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COMPARISON OF YIELD PERFORMANCE OF SOYBEAN VARIETIES UNDER SEMI-ARID CONDITIONS

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ABSTRACT

Selection of suitable cultivar for an agro-climatic zone is of prime concern for soybean growers. Moreover, identification of suitable plant traits showing maximum contribution to final seed yield is important for plant architects. To find out superior varieties and plants traits for semi-arid conditions of Pakistani Punjab, growth and yield performance of four soybean varieties viz., Rawal, Williams-82, SA-72-60, and PSC-60 was tested through field study. Experiment was laid out in randomized complete block design (RCBD). Soybean variety PSC-60 showed best performance as it gave significantly higher seed yield (697.3 kg ha^{-1}), biomass (2008 kg ha^{-1}) plant population (31 plants ha^{-1}), plant height (27.43 cm), number of leaves $plant^{-1}$ (25), number of pods $plant^{-1}$ (16.3), number of seeds pod^{-1} (2.867) and number of seed $plant^{-1}$ (32.87). Contrastingly, soybean variety Williams-82 was found to be inferior as it gave lowest value of these parameters. Seed yield showed a significant positive relationship with plant population (R^2=0.865), plant height (R^2=0.652), leaves per plant (R^2 =0.637) and plant biomass (R^2=0.793), number of pods per plant (R^2 =0.681), number of seeds per pod (R^2 =0.793) and number of seeds per plant (R^2 =0.685) whereas non-significant negative relationship with 100 seed weight and harvest index. The strongest relationship of seed yield was seen with number of seeds pod^{-1} (b=500.9) followed by number of pods $plant^{-1}$ and the weakest with plant biomass (b=0.277). Therefore these traits should be considered to be most important while selecting improved soybean genotypes under semi-arid conditions.

Key words: soybean, varieties, seed yield, plant traits, regression, biomass

INTRODUCTION

Soybean (*Glycine max* L.) is an important legume crop. It originated from East Asia but it is well adapted to tropical, subtropical and temperate regions of the world, and can be successfully grown during spring as well as the summer season. United States, Brazil, Argentina, China, India, Paraguay and Canada are the major soybean producers in world. It is now becoming important valuable crop of other countries because it is a major source of protein, energy, polyunsaturated fat, fibers, vitamins, minerals, both for humans and livestock. Soybean seed contain 40-42% good quality protein and 18-22% oil, depending upon genetic and environmental factors (Krishnan, 2000).

It is multi-dimensional in its uses but widely grown for its edible beans. Due to rich in best quality protein it is regarded as "the meat that grows on plant". Soybean plant is classified as oilseed rather than pulse crop as approximately 85% of the world's soybean crop is processed into soybean meal and vegetable oil. In Pakistan, it is categorized as one of the non-conventional oilseed crops. Although soybean as an oilseed crop was introduced in Pakistan during 1970's along with sunflower, but it could not become so popular among growers even after 3 decades. Even during the previous ten years (2000-2009) there has been a gradual decline in area and production of soybean in Pakistan (Anonymous, 2009). The main reason behind was lack of knowledge regarding identification of soybean varieties suitable for different agro-ecological zones of country.

For the proper understanding of seed yield performance of any crop cultivar under specific set of environmental conditions, it is necessary to study the contribution of various yield determining parameters towards final seed yield. It will not only help in selecting suitable variety for an agro-ecological zone but also provide guideline for breeder to develop improved variety of a certain crop. Therefore correlation and regression studies among yield and yield contributing traits of soybean may provide knowledge which will be of greater significance for agronomists and plant breeders in manipulation in any crop improvement programme as economic yield is the result of the expression and association of several plant growth components (Dewey & Lu ,1959).

Previous studies in different parts of the world suggested various plant traits which should be considered to be most important while selecting soybean genotypes for higher seed yield. Plant height at harvest, number of pods per plant, weight of 100 seeds and seed yield were used to assess the performance of improved varieties of soybean. The newly recommended improved varieties of soybean have a wide range of maturity and diverse morphology (Olufajo, 1992; Adeniyan, and Ayoola, 2006). Similarly it was reported by Jin et al. (2010) that the yield increase is correlated with increasing pod

number, while seed size and seeds per pod does not change greatly over time. Khan *et al.* (2000) studied heritability and correlation among yield determining components of 86 genotypes in Pakistan and reported that seed yield had a significant positive relationship with all yield components except pod height. In continuation of the findings of previous researchers, study was planned to evaluate the yield performance and find out the yield contributing traits of some new soybean varieties under semi-arid conditions of Sargodha-Punjab, Pakistan.

MATERIALS AND METHODS

Field experiment was performed at research area of University College of Agriculture, University of Sargodha, during autumn season of 2010 to evaluate the growth and yield performance of soybean varieties. Four soybean varieties viz., Rawal, Williams-82, SA-72-60, and PSC-60 were tested. Experiment was laid out in a randomized complete block design (RCBD) and each treatment was replicated four times. A net plot size of 2.70 m x 7.0 m was kept.

The crop was sown during first week of August by drill machine. Seed rate of 40 kg ha^{-1} was kept while maintaining row distance of 45 cm and plant to plant distance of 5 cm. NPK in the form of urea, DAP and potassium sulphate, respectively, at the rate of 60-75-30 kg ha^{-1} was applied. Full dose of each of nitrogen, phosphorus and potassium was applied basally. After 1st irrigation, weeds were removed by hoeing. All other agronomic practices were kept uniform among treatments applied.

Parameters related to plant growth and yield such as plant population m^{-2}, plant height, number of leaves $plant^{-1}$, number of pods $plant^{-1,}$ number of seeds pod^{-1}, number of seeds $plant^{-1}$, 100-seed weight, plant biomass, seed yield, and harvest index (HI) were recorded at maturity.

The data thus collected were analyzed statistically by the analysis of variance technique and treatment means were compared using LSD test at 5 % level of probability (Steel *et al*., 1997).To assess the relationship of seed yield with other parameters, regression analyses were performed on MS Excel computer package.

RESULTS AND DISCUSSION

Analysis of variance of seed yield and other parameters related to yield showed that plant population, number of pods per plant, number of seeds per pod, seed yield and plant biomass of different soybean varieties differed significantly at 1 % probability level whereas plant height, leaves per plant and number of seeds per plant of these varieties varied with each other at 5 % probability level. However, statistically non-significant differences were found among these varieties parameters with respect to 100 seed weight and harvest index.

Data of means of plant biomass, plant height, number of leaves per plant and plant population of different soybean varieties are given in table 1. A perusal of these data reveals that soybean variety PSC-60 produced significantly highest biomass (2008 kg ha^{-1}), plant height (27.43 cm), number of leaves per plant (25) and plant population (31 plants m^{-2}) and remained statistically at par with that of SA-72-60 with respect to plant height (24.7 cm) and number of leaves per plant (19.3). However, lowest biomass (852.5 kg ha-1), plant height (20 cm), number of leaves per plant (11.47) and plant population (21.33 plants m^{-2}) were observed in soybean variety Williams-82.

Seed yield is of prime concern to soybean growers. A comparison of seed yield and yield contributing traits has been presented in table 2 which showed that statistically higher seed yield (697.3 kg ha-1), plant population (31 plants ha^{-1}), number of pods per plant (16.3), number of seeds per pod (2.867) and number of seed per plant (32.87) were recorded in soybean variety PSC-60. However this variety did not differ significantly from soybean variety SA-72-60 with respect to number of pods per plant, and from both SA-72-60 and Rawal with respect to number of seeds per plant. On the other hand, soybean variety Williams-82 was found to be inferior as it gave lowest seed yield (354.2 kg ha-1), plant population (21.33 plants m-2), number of pods per plant (9.57), number of seeds per pod (2.23) and number of seeds per plant (20.77). However, harvest index and 100 seed weight did not vary significantly among different soybean varieties. However, highest 100 seed weight (15.73 g) and harvest index (42.53) were given by soybean variety Williams-82 while the lowest by PSC-60.

Regression analyses as presented in figures 1, 2, 3, 4, 5, 6 and 7 indicated a significant relationship of seed yield with plant population m^{-2}, plant height, number of leaves per plant, plant biomass, number of pods per plant, number of seeds per pod, and number of seeds per plant at 1% probability level. However non-significant negative relationship of seed yield was found with 100 seed weight and harvest index (Data not shown). Regression analyses of seed yield with vegetative growth parameters revealed a strong positive relationship of seed yield with plant population (R^2=0.865), plant height (R^2=0.652), leaves per plant (0.637) and plant biomass (R^2=0.793) (Figures 1, 2, 3and 4). As regards yield components, seed yield was found to have a strong positive relationship also with number of pods per plant (0.681), number of seeds per pod (0.793), and number of seeds per plant (0.685) (Figures 5, 6 and 7). Among regression analyses of seed yield with all parameters studied, highest value of regression coefficient (500.9) was observed with number of seeds per pod (Figure 6)

whereas lowest value of regression coefficient (0.277) was seen with plant biomass (Figure 4).

Our results are in close conformity to those of previous investigators who also found plant height, number of leaves per plant (Malik *et al*., 2007), number of pods and seeds (Khan *et al*., 2000; Board *et al.*, 2002; Liu *et al*., 2005; Arshad *et al.*, 2006) to be the most important plant traits contributing to improved economic yield in soybean crop and hence suggested that these traits should be given more importance while selecting superior soybean genotypes. Furthermore, it was also observed by Liu *et al.* (2005) that harvest index had no relationship with seed yield. Although plant height had no direct influence on final seed yield even tall statured soybean varieties produced larger number of leaves which in turn supplied greater amounts of assimilates for seed growth resulting in higher seed yield. Similarly plants of soybean varieties with tall height had longer growth duration which resulted in larger number of pods and seeds. Moreover, the positive relationship of seed yield with number of pods and seeds was probably due to fact that these are the yield components of important nature in soybean.

However, negative correlation of seed yield with 100 seed weight and harvest index is not supported by findings of Cui and Yu (2005) and Arshad *et al.* (2006) who noted that 100 seed weight and harvest index had a direct effect on final seed yield of soybean. The negative relationship of seed yield with 100 seed weight and harvest index was probably attributed to environmental effects as regression analysis of these two parameters with seed yield was found to be statistically non significant in these studies.

Table 1. Comparison of plant biomass (kg ha^{-1}) and biomass related parameters of various soybean varieties

Varieties	Plant height (cm)	Number of leaves plant^{-1}	Plant population m^{-2}	Biomass (Kg ha^{-1})
Rawal	22.07 ^{b}	14.23 ^{bc}	23.00 ^{c}	1188.0 ^{bc}
Williams-82	20.00 ^{b}	11.47 ^{c}	21.33 ^{c}	852.5 ^{c}
SA-72-60	24.70 ^{ab}	19.30 ^{ab}	27.33 ^{b}	1477. 0 ^{b}
PSC-60	27.43 ^{a}	25.00 ^{a}	31.00 ^{a}	2008. 0 ^{a}
LSD	5.019	6.929	3.477	427.6

Table 2: Comparison of seed yield (kg ha-1) and yield related parameters of various soybean varieties

Varieties	Number of pods plant^{-1}	Number of seeds pod^{-1}	Number of seeds plant^{-1}	100- seeds weight (g)	Seed yield (kg ha^{-1})	Harvest index (%)
Rawal	12.70 ^{b}	2.467 ^{c}	27.40 ^{ab}	13.73	476.8^{b}	39.73
Williams-82	9.57 ^{c}	2.23 ^{d}	20.77 ^{b}	15.73	354.2^{c}	42.53
SA-72-60	14.20 ^{ab}	2.63 ^{b}	29.50 ^{a}	14.97	554.2^{b}	38.60
PSC-60	16.30 ^{a}	2.87 ^{a}	32.87 ^{a}	12.57	697.3^{a}	34.97
LSD	**2.986**	**0.08935**	**7.465**	**NS**	**79.84**	**NS**

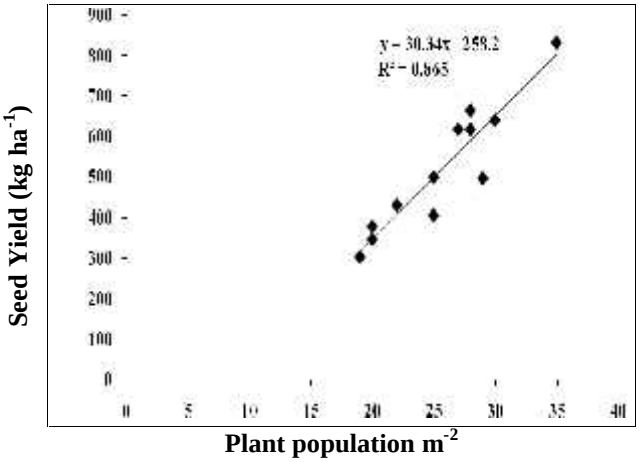

Figure 1: Regression analysis of seed yield as affected by planting density

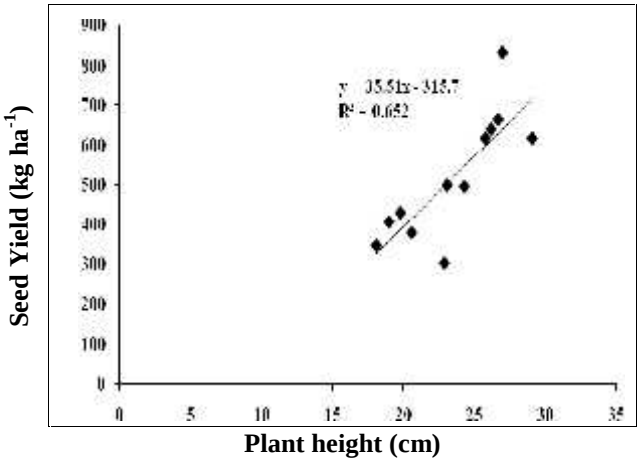

Figure 2: Regression analysis of seed yield as affected by plant height

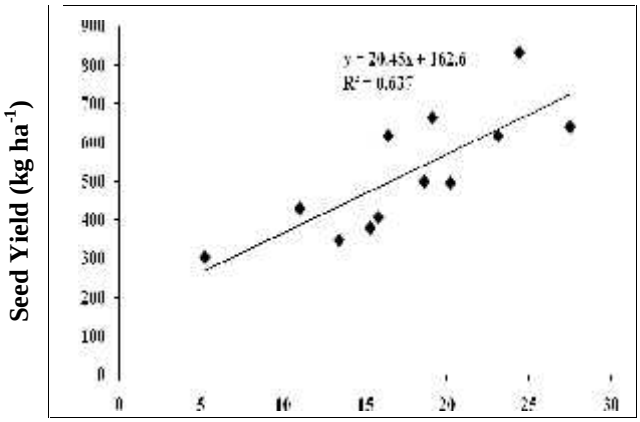

Figure 3: Regression analysis of seed yield as affected by leaves per plant

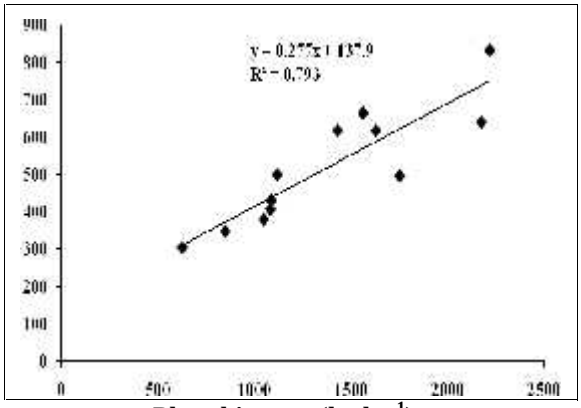

Figure 4: Regression analysis of seed yield as affected by plant biomass

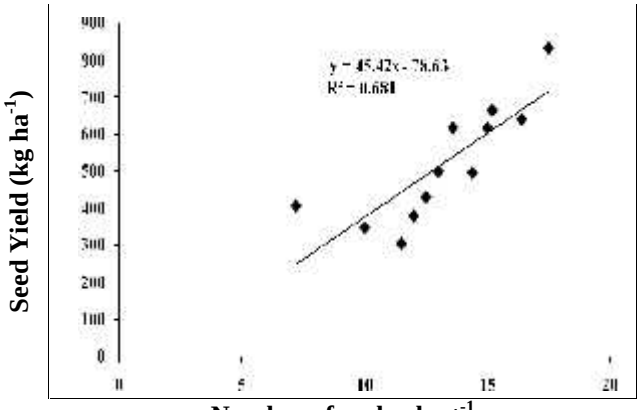

Figure 5: Regression analysis of seed yield as affected by number of pods plant^{-1}

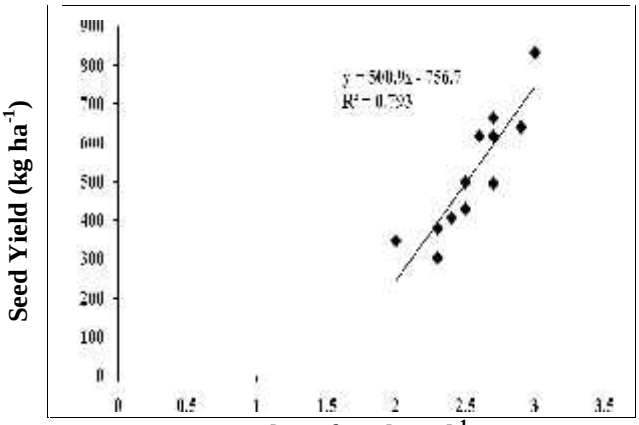

Figure 6: Regression analysis of seed yield as affected by number of seeds pod^{-1}

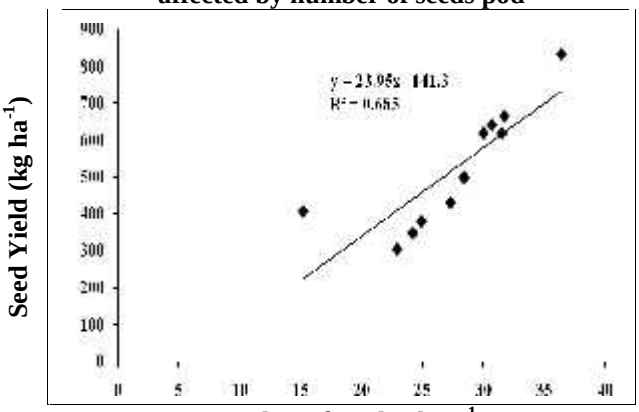

Figure 7: Regression analysis of seed yield as affected by number of seeds plant^{-1}

Conclusion: Out of all the varieties studied, soybean variety PSC-60 performed best with respect to seed yield and yield contributing traits therefore it is proved to be most suitable for sowing under agro-climatic conditions of Sargodha, Punjab-Pakistan. It is followed by soybean varieties SA-72-60 and Rawal. However, soybean variety Williams-82 was found to be inferior to all other varieties. All the plant traits, except 100- seed weight and harvest index (HI) positively contributed towards final seed yield. However maximum contribution was given by number of seeds per pod followed by number of pods per plant. Therefore, these traits should be given top priority when breeding was aimed at selecting superior soybean genotypes. However, minimum contribution was given by plant biomass therefore this trait should be given least importance.

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