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Growth and yield response of different soybean genotypes under semi-arid conditions of Faisalabad

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Abstract

In spite of many success stories and multi benefits associated with soybean cultivation in the whole world, survival of this crop always creates problems in different regions of Pakistan due to unavailability of resilient genotypes and fixed cropping systems. There is a need to promote soybean cultivation in different agro-climatological belts of Pakistan by conducting adaptability trials of available genotypes. Therefore, a planned experiment was performed to compare the performance of 22 soybean genotypes of diverse origin (Faisal Soybean, Ajmeri, Rawal-1, NARC-2, 17419, 17121, 17122, 17423, 17429, 24010, 24505, 24506, 24507, 24508, 24512, 24513, 24563, 24566, 24567, 24592, 24595, 24597) under semi-arid conditions of Faisalabad, Punjab, Pakistan. Experiment was carried out following randomize complete block design with three replications. Different parameters related to seed emergence, yield and growth of soybean were documented by using standard procedure and data were statistically analyzed through Fisher's analysis of variance techniques. Result indicated that Faisal soybean performed best among all the treatments followed by Rawal-1, Ajmeri and NARC-2. As, maximum plant height (68.33 cm), number of pods per plant (60), 1000 seed weight (142 g), seed yield (3930.30 kg ha^{-1}) and harvest index ((45.17 a) were observed with Faisal soybean however minimum plant height (22 cm), number of pods per plant (10.67), 1000 seed weight (98.67 g), seed yield (833.33 kg ha^{-1}) and harvest index (29.76 f) were recorded with genotype 17423. Therefore, it is concluded that Faisal Soybean would be the best choice among all the understudied genotypes for the farmers of the district, Faisalabad.

Keywords: Soybean genotypes, adaptability, semi-arid conditions, Faisalabad.

Introduction

Soybean (*Glycine max* L.) is one of the chief oil seed crops and belongs to family Fabaceae. Basically, it is leguminous crop inherited to East Asia. Soybean considered as miracle crop as it possess many qualities like, 38-42% good quality protein, 20-24% oil content and 29% carbohydrates (Graham and Vance, 2003). Besides this, it is a very good source for ascorbic acid, calcium, thiamine, carotene and iron **(**Probst and Judd, 1973). Soybean oil consists of 85% polyunsaturated fatty acid like linoleic acid. These unsaturated fatty acids are not synthesized by human body (Antalina, 2003; Balasubramaniyan and Palaniappan, 2003).

In Pakistan there is a big problem of edible oil availability and our domestic oil production is 25% of the local demand which could not make pace with the increasing local demand. We import almost 75% enormous amount of edible oil from different countries of the world each year to fulfill our domestic requirements (Khan *et al*., 2012; Ahmed *et al*., 2014). Soybean is identified as one of the unconventional oilseed crops. During 1970's, sunflower and soybean were introduced in Pakistan as oil seed crops, but soybean couldn't be adopted by farmers even after 3 decades. During last 10 years, there has been a steady deterioration in area and growth of soybean (Anonymous, 2009). There are many factors that can be considered for commercial downfall of soybean, among those seed viability, poor germination count, unavailability of quality seed, climatic hazards and poor marketing system are the major problems in semi-arid region of Pakistan (Yari *et al.*, 2010). One of the main issues in selecting suitable soybean genotype under the prevailing conditions of country is lack of proper information knowledge. It is necessary to study all yield and yield related traits of a crop to understand and then improve its performance under specific local conditions. It will be helpful not only in choosing climate and environment resilient varieties for a zone but also for breeders in order to develop new varieties of that crop (Dewey & Lu, 1959). Some site specific studies have revealed that some of the important plant parameters should be kept in consideration while choosing appropriate soybean genotypes for improved grain yield. Plant architecture, number of pods per plant, 1000 grain weight and grain yield are the important parameters which are used to compare the performance of different soybean varieties. Different improved and recommended soybean types have diversified morphological characters (Olufajo, 1992; Adeniyan, and Ayoola, 2006). Likewise, Jin *et al.* (2010) had revealed that improved soybean yield was directly related with improved pods per plant. However, there was no significant difference was found among seeds per pod and seed size. Similarly, Khan *et al*. (2000) conducted a research trail by using 86 genotypes in Pakistan to check the heritability and relationship between different yield parameters of selected genotypes. He concluded that improved grain yield was directly affected by different yield contributors.

For continuous improvement of this crop, it is important to develop new biotic and abiotic stress resistant lines through efficient genetic diversity methods (Jan *et al.,* 2016). The genetic variability among different germplasm can be studied by measuring the differences/similarities among different quantitative traits of soybean genotypes (Iqbal *et al.,* 2008). Therefore, it is necessary to check the performance of genetically diversified genotypes under local prevailing conditions (Khokhar *et al*., 2002).

Materials and methods

Experimental site and soil status

The field trail was laid out at Agronomy farm, University of Agriculture, Faisalabad. Before sowing, different soil samples from depth of 30 cm were collected by using auger and were analyzed by using facility from Ayyub Agriculture Research Institute Faisalabad. Soil analysis report is shown in Table 1.

Treatment description and experimental design

Soybean germaplasm was collected from National Agriculture Research Center (NARC), Islamabad and Ayyub Agriculture Research Institute (AARI), Faisalabad**.** Experiment was consist of 22 soybean genotypes (Faisal Soybean, Ajmeri, Rawal-1, NARC-2, 17419, 17121, 17122, 17423, 17429, 24010, 24505, 24506, 24507, 24508, 24512, 24513, 24563, 24566, 24567, 24592, 24595, 24597). Randomize complete block design was used with three replications and plot area was 1.5 m × 6 m.

Crop husbandry

Two plowing followed by planking was performed for seed bed preparation. Soybean seeds were inoculated with Rhizobium culture provided by Ayyub Agriculture Research Institute, Faisalabad. For seed inoculation, inoculant was mixed with water to form an even and pourable suspension. Sugar was also mixed in water to supplement the adhesion of the inoculant to the seeds. After inoculation, seeds were dried and sown by manual dibbling (Choppa method).

N, P and K were applied according to their respective recommended doses of 25, 50 and 50 kg ha^{-1} to full fill soybean nutrients requirements. DAP (Diammonium phosphate) and MOP (Murate of potash) were applied as a source of phosphorus and potassium respectively; DAP also adds N in the soil. Both of the fertilizers (DAP & MOP) were used at sowing. Urea was used to full fill the remaining amount of Nitrogen. However, N was applied in three splits at the time of sowing (available via DAP), at first irrigation and at flowering (available via Urea).

After 15 days of sowing, first irrigation was applied while next irrigations were applied depending upon crop requirements. During the whole growing period four irrigations were applied at different stages from sowing to maturity. The insect and diseases control was insured by using chemical spray (Dimecron 100% at rate of 600 ml ha^{-1}). The field was kept free from weeds by using conventional (tillage) methods in order to avoid weed crop competition.

Yield and Yield Components

Soybean crop was harvested in the 2nd week of November, 2018 at physiological maturity. Before harvesting plant height of 10 randomly selected plants from each plot was recorded and average was computed. After harvesting, soybean crop was sun dried for four days separately of each plot and tied into bundles. From each plot, 10 plants were selected, total number of pods and branches were counted and average was calculated. 1000 grains from each plot were collected and weighed (weighing balance model). Grain yield of each plot was recorded and converted into kg/ha. Harvest index (HI) was calculated by the following formula.

$$H.I = Economical\ yield\ /\ Biological\ yield\ * 100$$

Statistical analysis

Collected data was statistically analyzed by variance technique and differences among treatments were compared by HSD (Honest Significant Difference) test at 5% probability (Steel *et al*., 1997).

Results

Results disclosed that different genotypes performed differently under agro-ecological environment of Faisalabad (Table 2). Among yield contributing parameters, maximum plant height (68.33 cm), number of branches per plant (7.33), number of pods per plant (60), 1000 seed weight (142 g), seed yield (3930.30 kg ha^{-1}) and harvest index (45.17 a) were observed with Faisal soybean. Following Faisal soybean the performance of Rawal-1 was best among all other genotypes. Rawal-1 exhibited plant height (54 cm), number of branches per plant (5.33), number of pods per plant (58), 1000 grain weight (131 g), grain yield (3866.70 kg/ha) and harvesting index (44.49) Minimum value for plant height (22 cm), number of branches per plant (1.67), number of pods per plant (10.67), 1000 seed weight (98.67 g), seed yield (833.33 kg ha^{-1}) and harvest index (29.76 f) were observed with genotype 17423 (table 2).

Discussion

Plant height is normally considered as an important contributor towards final yield of soybean, as frequently healthy or taller plants surround more pods and finally contribute additional biological and grain yield. Statistically notable differences in plant stature (Table 2) could be attributed to genetic diversity of soybean genotypes. Rasaily *et al*. (1986) and Ghatge and Kadu (1993) stated that there is high inconsistency in plant stature of soybean genotypes. The strong association between pods/plant and final seed yield showed that pods/plant have greater contribution to seed yield of soybean. Results of this experiment are similar with that of Khan *et al.* (2015) who recorded significant difference based on number of pods per plant among soybean genotypes.1000 grain weight is the most imperative yield causative factor which can be used to estimate the grain harvest of any crop. It is directly related to number of pods/plant and number of seed/pod. In this study, significant difference was observed among all the genotypes (Table 2). Variations in different yield contributing parameters might be due to the genetic differences of soybean genotypes (Ghatge and Kadu, 1993). These results are analogous with the finding of Olewe (2014) and Saba *et al*. (2017) who reported significant variation in 1000 seed weight among soybean genotypes. All prevailing environmental circumstances during reproductive stages, especially strength and quality of solar radiations intercepted at canopy level are important factors which significantly affect all yield related attributes of soybean (Board and Harvill *et al*., 1996). Furthermore, significant differences among grain yield of different genotypes could be exploited to improve different growth and yield parameters such as plant height and 1000 grain weight of those varieties (Table 2). Harvest index presented that both grain yield and dry matter production are directly proportional to each other. Similarly, Amanullah *et al.* (2006) has published a positive relationship between improved grain yield and harvest index while negative relationship between dry matter production and harvest index.

Conclusion

It is concluded that in agro-ecological conditions of Faisalabad, among all the germplasm under study, Faisal soybean performed best in autumn season.

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Table 1: Soil analysis report before sowing crop

Determination	Value
pH	7.9
EC (dS m^{-1})	0.63
Organic matter (%)	0.91
Available Phosphorus (ppm)	9.8
Available Potassium (ppm)	220
Saturation (%)	36

Table 2: Different yield and yield related traits of soybean as influenced by different genotypes

Genotypes	Plant height	Number of branches per plant	Number of pods per plant	1000 grain weight(g)	Seed yield (kg/ha)	H.I (%)
Faisal soybean	68.333 a	7.33 a	60.33 a	142.00 a	3930.30 a	45.17 a
Ajmeri	49.667 bc	4.66 bc	48.67 b	124.33 abc	3266.70 b	38.303 cd
Rawal-1	54.000 b	5.33 b	58.00 a	131.00 ab	3866.70 a	44.49 ab
NARC-2	49.667 bc	4.66 bc	48.00 b	122.33 abcd	3233.3 b	37.59 cde
17419	33.333 fgh	3.67 def	28.67 fgh	100.00 ef	2766.70 bcde	36.62 cde
17121	33.000 ghi	3.67 efg	27.67 ghi	109.67 cdef	2700.00 cdef	35.02 cdef
17122	30.667hij	3.00 ghi	24.67 hi	100.33 ef	1900.00 g	34.54 cdef
17423	22.000 k	1.67 k	10.67 j	98.67 f	833.33 h	29.76 f
17429	32.333 hij	3.67 efg	27.67 ghi	108.67 cdef	2600.00 def	34.62 cdef
24010	30.667 hij	2.67 hij	22.67 i	103.00 def	1900.00 g	34.54 cdef
24505	31.667 hij	3.33 fgh	25.67 hi	107.67 cdef	2266.70 efg	34.87 cdef
24506	43.667 cd	4.66 bcd	40.00 c	122.33 abcd	3233.3 b	37.77 cde
24507	39.333 defg	4.33 cde	34.00 def	116.00bcdef	3233.3 b	38.77 bc
24508	41.333 de	4.33 bcd	37.67 cd	117.67bcdef	3166.70 bc	38.57 bc
24512	25.667 jk	2.33 ijk	14.67 j	98.33 f	1133.30 h	31.81 ef
24513	26.333ijk	2.33 ijk	22.33 i	102.67 def	1200.00 h	32.43 def
24563	31.667hij	3.33 fgh	25.00 hi	106.33 cdef	2216.70 fg	34.10 cdef
24566	37.333defgh	4.00 cde	31.67 efg	112.67bcdef	2900 bcd	36.62 cde
24567	35.667 efgh	4.00 def	30.00 efgh	112.33bcdef	2966.70 bcd	36.62 cde
24592	32.000hij	3.33 efg	27.33 ghi	108.00 cdef	2233.70 fg	33.33 cdef
24595	40.000 def	4.33 cde	34.67 cde	117.33bcdef	3033.30 bcd	37.44 cde
24597	42.000 de	4.66 bcd	39.00 cd	120.00 bcde	3100.00 bcd	36.68 cde