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Original Research Article

ASSESSMENT OF GENETIC VARIABILITY AMONG SOYBEAN EXOTIC GENOTYPES FOR ADAPTABILITY AND YIELD

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Abstract: *Comprehensive research was performed in the experimental area in Plant Breeding and Genetics situated in the University of Agriculture Faisalabad to estimate the analysis of variance and correlation of the soybean exotic accessions conducting a randomized complete block design comprising four check varieties. All recommended cultural and agronomic practices were followed homogenously for each experimental genotype during the study. The data for various morphological and phonological characters were recorded from sowing to harvesting and was subjected to measure the analysis of variance of amplified block design and analysis of simple correlation. The analysis of variance revealed that accessions were significantly dissimilar with one another parameter except for days to germination. The findings indicated the variation in the experimental population, reporting the scope of improvement in these traits. The breeding material carries the different ranges of characters such as height of plant starting 14 to 57cm, hundred seed weight from 6 to 42g, number of pods in plant from 4 to 42, number of grains per plant from 8 to 96, germination days from 4 to 10, weight of fresh plant ranges 7 to 186g, maturity days 74 to 135, day to flowering from 24 to 54 and weight of seeds per plant was 9 to 89g. SUMTER, 9831, STARR, Maxcy, 9041, Leslie, ada, and Norman were identi9fied as promising genotypes i9n terms of high yield with better adaptability. Results concluded that considering the plant height, number of pods, and number of seeds are the promising traits for the selection standards and to attain soybean yield.*

Keywords: Soybean, exotic, variation, correlation, adaptability

Introduction

Soybean (*Glycine max)* L. Merril) in the world is the main oilseed and legume crop, also known as "meat of the field". Ia t is widely cultivated oilseed crop that shares 30% of processed vegetable oil and considered better biodiesel fuel among other oilseed cworldwideworld (Graham and Vance, 2003). To fulfill the requirement of country soybean is cultivated on 3650 hectares mostly in Sindh and KPK, with the increasing demand in poultry industry. So, there is a significant gap between demand and consumption. It is an economical source of protein ranging (40-42%), and high-quality edible oil of (18-22%) covers the increasing industrial demand (Khurshid, 2017). It is known to be an amazing crop containing 6% of ash, carbohydrates 11%, poly un-saturated (linoleic and linolenic), and 85% of good quality fatty acids (Iqbal *et al*., 2010). Its meal is also consumed by milking animals and in the poultry industry full of phosphorus, minerals, iron, and calcium. Soybean distinctive composition, nutritional composition, health benefits, and increasing demand give it a high value having no appropriate alternative crop.

The main constraints of soybean cultivation in Pakistan are poor adaptability, low output, and competition with major crops. Inter culture with sugarcane crop in zaid-rabi season can be practiced to increase production by symbiotic relation. Various factors affecting soybean's adaptability are altitude, day length, water stress, humidity, temperature,

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rainfall and soil health, which are also responsible for low production.

Present status of soybean cultivated area and production of Pakistan is not satisfactory to meet the demand. So, there is no edible oil and meal production for local consumption. However, soybean production is increasing quickly in other agriculture countries because it has many by-products that can be consumed for animals with good protein source. Pakistan poultry industry is increasing dramatically with a rate of 10% annually, so soybean production has a bright scope to fill the import gap. The import of soybean is mostly in the form of soy oil and meal due to insignificant production of soybean. Pakistan has an intensive cropping system in which cereal crops have a dominant position and soybeans never attained a significant position between cash crops. There were no valuable efforts in the improvement of soybean it is neglected by years due to which it covers short area under cultivation. However, researcher analyzed that Pakistan has suitable climate for soybean cultivation at different locations.

According to present conditions, an increase in soybean production is possible by developing well adapted genotypes in Pakistan. To attain our purpose, diverse germplasm collected from the world and locally improved genotypes should be experienced in different zones of Pakistan. Promising genotypes selected from this procedure should be further evaluated to rich gene pool by using various breeding and biotechnological techniques. Pakistan research stations are working on soybean to resolve the adaptability issues. Recently some researcher developed suitable genotypes for cultivation on different locations. However, the cultivation of these genotypes has not increased the area under cultivation for longer. Due to this reason, no proper data is available to evaluate its performance. So, there is a need to test soybean in multi-locations.

The Objectives of the research are:

a) To estimate the genetic variability of soybean accessions for yield related characters.

b) Identification of important Yield related parameters from exotic genotypes.

Materials and methods

Experimental conditions

The reported experiment was performed in the experiment area of the Department of Plant Breeding and Genetics, University of Agriculture Faisalabad. The trial area is situated between 73°-05° longitude on East and 30°-26° latitude on north in the rolling flat areas in the North Eastern Punjab with rising elevation of 185 meters above the level of sea. The trial was performed in the spring season on the 6 February in 2019 at the temperature of 19ºC. The research assessed the adaptation and stability in character of one hundred (100) exotic genotypes of soybean for variable phenological and observable morphological parameters. Four local varieties were utilized as check in the experiment to compare the variations.

Experimental Material

One hundred exotic soybean accessions were taken from the United States Department of Agriculture to estimate the adaptability in the local environmental situation for the adaptability with stable yield. There were four check varieties as Ajmeri in the following Table 1, the exotic soybean based on their USDA IDs, genotype, and group of their maturity is mentioned.

Table 1: Soybean hundred exotic accessions of various maturity groups

A	Exotic genotypes	Maturity group	Plant ID
1	OT89-08	000	546046
2	OT89-09	000	546048
3	Acme	00	548498
4	Ada	00	548499
5	McCall	00	54858
6	OT89-04	00	546042
7	Pembina	00	638510
8	Chico	00	542402
9	ORG83-71	00	511357
10	OT89-02	00	546040
11	9007	00	572277
12	Norman	00	548535
13	Portage	00	548607
14	Lambert	0	562373
15	Clay	0	548534
16	9041	0	572275
17	ProSoy	0	638511
18	Daeel	0	508083

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19	Swift	0	548500
20	J72	0	556756
21	Comet	0	548539
22	9062	0	561584
23	Traverse	0	548621
24	LL89-605	I	544533
25	B117	I	556843
26	A1395	I	568240
27	Chippewa	I	548530
28	M70-187	I	564276
29	DSR-128	I	556877
30	S12-82	I	561205
31	Leslie	I	557011
32	J8287	I	556755
33	Felix	I	572245
34	J231	II	556786
35	CX248	II	562637
36	L83-4387	II	547816
37	RS 2300	II	556552
38	A2484	II	556505
39	S23-12	II	556822
40	PL 6940104	II	556523
41	CX210	II	546480
42	DSR-207	II	556600
43	PX185-44	II	556484
44	S33-45	III	556586
45	AP-3132	III	556854
a46	CX313	III	576164
a47	COKER 393	III	556568
a48	J-112	III	556632
49	DSR-352	III	556709
50	A-3935	III	5568657
51	9402	III	556875
52	HAWKSON	III	556823
53	3580	III	556668
54	LG04-6863	IV	658307
55	SRF-425	IV	556475
56	BARC-9	IV	555399

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57	N98-4445A	IV	636691
58	Stressland	IV	593654
59	BARC-10	IV	572270
60	CX434	IV	576162
61	LD00-3309	IV	639740
62	Cisne	IV	593256
63	Bronson	IV	577798
64	FFR 500	V	568238
65	HT5203	V	556752
66	BARC-8	V	555398
67	DELTAPINE 415	V	556906
68	A5149	V	558782
69	HARTZ-5164	V	556834
70	6995	V	556904
71	HSC-591	V	561578
72	9442	V	556841
73	Rhodes	V	561400
74	HARTZ 922	VI	542053
75	HARTZ-6383	VI	556720
76	GK-67	VI	556716
77	DELTAPINE 506	VI	556636
78	FFR-668	VI	556620
79	D88-5320	VI	561571
80	S69-96	VI	556656
81	SUMTER	VI	556722
82	GK-67	VI	556716
83	LANCER	VI	556504
84	STARR	VII	556818
85	Buckshot-723	VII	543832
86	S-74-40	VII	556868
87	9711	VII	556916
88	WILSTAR 790	VII	556571
89	SUMTER	VII	556722
90	G-93-9223	VII	595099
91	A7372	VII	556686
92	HSC 721	VII	538774
93	COKER 627	VII	556825
94	HY 798	VIII	576155
95	Bienville	VIII	567788
96	Maxcy	VIII	568236
97	Hagood	VIII	555453
98	9831	VIII	561586
99	COKER 488	VIII	556537
100	USDA-N8002	VIII	676972

Experimental layout

There were a hundred accessions with three replications in trial by conducting a randomized complete block design. Different genotypes retained various groups of maturities in the experiment of soybean. In the field circumstances, the layout of ten genotypes were analyzed for every changed maturity group. Recommended rate of fertilizers 25:50:40 NPK was applied and by following the agronomical and cultural operations during the preparation of seed-bed in the experiment. All other inputs were essential for crop growth were also done such as hoeing, spraying and irrigations. The soybean sowing was completed by using dibbler keeping the one seed in

each hole, and plant distance of 6cm was maintained while row-to-row space was 30cm of each in the trial. Single row comprising of 15 seeds of one genotype with randomization was done in the experiment. Due to its small stature a lot of weed competition comes in soybean; to reduce crop growth the spray of narrow and broad leaves weedicides was operated and insecticide and pesticides were also applied in the research area. Data were recorded at the day first till to harvesting of various morphological characters by randomly selecting five soybean plants of every genotype. This data was taken from tagged plants and saved separately. All material of soy plants was maintained in normal positions during the procedure, starting from cultivation to harvesting. Following traits were studied;

Data Recording

Given parameters were studied and data was collected for such traits from soybean plants in various stages of development of each maturity group.

- Days to germination
- Plant height (cm)
- Days to flowering
- Number of pods per plant
- 100 seed weight
- Fresh plant weight (g)
- Number of seeds per plants
- Seed weight per plant (g)
- Days to maturity

Biometrical analysis

Analysis of variance (ANOVA)

In the experiment hundred genotypes were estimated, and mean values from collected data were also tested. Randomized complete block design was used for different traits in this study. The Statistica 6.0 software was used to estimate the various significances.

Simple Correlation Analysis

The Analysis of simple correlation for the genotypes was estimated between the observed characters following the statistical technique presented by Pearson in 1956.

Results and discussion:

Analysis of variance of Glycine max. L for different characters accessions.

The ANOVA results for the days to germination are given in the Table 2. The findings of the results cleared the non-significances differences between the test entries. The minimum number of days taken to germinate was Felix from the MG-I. However, Rhodes accession from MG-V takes the maximum number of days to sprout. LL89-605, SUMTER, Portage, 9831 and Daeel showed significant results from the varieties however, GK-67 showed the similar results as Felix. Rhodes showed significant results from varieties and Lambert, 9007, DSR-128, S12-82, A2484, ProSoy, Buckshot-723 and COKER 393. MG-II showed significant differences from other maturity groups. The different accessions germinated in the range of 4 to 10 days. Malik *et al.* (2006) and Ahmad *et al.* (2019) found the non-significant results between soybean genotypes. The results described the variations existing were extremely significant among the varieties and in exotic line for the plant height. Malik *et al*. (2007) Ahmad *et al*. (2019) and Sousa *et al.* (2015) found the high significant results in the treatments for plant height in soybean. Plant height averages were falling in the range of 14 to 57 cm. Each accession response differed where Hagood from the MG-VIII achieved the maximum plant height whereas Chico accession from MG-00 showed the lowest height in the genotypes.

Variations in results were obtained between entries test in flowering days character in soybean. Sousa *et al.* (2015), Saba *et al.* (2017), Malik *et al*. (2006) and Zhang *et al.* (2015) also found similar outcomes of significant differences in soybean genotypes for different parameters. The accessions started flowering from 24 days to 54 days, according to the various group of maturity. It was cleared that SUMTER from MG-VI was late in flowering among other exotic lines, followed by RS 2300 and A7372. However exotic genotypes like Portage from MG-00 and D88-5320 started blooming in shortest period. Huge significances were existing in results between the test entries of soybean in accessions for the number of pods present on one plant. Ahmad et al. (2019) and Zhang *et al.* (2015) also determined the significant variations among the exotic soybean genotypes for the same trait. The average number of pods calculated in soybean was falling from 4 to 42. The DSR-128 FROM MG-I had gained the maximum pods per plant in lines however FFR-668 from MG-VI showed the least number of pods in soybean genotypes per plant.

In soybean lines, significance in variation was present for the weight of hundred seeds between test entries and the correlation of check and test entries. Rehman *et al.* (2014), Shah *et al.* (2017), Ahmad *et al.* (2019) and Verma *et al.* (2017) found the similar results i.e., significant variations in exotic lines for hundred seed weight. The weight of hundred seeds was calculated between 6 to 42 g in trial. All genotypes N98-4445A from the group MG-00 achieved the highest hundred seeds weight however, minimum weight was calculated from the accession Felix from MG-I in this study.

The research indicated the high significant differences were present among the entries of tests in soybean accessions for the weight of fresh plant. Marchiori et al. (2015), Saba *et al.* (2017) and Zhang *et al.* (2015) founded the significant differences for the character between the soybean genotypes. El-Badawy and Mehasen lines showed significant difference in the parameters of fresh weight calculated from soybean. The mean of weight measured from fresh plants was

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7 to 186 g in the soybean. Maxcy belonged to MG-VIII secured the maximum weight of soybean plant while the minimum weight of accession measured from DSR-207 from MG-II in this research.

Significant outcomes were obtained between the test entries for the number of grains per plant in this study. Silva et al. (2017), Liu et al. (2008) Saba et al. (2017), Malik et al. (2007) and Ahmad et al. (2019) also got the matched results of significant differences in soybean for the trait of accessions. The calculation indicates the 8 to 96 grains obtained from one plant. Chippewa from MG-1 was the leading genotype in securing highest rate of seeds from and lowest rate of seeds was observed in the G-93-9223 from MG-VII accession in the soybean per plant. Highly significant variations from the results obtained among the test entries for the grain weight per plant in soybean. Matei et al. (2017), Ifrim et al. (2012) and Arshad et al. (2006) estimated similar significant differences in accessions for the parameter in soybean. Edugbo et al. (2015) found significant variations for the seed weight character between soybean accessions. The weight of grains was lying between the 9 to 89 g range. More significant variations from the results founded between test entries in soybean for days taken in maturity. Zhang et al. (2015), Saba et al. (2017), Ahmad et al. (2019) and Zhou et al. (2019) obtained significant differences among soybean genotypes for parameters. The soybean accessions had taken the 74 to 135 days to maturity. Acme had taken the more days to full maturity while OT89-09 from the MG-000 group gets the maturity in minimum days.

Correlation analysis

Correlation analysis finds the intensity of association between two traits (Zhang *et al.* 2015). The idea was first time used by Francis Galton in 1954. Simple correlation analysis was applied for exotic accessions of soybean, where yield and yield related components are presented in (Table 3). Results showed that days of germination had a negative and non-significant relationship with fresh plant weight and seed weight per plant. While it showed negative and significant association with day to maturity, hundred seed weight, and day to flowering. Days of germination had a positive and significant association with plant height however, positive and non-significant with the number of pods per plant and the number of seeds per plant. Ahmad *et al.* (2019) reported similar results. Plant height had positive and non-significant association with day to flowering day to maturity number of pods per plant. Ahmad *et al.* (2019), Zhang *et al.* (2015) and Iqbal *et al.* (2010) found positive and significant associations with the number of seeds per plant.

Days to flowering had negative and non-significant associations with the number of pods per plant, number of seeds per pod.and seed weight per plant. Zhang *et al.* (2015) and Iqbal *et al.* (2010) found positive and significant association of day to maturity with days to flowering. Hundred seed weight showed positive and significant relationship with day to maturity. Verma *et al.* (2017) reported a negative and non-significant relationship between plant height and the number of pods per plant. Number of pods per plant had a positive and significant correlation with the number of seeds per plant, seed weight per plant. Ahmad *et al.* (2019) revealed positive and significant correlation between number of seeds per plant. Plant height and hundred seed weight showed non-significant results. Number of seeds per plant had positive and significant association with plant height and the number of pods per plant. Kuswantoro et al. (2017) analyzed a positive and significant relationship between the number of seeds per plant with seed weight per plant.

Results indicated that total seed weight had a positive and significant association with number of pods per plant and number of seeds per plant. Ahmad *et al.* (2019), and Kuswantoro et al. (2017) found positive and significant association of number of seeds per plant. Fresh plant weight had positive and significant association with days of flowering and plant height. Ahmad *et al.* (2019) and Iqbal *et al.* (2010) found positive and significant association of seed weight per plant. Results indicated that days of maturity had positive and significant correlation with day to flowering and hundred seed weight while it had a negative and significant association with the number of seeds per and number of pods per plant. Zhang *et al.* (2015), Kuswantoro et al. (2017) and Ahmad *et al.* (2019) find the significant results for day to flowering.

Table 2: Analysis of variance of *Glycine max* L. genotypes

SOV	DF	DOG	PH	DOF	PPP	HSW	FPW	SPP	SWP	DOM
Blocks	2	2.07896	6.559	5.081	7.433	7.433	10.6365	14.76	0.88	0.318
Entries	103	4.023	205.867**	180.2718**	222.636**	222.636**	90.3863**	2409.648**	1219.23**	814.5**
Error	206	0.5926	1.0218	1.418	1.1616	1.1616	1.8473	1.165	4.7233	1.2184
Total	311									

Here, DOG = Days to germination, DOF = Days to flowering, DOM = Days to maturity, FPW = Fresh plant weight, HSW = Hundred seed weight, PH = Plant height, PPP = Number of pods per plant, SPP = Number of seed per plant, SWP = Seed weight per plant

Table 3: Simple correlation coefficients among various traits in soybean genotypes

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	DOF	DOG	DOM	FPW	HSW	PH	PPP	SPP
DOG	-0.1213**							
	0.7777**	-0.1526**						
DOM		-0.0693						
FPW	0.4113**	N.S.	0.4531**					
HSW	0.0992 N.S.	-0.6898**	0.1153**	0.0368				
PH	0.0838 N.S.	0.1571**	0.0833 N.S.	0.2841**	-0.1647**			
PPP	-0.2564**	0.0361 N.S.	-0.2400**	-0.1291**	-0.0041 N.S.	0.0718 N.S.		
SPP	-0.1832**	0.0908 N.S.	-0.2076**	-0.2079**	-0.0584 N.S.	0.1860**	0.7160**	
SWP	-0.2847**	-0.0734 N.S.	-0.4179**	-0.2694**	0.1035 N.S.	-0.0354 N.S.	0.4830**	0.4552**

Here, DOG = Days to germination, DOF = Days to flowering, DOM = Days to maturity, FPW = Fresh plant weight, HSW = Hundred seed weight, PH = Plant height, PPP = Number of pods per plant, SPP = Number of seed per plant, SWP = Seed weight per plant

Conclusion

The present study evaluated that breeding resource such as SUMTER, 9831, STARR, Maxcy, 9041, Leslie, ada, and Norman may be utilized in breeding programs to get a high yield with better adaptability. Results concluded that considering the plant height, number of pods, and number of seeds are the promising traits for the selection standards and to attain soybean yield.

Conflict of interest

Authors declared no conflict of interest among them.

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