Pak. J. Bot., 19(1): 81–88, 1987.

TESTCROSS EVALUATION OF SOYBEAN LINES

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Abstract

A study involving 12 soybean lines (6 adapted and 6 non-adapted) and 4 lines (2 adapted and 2 non-adapted) were used as female and male, respectively. Groups of crosses, adapted x adapted, adapted x non-adapted, and non-adapted x non-adapted were made and planted with two checks Century and Pella at three different locations. Highest yields were obtained from adapted and adapted crosses but the mean yield of adapted and non-adapted crosses was equal to the mean yield of the checks.

Introduction

The combining ability has been used extensively in corn for hybrid production but it can be used in soybean (*Glycine max* (L) Merr.) and other self-pollinated species. There is lack of genetic diversity in commercial soybean therefore, it is necessary to have genetic diversity because crop species having narrow genetic base are vulnerable to diseases and insects. Those species which have broad genetic base are not only more resistant to adverse environments but also have great potential for the improvement of desirable characters. The main objective of making crosses in soybean is to produce population from which desirable pure lines can be selected. Thus, combining ability in soybean refers to the ability of a parent to produce desirable advance generation progeny. St. Martin and Renjifo (1984) studied the combining ability in advance generation of 12 crosses made from 4 adapted cultivars and 3 introduced soybean lines. They suggested an important role for specific combining ability in inheritance of grain yield. In order to increase the genetic diversity in soybean, it is necessary to make crosses with exotic germplasm. Exotic germplasm and plant introduction as sources have been used in several species in order to increase the variability. Malm (1968) crossed widely used sorghum male sterlies with fertility restorer lines developed from African introduction. Four of the restorer lines produced hybrids that yielded significantly more than check hybrids.

Paschal & Wilcox (1975) made 30 crosses of adapted cultivars and exotic strains of soybean as parents and studied yield, its components and other agronomic characters and also the importance of general combining ability and specific combining ability. They found that general effects were significant for all characters while specific combining ability effects were significant for seed size, maturity and height. Isleib & Wynne (1983)

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Table 1. Parental Lines

FEMALE			
	Adapted		Non-adapted
1.	A78-227015	7.	PI 153309
2.	A78-227016	8.	PI 90566-1
3	A79-239003	9.	PI 91113
4.	A79-334010	10.	PI 68508
5.	A79-232005	11.	PI 290126 B
6.	HW 79054	12.	PI 404160 A
MALE			
1.	Century	3.	PI 189930
2.	Pella	4.	PI 253665 D

selected 27 exotic groundnut (*Arachis hypogaea* L.) and each exotic line was crossed as male to breeding line. They proposed that exotic's *per se* could be used as a criterion for selection of parents for yield.

A testcross procedure such as the one proposed by Kenworthy (1980) is useful for eliminating poor parental lines. It is also used in the early evaluation of the segregates from the crosses. The main objectives of this experiment involving adapted and non-adopted parents was to investigate combining abilty in F_3 maturity group bulk.

Materaials and Methods

This study was conducted at Ohio State University, Colombus, U.S.A. In this study, 12 soybean lines (6 adapted and non-adapted) and 4 lines (2 adatped and 2 non-adapted) were used as female and male respectively (Table 1). These lines (adapted and PI) are classified as late maturity Group II and early III. These two groups were chosen in order to avoid variation in maturity. From each cross, 25 to 30 F_2 plants which were similar in maturity i.e., late group II and early group III were linked in order to get uniform maturity among all entries. These 48 maturity group links were used as entries and planted with two checks, Century and Pella at three different locations. At all three locations, planting was done in a randomized complete block design with three replications. Each plot consisted of two rows spaced 76 cm apart and 3 m in length. Data were recorded for the follwoing characters:

Maturity = Number of days when approximately 95% of the pods had turned brown.
Lodging = Scored from 1 to 5, 1 indicating erect and 5 indicating horizontal taken at maturity.
Plant height (cm) = From the ground to the top of the stem measured at maturity.
Grain moisture = By electric grain moisture tester.
Grain weight = g per 100 random whole seeds.
Yield = Weight of seed expressed in kg/ha and adjusted to moisture content of 13%.

Data for all these characters were recorded at all 3 locations except maturity at 1 location. A combined analysis of variance was completed for yield maturity, height, lodging, grain weight and moisture by using the following model:

$Y_{ijk\ell}$ = $U + \lambda_i + \alpha_k + \gamma_\ell + (\alpha\gamma)_{k\ell} + (\lambda\alpha)_{ik} + (\lambda\gamma)_{i\ell} + (\lambda\alpha\gamma)_{ik\ell} + \beta_{j/i} + \epsilon_{ijk\ell}$
$Y_{ijk\ell}$ = Observed value of the jth replication of the centry representing the kth female, ith male at the location.
U = Overall mean.
λ_i = Location effect i = 1, 2, 3.
α_k = Female main effect K = 1, 2, 3, ..., 12.
γ_ℓ = Male main effect 1 = 1, 2, 3, 4.
$(\alpha\gamma)_{k\ell}$ = Effect of female x male interaction.
$(\lambda\alpha)_{i\ell}$ = Effect of female x location interaction.
$(\lambda\gamma)_{ik}$ = Effect of male x location interation.
$(\lambda\alpha\gamma)_{ik\ell}$ = Effect of male x female x location interaction.
$\beta_{j/i}$ = Block effect with ith location, j = 1, 2, 3.
$\epsilon_{ijk\ell}$ = Residual.

Protein and oil were analyzed by omitting block effect and error. F tests were obtained by using the appropriate mean squares. Least significant difference (LSDs) for male, female and interactions means were computed by using the formulae given in Field Plot Technique (Erwin *et al.*, 1962).

Mean of 12 female lines (adapted, non-adapted, adapted vs non-adapted) and 4 male lines (adapted, non-adapted, adapted vs non-adapted) were compared by orthogonal comparison.

Results and Discussions

The combined analysis of variance for yield, maturity, height, lodging, 100-grain weight, protein and oil is presented in Table 2. Yield differences among locations were significant. The mean yield at Columbus, was 1539 kg/ha while the yields at North

Table 2. Mean of characters of 50 entries at three different locations.

Characters	L.S.D. (0.01)	LOCATIONS Columbus	Wester Br.	NW. Br.
Yield (kg/ha)	473.54	1539	3421	2609
Maturity (Days after Aug. 31)	3.92	11	--	15
Height (cm)	9.44	70.9	92.9	101.1
Lodging (Score)	0.72	1.2	2.1	1.5
100-Grain Weight (g)	1.57	15.0	18.0	16.0
Protein (%)	NS	42.3	41.6	41.4
Oil (%)	NS	21.5	21.5	21.5

NS: Not Significantly Different

Western and Western Branch were 2609 kg/ha and 3421 kg/ha respectively. At Columbus, the poor yield was due to dry weather which was encountered during the seed filling period. At the North Western Branch, moderate levels of *Phytophthora* root rot may have reduced the yield.

There was significant difference for yield, height, lodging and oil percent and non-significant difference for maturity, 100 grain weight and protein percent between adapted and non-adapted females (Table 3). Crosses involving adapted females yielded 5% more than crosses of non-adapted females. Non-adapted females contributed greater height and lodging susceptibility to progeny. The greater loding in non-adapted females may have caused a portion of the reduction in yield (Weber & Fehr, 1966). Adapted females were found to be significantly different from non-adapted females in oil content. The non-adapted females contributed lower oil content to progeny.

Table 3. Means of different characters of adapted vs non-adapted females in crosses with 4 testers.

Female	Yield (kg/ha)	Maturity	Height (cm)	Lodging	100 Grain weight (g)	Protein (%)	Oil (%)
Adapted	2603	13	86.5	1.5	16.5	41.8	21.6
Non-Adapted	2480	13	90.3	1.7	16.4	41.9	21.3
	**	NS	**	**	NS	NS	**

**Significantly different at 1% level.
NS: Not significatly different.

Table 4a. Means of different characters of 6 adapted females in crosses with 4 testers.

	Female	Yield (kg/ha)	Maturity	Height (cm)	Lodging	100 grain wt. (g)	Protein (%)	Oil (%)
1.	A79-239003	2692	12	86.5	1.6	15.8	41.5	21.8
2.	HW-79054	2671	14	89.3	1.3	17.8	41.1	22.3
3.	A79-232005	2637	14	85.8	1.6	15.9	41.5	21.9
4.	A78-227016	2603	12	84.5	1.4	16.4	42.4	21.2
5.	A79-334010	2577	14	89.8	1.6	16.2	41.7	21.4
6.	A78-227015	2438	12	83.0	1.5	17.1	42.6	21.1
	LSD (0.05)	150	NS	2.7	NS	0.6	0.5	0.2

NS: Not significantly different.

Table 4a shows a significant difference for all characters among adapted females except maturity and lodging which indicated difference in value as parental material (Langhnm, 1949). Maximum yield (2692 kg/ha) was recorded by A79-239003 while lowest yield (2438 kg/ha) by A 78-227015. The maximum height, 89.8 cm was recorded in A79-334010 and the minimum height, 83.0 cm was recorded in A78-227015. The highest 100 grains weight, 17.8 gm, was recorded for HW 79054 as compared to 5.8 gm for A79-239003. Similarly there was a significant difference for protein content. The highest protein content, (42.6%) was found by A78-227015 while the lowest (41.1%) was by WH 79054. The highest oil content, 22.3% was recorded for HW 79054 and lowest oil contnet, 21.1% for A78-227015.

Table 4b. Means of different characters of 6 non-adapted females in crosses with 4 tester.

	Female	Yield (kg/ha)	Maturity	Height (cm)	Lodging	100 grain wt. (gm)	Protein (%)	Oil (%)
1.	PI 90566-1	2568	12	92.0	1.7	16.4	41.4	21.6
2.	PI 91113	2506	14	92.8	1.8	15.4	40.6	21.7
3.	PI 153309	2498	16	95.5	2.0	15.8	41.9	21.1
4.	PI 290126 B	2454	11	84.8	1.4	18.3	42.9	21.4
5.	PI 68508	2447	10	86.5	1.8	15.5	42.1	21.2
6.	PI 404160A	2410	14	89.8	1.7	16.4	42.2	21.0
	LSD (0.05)	NS	3	2.7	0.3	0.6	0.5	0.2

NS: Not significantly different.

Table 5. Means of different characters of adapted vs non-adapted males in crosses with 12 female lines.

Male	Yield (kg/ha)	Maturity	Height (cm)	Lodging	100 grain Wt. (gm)	Protein (%)	Oil (%)
Adapted	2687	14	89.8	1.4	16.1	41.4	21.7
Non-Adapted	2396	12	87.5	1.8	16.8	42.2	21.3
	**	NS	*	*	**	**	**

NS: = Non-Significant, * = Significant at 5% level, ** = Significant at 1% level.

There was significant difference for maturity, height, lodging, 100-grains weight, protein % and oil % among non-adapted females (Table 4b). There was 6 days range in maturity dates. PI 153309 produced the tallest plants, 95.5 cm and PI 290126B the shortest, 84.8 cm. The lowest lodging score, 1.4, was recorded for PI 290126B and the highest score, 2.0, was in PI 153309. PI 290126B had highest 100 grain weight of 18.3 gm while lowest 15.4 gm was recorded for PI 91113. For protein content PI 290126B was found highest (42.9%) while PI 91113 was the lowest (40.6%). The highest oil content value 21.4% was found in PI 290126B while the lowest, 21.0% was in PI 404160A.

Crosses including adapted males yielded 12.0% more than non-adapted males (Table 5). Adapted males were found to be taller than non-adapted males. There was contribution of lodging susceptibility to progeny by non-adapted males. Cross consisting of non-adapted males were 4% greater in grain weight than adapted males. Non-adapted males were greater in protein content but lower in oil.

Adapted and adapted crosses out yielded the checks by 9% and thus should have potential for selection of improved cultivars. Adapted and non-adapted crosses average about the same yield as the check and thus some of the crosses might have potential for cultivar development (Table 6).

Table 6. Mean of female crosses involving adapted and non-adapted parents.

Crosses	Yield (kg/ha)	Yield (% of checks)
Checks	2535	100
Adapted female x adapted male	2755	109
Adapted female x non-adapted male	2450	97
Non-adapted female x adapted male	2619	103
Non-adapted female x non-adapted male	2341	92

Some of the superiority of F_3 bulks over the check might, however, be due to heterosis (hecterosis in F_3 is expected to be 1/4 of the F_1) and any heterotic superiority could not be exploited in the develoment of pure line cultivars.

From this study, it is evident the crosses involving adapted parents produced higher yields than crosses having non-adopted parents. Paschal & Wilcox (1975) studied diallel crosses of adapted and non-adapted parents in soybean and reported greater heterosis in F_1 hybrids from parents of like origin than from those of geographically diverse parents. In other crops, it has been reported by Malm (1968), Rojas & Spragu (1952) and Vandenberg & Matzinger (1970) the germplasm of different geographic origin is the cause of genetic diversity and that hybrids of diverse parents should be higher yielding than hybrids involving parents of similar origins.

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(Received for publication 4 December, 1985)