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Yield and Quality Traits of Soybean Cultivars Response to Different Planting Windows

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Abstract: The field experiment was attempted to figure out the time of sowing for diverse cultivars of soybean in the agro-ecological environment of Charsadda, Khyberpakhtunkhwa. Experiment composed of planting windows (14th March, 21st March, 28th March, 4th April and 11th April) and two varieties (Swat-84 and Williams-82). The experiment was arranged in randomized complete block design with split plot adjustment having sowing windows in the main plot and genotypes in the subplot and replicated thrice. The data have been compiled on the number of pods per plant, the number of seeds per plant, height of the plants, 1000-weight of the seed, seed yield, biomass performance, protein content and oil percent. The statistical analysis of the data confessed significant differences between the means of attributes at contrasting sowing date treatments. The varieties with early sowing has assembled elevated yield and quality compared to delayed planting dates. The results have declared that a larger number of pods per plant and the number of seeds per plant were produced by 21 March and Williams-82. In the same way, the utmost seed yield (1648.10 kg ha^{-1} and 1441.23 kg ha^{-1}) were also registered by 21th March, Williams-82 and 14th March, Williams-82, accordingly. Therefore, 21th March plantation was the outstanding for elevated yield of soybean. Whereas, among the two varieties Williams-82 proved the best results in Charsadda.

Keywords: Planting Windows, Quality, Soybean Cultivar, Seed Yield

1. Introduction

The soybean is standardized more as an oil seed crop than as a pulse. It encompasses 40-42% protein and 18-20% of oil content (Devi et al., 2012). Due to its great dietetic value there is an elevating request for food made with soy for instance the soy milk, the soybean sprouts, soy nuts, several types of tofu, cottage cheese and curd (Rao et al., 2002). In Pakistan, the seed performance of soybean is very stumpy related to its potential for yield and the average of the world. In spite of many uses, poor performance of soybean on the field has declined its attractiveness among the Pakistani farmers because there is an absence of concentration for the growing of edible oilseed among the growers. There are numerous dynamics restraining the production of soybeans for famers. Among these factors: asymmetrical planting phase, climate unpredictability, low percentage of germination of seeds, poor quality and the Irrigation scarcity. Analyzing the soybean varietal and agronomic blemishes can advantage us to bond this gap. Rapid germination and even crop stands are crucial for attaining greater yield (Yari et al., 2010). Another probable reason for the truncated production is the non-adoption of new cultivars established with extra nutrition requirements. The planting of the soybean varieties of elevated yield potential at prime planting time is deliberated an approach of hope to upsurge the production of soybeans. Choice of varieties plays a large role in the escalation of soybean production. In general, the planting time diverges according to the climatic situations of the region and the cultivar to be cultivated. The different varieties of soybeans are sensitive to changes in the environmental conditions where the crop is planted. Therefore, it is also obligatory to study the genotype × environment

interaction to recognize the varieties which are stable in different environments (Calvino et al., 2003a). Earlier studies have demonstrated that the early or delayed sowing has diminished significantly the performance of crops (Rehan, 2002).

Date of planting is the variable which has the most imperative effect on yield of crop (Calvino et al., 2003a, b). A good management of the soybean by the planting date is a tremendous approach to increase both the performance of crop and economic remunerations. The effects of the time of planting on the performance of the soybean and other characters varied with the localities (Naeve et al., 2004). The environmental circumstances concomitant with late sowing affect the features of crop associated to the seizure of the radiation and distributing of the crop assets. These comprises less vegetative growth (Board et al., 1992), the shorter shoots (Boquet, 1990); the lower reproductive nodes (Board et al., 1999), and the restriction in the phases of reproduction (SlaferKantolic and, 2001). In the spring grown sole crops of soybean, the yield is more sensitive to nutritional problems and deficits in water during the end of the flowering and the filling of the grain, and the number of grains is the foremost component of yield involved in this response (Andriani et al., 1991). Late planting generally moves reproductive growth into the less auspicious conditions with the tinier days and sunshine and lower temperature (Egli and Bruening, 2000). In a simulation study, Egli and Bruening (1992) have establish that the reduction of radiation and temperature accounted for the major part of the decrease in yield related with the delayed planting in well-watered soybean crops to grasp maturity in the late season. CROPGRO-soybean model can be used to mimic the growth and development of the soybean. In order to determine the best time for planting of soybeans, CROPGRO soybean model from the DSSAT (a decision support system for the Agro-technology transfer) of the United States might be regulated. The objective of our study was to assess the effect of sowing time and varieties on the performance e and quality aspects of the soybeans in the agro-ecological conditions of Charsadda (Pakistan).

2. Materials and Methods

In order to assess the effects of various planting windows and the cultivars on numerous yield and quality attributed to soybean, a split plot experiment grounded on the randomized complete block design with three replicates was directed in the Agriculture Research Station Harichand, Charsadda, Pakistan (34° 8' 43'' North, 71° 43' 53''East, and 282 m above the sea level) during the year 2015. Due to a great evapotranspiration, Charsadda has a semi-arid climate with average annual precipitation of about 200 mm. The soil of the experimental station was a sandy clay loam with the proportion of sand, silt and clay as 51.15, 22.50 and 26.35%. The pH of the soil was 7.8 and EC0.96 dSm^{-1}, respectively. The content or percentage of organic matter, total nitrogen, phosphorus and potassium were 0.69, 0.067%, 14 and 188 mg kg^{-1}, respectively. The bulk density and the cation exchange capacity was 1.45g CC-1 and 4.4 cmol kg^{-1} respectively. Five dates of plantation, comprising 14th March, 21st March, 28th March, 4th April and 11th April (T1, T2, T3, T4 and T5, respectively) have been deliberated as main plots and cultivars comprising Swat-84 and Williams-82(V1 and V2, respectively) have also been considered as sub- plots.

Their details are as given below:

Factor A: (Main plot)

Planting windows

T1 = 14th March

T2 = 21st March

T3 = 28th March

T4 = 4th April

T5 = 11th April

Factor B: (Sub plot)

1. Swat-84
2. Williams-82

Each sub-plot was composed of six rows of 6 m long and 30 cm at distance. Whereas, the distance between the plants on each line was 5 cm. Management factors of crop like the preparation of the land, fertilizer, and fight against the weeds have been followed as acclaimed for local area. All the measures for the protection of plants have been implemented to make the crop free from insects. The data were documented on ten plants selected at random from each entry of each replication for number of pods per plant, the number of seeds per plant, the height of the plants, 1000-seed weight, seed yield and biomass yield has been noted. The protein and the oil content of the seed of soybean have been achieved by using the method of Kjeldahl and method of Rooskhvisky, respectively. The data were scrutinized statistical using the analysis of variance of Fisher's technique and least significant difference (LSD) test at the 5% level of probability (Steel et al., 1997).

3. Results and Discussion

Data analysis showed that the yield and the quality parameters were significantly ($p \leq 0.05$) affected by different of planting windows. However, the feedback of diverse cultivars differ only for number of pods per plant, the number of seeds per plant, the height of the plants and seed yield. The interaction between these two factors was also non-significant for all the characters noted.

3.1. Pods per Plant

Concerning the number of pods per plant our results showed a diminution with delay in the sowing period (Table 1). The highest number of pods per plant (30.53) was recorded by planting date 21st March. As regards diverse cultivars, Williams-82 produced considerably more pods per plant (22.79) as compares to Swat-84 (21.19). These results correspond to the findings of Ahmed et al. (2010) on the soybean pods. In alternative experiment Ahmed et al. (2008) have also observed the similar results. The number of pods per plant was significantly affected by the genotype (Hwang, 1998).

Table 1. *Influence of various planting windows on yield and quality traits of soybean cultivars.*

Treatment	Number of pods per plant	Number of seeds per plant	Plant height (cm)	1000-seed weight (g)	Seed yield (kg ha^{-1})	Biomass yield (kg ha^{1})	Protein percentage	Oil percentage (%)
Variety								
Swat-84	21.19b	54.58b	77.16b	71.63	1122.9b	4166.7	33.61	20.84
Williams-82	22.79a	59.72a	81.83a	71.96	1229.0a	4222.3	33.98	21.10
LSD	1.03	2.28	3.75	NS	103.22	NS	NS	NS
Planting windows								
T1 = 14th March	22.97b	58.81b	92.13a	72.85ab	1414.3a	4309.0ab	32.65c	21.90a
T2 = 21st March	30.53a	82.23a	97.23a	75.79a	1531.2a	4431.5a	33.57b	21.60ab
T3 = 28th March	22.43b	58.95b	79.77b	72.48b	1194.8b	4188.0bc	33.92ab	21.05bc
T4 = 4th April	20.10b	51.04c	66.83c	70.88b	930.8c	4093.8cd	34.53a	20.37cd
T5 = 11th April	13.90c	34.73d	61.50c	66.97c	808.7c	3950.3d	34.32a	19.92d
LSD	3.44	3.97	6.44	3.14	175.69	204.90	0.64	0.77
Interaction	NS	NS	NS	NS	NS	NS	NS	NS

The columns carrying same letter are statistically non-significant at P≤0.05. NS = Non-significant

3.2. Number of Seeds Per Plant

Data analysis revealed that the highest seed number per plant (82.23) was noted in the plots cultivated on 21st March (Table 1). These results are very similar to the findings of Calvino et al. (2003b) who have registered an increase in the number of seeds per plant in early seeding as compared to the delayed planting. In the cultivar, the elevated number of seeds per plant 59.72 has been noted in the Williams-82. There was also a lot of variance between the size and the weight of the seeds at the early and delayed the planting. These results are relatively in line with the conclusions of Lee and Hwang (1998), who described that the number of seeds per plant was significantly affected by the genotype.

3.3. Plant Height (cm)

Height of plant characterizes the phenology and growth of the crops. The height of the plant has been considerably affected by different planting windows (Table 1). March 21 plantation produces significantly larger plants 97.23 cm than all the other treatments. Similarly, among the two varieties Williams-82 produced 81.83 cm statistically higher plants against significantly the shortest plants 77.16 cm for Swat-84. The greater plant height documented in 21st March was possibly due to relatively more long period of growth with the optimal environmental conditions. These results are consistent with those of noted by Wade and Johnston (1975), which indicated that the sensitivity to photoperiod has noticeable reduction in the period of growth due to the late seeding could account of the decline in the height of the plant.

3.4. 1000-Seed Weight (g)

The planting time treatments exhibited that the extreme 1000 seeds weight of 75.79 (g) soybean was documented in T2 (21st March), which was statistically similar with T1 (72.85), when the planting was ended on 14th March (Table 1). These two treatments were statistically similar with each other against the least weight of 1000 seeds (66.97 g) has been detected in T5 (11th April). This situation could be due to the short period of vegetative growth and long period of filling of the grain and ripening that significantly upturned the weight of 1000 seeds. These results are in concomitant with Pedersen and Lauer (2004), in the case of soybeans, which demonstrated that the average weight of the seeds of early sowing has been higher than that of the late planting. The early varieties planted have acquired more time and the growth period to accrue more photo-assimilates. In addition, high temperature caused contracting of seeds during the delayed planting. There was statistically comparable performance of two varieties Williams-82 and Swat-84 with 1000 seeds weight of (71.96 g) and (71.63 g), respectively (Table 1). The deferral in planting time from 21st March induced a decline in the weight of the seeds. The performance of the seed is affected by the weight of the seeds. These results correspond to the conclusions of Adeniyan and Ayoola (2007). However, the interactive effect of cultivars and the planting windows was non-significant.

3.5. Seed Yield

The seed yield of soybeans has been significantly ($p \leq 0.05$) affected by different planting windows and cultivars (Table 1). Maximum seed yield 1531.2 kg ha^{-1} was reached in 21st March sowing which was statistically in line with the performance of the 14th March, but significantly superior than the rest of the planting windows. Elevated seed yield in T2 can be due to a larger leaf area closely linked to Kumudini et al.(2001) stated that a better leaf surface improved the performance of grain because of the increase in the interception of solar radiation and the improved exchange rate of carbon. The cultivars Williams-82 have produced significantly more seed yield of 1229 kgha^{-1} compared to Swat-84 1122.9 kg ha^{-1}. These findings are in agreement with results showed by Evans (1996), who demonstrated that the genotypes had a significant effect on performance of seeds. Our results suggested that delayed planting dates of soybeans after March, induced a considerable performance losses as a result of decline in vegetative and reproductive growth. Delayed planting due to the loss of appropriate time for growth, the plant has not been reached its potential capacity

because the interception of the light and the crop simulates partitioning were seriously affected and therefore cause the decline in the yield. In the case of untimely planting there is more time for the growth of plants in the optimum conditions of temperature and humidity; seed yield rising is rational. With the delayed planting the growth period becomes short. Elevated temperature during flowering diminishes the seed yield and components of the yield of the soybean. In a further, studies the late planting lessen the yield (Kane et al., 1997; Board et al., 1999; Egli and Bruening Kantolic, 2000; and Slafer, 2001). Similar results have been registered with the delayed planting by Ahmed et al. (2010), Calvino et al. (2003) and Ngalamu et al. (2012).

3.6. Biomass Yield

The analysis of the data exposed that biological performance of soybeans was significantly inclined by diverse sowing dates. Late planting of soybeans after March led to severe decline in biomass over time. Among the five dates of plantation, the soybeans produced significantly more biomass yield of 4432 and 4308 kg ha^{-1} with T2 and T1, respectively, beside the lowest T5 (3950.3 kg ha^{-1}) (Table 1). On the other hand, no significant difference between the cultivar swat-84 and Williams-82 with respect to soybeans biological performance has been registered (Table 1). The same results were registered with the delayed planting by Ngalamu et al. (2012), Ahmed et al. (2010) and Calvino et al. (2003) in the framework of their experiments.

3.7. Protein Contents (%)

The analysis of the data (Table 1) showed that the concentration of the protein of soybeans has been significantly affected by planting windows. Untimely planted soybeans (T1: 14thMarch) generate the seed with low protein content of 32.65%. On the other hand, the protein content was augmented with late sowing as delayed planted (T4) crop has given 34.53 utmost protein percentage which was analogous withT5 (34.32%). This ceiling protein percentage could be due to the most favorable temperature during seed development and maturity. While the lesser percentage with the crop sown early was due to the effect of environmental factors, such as elevated temperature and the photoperiod at the maturation. No considerable difference was observed between the cultivars concerning percent protein. These results are in agreement with those noted by Khan et al.,(2001), who mentioned that the protein contents in crops sown late were higher than the crops sown early. The results are also compared with the results of Moosavi et al., (2011).

3.8. Oil Percentage

The results in terms of the percentage of oil in the soya beans revealed that there was significant difference between the effects of the different planting windows on this attribute. Although, no significant difference was documented in the different cultivars. Interactive impact of these two factors was also non-significant (Table 1). Elevated percentage of oil has been noted in T1 (21.90%) followed by T2, T3 and T4 which were statistically at similar with each other. Delay in the planting diminish in the concentration of oil and the seeds harvested from T5produced lowest percentage of oil 19.92% statistically at T4. The seeds harvested from untimely sowing evolved and matured at high temperature which resulted in highest percentage of oil compared to crops sown late. Suryavashi et al. (1993) and Wolf et al. (1982) have demonstrated more oil content from seeds mature at elevated temperature that the seeds mature at low temperature. Nishioka and Okumura (2008) have also accomplished related results and recommended that the boosted in the oil content at early sowing. Hu and Waitrak (2012) has described that the towering temperature coupled with a delay in the plantation may have a depressive effect on the quality and performance of soybean seeds by changing the protein and oil content. Sowing methods affected the percentage of oil and the utmost oil percentage was established in early sowing Calvino et al. (2003a).

4. Conclusion

From this study, it is accomplished that early seeding of soybean (14th March) is more convenient in terms of elevated yield to that sown delayed in agro-ecological environment of Charsadda. In these conditions, the variety Williams-82 appear more appropriate than Swat-84, as it exceeded concerning the production.

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