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RESEARCH ARTICLE

Establishment of procedure to evaluate soybean for various temperature regimes at seedling stage

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ABSTRACT

Soybean is a legume crop and it has importance for both of its products, bean and oil. The bean of soybean contains many sorts of minerals and vitamins, while Soy oil contains various dietary minerals and used for various raw use and cooking purposes. To identify the optimum temperature of soybean plant germination and adaptive variety for Pakistani regions, a seedling stage experiment was conducted in the chickpea laboratory of University of Agriculture Faisalabad, Pakistan. Basic purpose of this experiment was to establish the procedure for soybean cultivation to gain profitable yield and it was carried to focus on growth and development in both shoot and roots of the plant sown in specific temperature. Controlled uniform conditions of two different temperature treatments i.e., 25°C and 30°C were maintained and four local genotypes (NARC, Faisal, Ajmeri and Rawal-1) were used. These genotypes showed improved extensive shoot morphology of the plant, while the root morphology remained unaffected.

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INTRODUCTION

Soybean (*Glycine max* L.), is the most important oil seed crop of the world, contributes 25% of world's edible oil consumption. It has 16-20% oil content and 40-42% proteins. Soybean is also called king of beans. It fulfills one third of protein need of the world. Seed vigor always has a great importance in terms of plant's ultimate potential (Tekrony et al., 1987). Soybean can be cultivated in both seasons that is Feb-June and July-Oct. Hoeft et al., (2000) described 30˚C is the optimum temperature for soybean germination.

The germination and emergence in Feb-June are extensively affected by low temperature and moisture content because respiration of mitochondria, expanding ability of embryo and imbibition rate significantly affected by low temperature. High temperature causes damage in reproductive growth as well as decrease in potential of yield. High temperature affects the germination of soybean (Boakye and Hume, 1975; Heatherly et al., 1998; Tacarindua et al., 2013; Hatfield et al., 2015).

Selection of best suitable genotype with production method under best suited environmental condition is the key of desired and profitable production of soybean (Ashlock, et al., 2000; Heatherly et al., 1998). The Objective of present investigation was to determine the optimum level of temperature for soybean germination and to achieve the optimum germination temperature for adaptive varieties of the Pakistan and these findings will also help the scientists in evaluation in those area having similar environmental conditions like Pakistan.

MATERIALS AND METHODS

The aim of conducting the experiment in lab conditions was to evaluate high temperature and low temperature tolerant soybean plants. The experiment was designed in CRD and four local genotypes of *Glycine max* L were used named as, NARC, Faisal, Ajmeri and Rawal-1. Seeds of these four genotypes were divided into two group each having three replications for two temperature treatment that i.e., 25˚C and 30˚C. Sand was used as growth medium.

Ethanol treatment

To avoid any contamination the soybean seeds are treated with 70% ethanol with slightly shaking for about 10 minutes and the seeds were finally washed with distilled water. The washed seeds were placed on the paper towel which were soaked well in water.

Sowing of seeds

Plastic tubes are filled with sand which was used as growth medium and soaked seeds were sown in tubes and divided them in two groups for different temperature treatment.

Germination chamber

Germination chamber are used to provide uniform treatment effect and both groups of test tubes were placed separately under 25°C and 30°C temperature and standard humidity was maintained. After seven days of germination the seeds from controlled chamber were examined for observation shoot and root morphological traits.

Data analysis

In the experiment three replications were used for each group of temperature treatment. Collected data were analyzed through Statistix 8.1 software (2003). ANOVA results showed significant results for morphological parameters except root fresh weight. Data were subjected for correlation analysis to determine the relationship between parameters (Fakorede and Opeke 1985). Correlation analysis is used to study the association between two variables, it gives results either positive or negative and sometimes it describes there is no relationship at all. Correlation analysis plays very important role in selection of best genotype. Breeding components are reliable when results come in favors of positive relationship. Selection of best genotype become tricky when there is negative relationship among traits (Nemati et al., 2009). Correlation coefficients considered important in indirect selection of best genotypes in breeding program as it tells about the genetic relationship as well as degree of relationship and non-genetic relationship between two variables (Hallauer and Miranda 1981).

RESULTS AND DISCUSSION

Soybean is considered as more valuable crop, but growth is affected by low as well as high temperature and it cause ultimate reduction in production. So, there is need to make breeding steps to evaluated

soybean against various temperature stress to develop tolerant variety as the Pakistan' s temperature is not most suitable for soybean production as compared to other countries. Analysis of current study showed significant differences in root fresh weight, relative seedling length and relative shoot length for temperature treatments (Table 1). Significant relative values for seedling length and shoot length strongly suggest that these two parameters are affected by variation in temperature. Raw data indicates that increase in temperature from 25 ˚C to 30 ˚C tends to increase the seedling length and shoot length (Table 4). Increase in temperature increases the photosynthetic activity that ultimately results in seedling growth so it considered as warm season crop. Low temperature cause reduction in growth due to chilling effect. Chilling damage was mostly observed at the time of seedling emergence and germination period that may cause death of seedling. Shoot fresh weight being non-significant and RShL being significant indicates that by increasing temperature, plant adopts such strategy that whole biomass produced by the plant remains same but seedling length increases (Gilman et al., 1973; Hatfield and Egli, 1974; Hatfield and Prueger 2015).

Table 1. Analysis of Variance of some polygenic traits at different temperature treatments

Parameters	F-VALUES
Root fresh weight	8.32^{*}
Relative root length	3.96^{NS}
Relative seedling length	24.1^{**}
Relative Shoot length	16.5^{**}
Shoot fresh weight	0.45^{NS}

The study was showed shoot growth was more affected at low temperature treatment as compare to high temperature (Table 2). So, results are in favors of soybean production after May (July-Oct). Root fresh weight (RFW) decreases by increase in temperature. No significant variation in relative root length and shoot weight was observed that suggests that increase in temperature does not affect the root morphology (Table 1). Root characteristics are less studied in soybean as compare to other major crops like cotton, maize and rice but scientists suggested that hydraulic conductivity is more sensitive (Khan et al., 2016; Alsajri et al., 2019).

Table 2. Effect of temperature on Length and fresh weight of Root and Shoot of 1 Week old *Glycine max* L. Seedlings

Temperature/ Treatments (˚C)	Mean seedling length (cm)	Mean Shoot Length(cm)	Mean Root Length (cm)	Mean Root Fresh Weight (g)	Mean Shoot Fresh Weight(g)
25	20.62	12.00	8.50	0.34	0.62
30	25.64	14.16	11.59	0.27	0.79

Root length, shoot length and seedling length showed a positive correlation at both 25˚C and 30°C. Rest showed a medium positive and some negative correlation at 25˚C while at 30˚C, root fresh weight showed positive correlation with root length (Table 3). The effect of temperature treatments on individual genotype has been shown in Table 4. NARC II is showing a great influence on every parameter due to temperature variation while Faisal and Ajmeri are almost stable. Rawal-1 is showing an increase in every parameter at 30˚C. Khaled et al. (2011) explained that soybean plantation in June increase the lateral roots which contribute positively in root biomass. This is in favors of high temperature plantation.

Table 3. Pearson correlation analysis for soybean seed growth at varied temperatures

@ 25°C	RFW	RL	SL	SFW
RL	-0.4045			
SL	-0.4443	0.9837*		
SFW	-0.1821	0.1732	0.3454	
ShL	-0.4414	0.8921*	0.9586*	0.5984
@ 30°C				

RL	0.9671*			
SL	0.9640*	0.9999*		
SFW	0.1104	0.0377	0.0463	
ShL	0.9920*	0.9845*	0.9816*	0.0077

Table 4. Mean values of various *Glycine max* L. parameters at varied temperature effect

Temperature	Varieties/ Parameters	NARC II	FAISAL	AJMERI	RAWAL-1
	SL (cm)	17.24	25.16	22.86	17.21
	ShL(cm)	6.92	14.77	12.30	10.63
@ 25˚C	RL (cm)	10.31	10.41	10.08	6.58
	RFW(g)	0.09	0.20	0.16	0.07
	SFW(g)	0.58	0.76	0.51	0.64
	SL (cm)	30.19	29.58	21.50	21.30
	ShL(cm)	14.68	15.14	13.33	12.66
@ 30˚C	RL (cm)	15.50	14.19	8.87	8.63
	RFW(g)	0.29	0.29	0.25	0.23
	SFW(g)	0.72	0.87	0.80	0.78

SL = Seedling length; ShL = Shoot length; RL = Root length; RFW = Root fresh weight; SFW = Shoot fresh weight

CONCLUSION

Low and high temperatures have a significant impact on soybean seedling emergence. Low temperatures hampered soybean seedling growth and development more than high temperatures, which was observed across all cultivars. Tolerance level of a cultivar can be supposed by observing the morphological changing in studied parameters. Seedling length and shoot length show highly significant variation at different temperatures. Hence, these parameters should be kept in mind while screening soybean Germplasm for temperature tolerance. The cultivars Faisal and Ajmeri showed little variation in the length and shoot length parameters under both the temperature regimes, and they can be used as temperature tolerant cultivars in the breeding programs. However, there is need to make more studies to get enough information for the understanding of root system under stress condition and the identification of yield contributing parameters of soybean. There is also need of more breeding program for exploitation and development of tolerant varieties with high production level.

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