70	12660
$7.753\ x_3 + 0.973\ x_5$	841.56	12887
$4.006\ x_3 + 0.242\ x_6$	841.26	12883
$6.813\ x_4 + 1.088\ x_5$	56.39	864
$6.546\ x_4 + 0.294\ x_6$	56.53	866
$0.965\ x_5 + 0.046\ x_6$	1.94	30
$2.097\ x_1 + 2.051\ x_2 + 1.075\ x_3$	22.76	348
$2.264\ x_2 + 5.596\ x_3 + 6.463\ x_4$	2.96	45
$11.209\ x_3 + 6.717\ x_4 + 1.116\ x_5$	862.98	13216
$6.815\ x_4 + 1.086\ x_5 + 4.689\ x_6$	56.2	870
$-1.690\ x_1 + 7.299\ x_3 + 6.435\ x_4$	2.85	44
$-2.468\ x_1 + 1.666\ x_2 + 6.514\ x_4$	29.86	457
$-2.155\ x_1 + 2.231\ x_2 + 1.009\ x_5$	35.37	542
$-2.176\ x_1 + 1.981\ x_2 + 0.277\ x_6$	35.86	549
$1.950\ x_2 + 6.809\ x_4 + 1.090\ x_5$	6.72	103
$2.229\ x_2 + 1.004\ x_5 + 3.187\ x_6$	14.48	222
$2.240\ x_2 + 2.294\ x_3 + 1.\ 608\ x_5$	6.80	104
$2.021\ x_2 - 2.189\ x_3 + 0.272\ x_6$	6.56	100
$5.825\ x_2 + 0.968\ x_5 - 0.035\ x_6$	386.99	5914
$-1.791\ x_1 + 2.216\ x_2 + 3.803\ x_3 + 6.397\ x_4$	5.72	88
$-1.751\ x_1 + 9.228\ x_3 + 6.647\ x_4 + 1.111\ x_5$	2.35	36
$1.953\ x_2 + 6.811\ x_4 + 1.065\ x_5 + 0.049\ x_6$	6.74	103
$11.292\ x_3 + 6.719\ x_4 + 1.114\ x_5 + 0.025\ x_6$	863.14	13218
$2.245\ x_2 + 2.468\ x_3 + 1.004\ x_5 + 1.076\ x_6$	6.34	97
$-1.839\ x_1 + 2.347\ x_2 + 6.094\ x_3 + 6.609\ x_4 + 1.127\ x_5$	3.74	57
$-1.789\ x_1 + 2.218\ x_2 + 3.846\ x_3 + 6.398\ x_4 + 0.187\ x_6$	5.65	87
$-1.836\ x_1 + 2.349\ x_2 + 6.183\ x_3 + 6.611\ x_4 + 1.125\ x_5 + 0.003\ x_6$	3.65	56

The correlation pattern of these traits among themselves and with yield was probably the reason for high selection efficiency of the indices involving these characters.

There was no significant increase or decrease in the relative selection efficiency with the addition of other characters to pods/plant. This clearly brings out the selection value of pods/plant alone in improving yield. Therefore, number of pods per plant alone could serve as a useful selection index for improving yield. The importance of pods/plant to improve yield has been frequently emphasized [5–7].

Table 2. Average selection efficiency of different combinations of indices in soybean

No. of characters in the index	Selection efficiency, %
One	2519
Two	3048
Three	1731
Four	2708
Five	72
Six	56

Variability is a basic prerequisite for any successful selection scheme. Enormous variability was generated in this study by crossing the wild species *G. formosona* with five cultivars of *G. max*, as is evident from the range and variability for six important traits in the F_2 populations of these crosses (Table 4).

The range of variation for pods/plant in F_2 also indicated the presence of transgressive segregation for this trait. It was accompanied by high genotypic variance. This is encouraging, since pods/plant is an important character for increasing the selection efficiency for yield. Thus, a lot of scope exists for improving yield by choosing the appropriate selection index involving pods/plant for improving yield.

Table 3. Selection indices with the highest selection efficiency in soybean

Selection index	Selection efficiency, %
x_3	12,883
x_3 x_4	12,660
x_3 x_5	12,887
x_3 x_6	12,883
x_3 x_4 x_5	13,216
x_3 x_5 x_6	5,914
x_3 x_4 x_5 x_6	13,218

As can be seen from the data presented in Table 4, *G. formosona* is characterized by higher pod number but this is accompanied by very low grain weight, consequently, its yielding ability is reduced. *G. max* has larger grains but lower pod number per plant as compared to *G. formosona*. Hence, it is interesting to observe the impact of recombination of these important genetic features in the two species, as emphasized by earlier studies [8]. The importance of increasing pod number and grain weight simultaneously for improving yield is confirmed by the higher efficiency observed in case of the selection indices involving these three traits, i.e. pod number, grain weight, and grain yield.

The range for these two yield traits (Table 4) clearly indicates that it should be possible to select segregates combining higher pod number and grain size, ultimately leading to increase in yield.

Table 4. Variance, mean and range in parents and F_2 populations of soybean

Character	Mean			Range			Variance
	P_1	P_2	F_2	P_1	P_2	F_2	VG_{F_2}
Days to maturity	82.8	98.0	92.0	80–98	94–118	74–162	84.2
Primary branches	4.8	9.0	7.9	3–9	6–13	1–22	10.4
Pods per plant	45.2	157.0	130.0	26–110	90–325	10–850	8179.9
Seed yield, g	14.5	1.0	4.6	8–27	0.6–1.6	0.5–22.0	13.3
100-seed weight, g	13.9	0.6	2.8	10.8–18.0	0.45–0.65	1.0–9.05	0.7
Oil content, %	19.1	9.4	13.6	17.0–22.0	8.2–9.8	10.4–18.5	19.9

VG_{F_2}—genotypic variance in F_2.

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