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Genotypic and phenotypic correlation studies on ten black gram genotypes under moisture deficit situation

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Abstract
Black gram (*Vigna mungo* L. Hepper) is an important food legume and it has high nutritive value with 24-26% protein. Black gram production is affected by various abiotic and biotic constraints which penalize seed yields. Among them, drought is known to cause the substantial reduction in the seed yield of the crop. This study was conducted to evaluate black gram genotypes for genetic parameters and drought tolerance. A total of 10 black gram genotypes were studied under moisture stress and non-stress situations in pot experiments at Assam Agricultural University during 2015. A complete randomized design with three replications was used. Analysis of genotypic and phenotypic correlation revealed that there was the significant positive correlation between seed yield with cluster per plant, leaf area, chlorophyll content, seeds per pod and pods per plant. It was also found that the correlations between seed yield with the number of days to 50% flowering and proline content were negative and significant. Characters like chlorophyll content, pods per plant and seeds per pod showed the significant correlation in both moisture stress and non-stress situation. However, further testing of these genotypes in the field conditions under both situations is required to assess the real worth of the genotypes.

Keywords: genotypic correlation, phenotypic correlation and stress and non-stress environments

Introduction
Black gram (*Vigna mungo* L. Hepper) is an important food legume and it has high nutritive value with 24-26% protein. Lack of suitable genotypes with adaptation to the environmental condition like water deficit conditions are the factors affecting black gram production. More than 87% of the area under pulses is presently rainfed and moisture stress is the main reason for crop failure or for low yield. Water deficit stress, at flowering and post-flowering stages of pulse crop, has been found to have a greater adverse impact than at the vegetative stage. (Cortes and suidana, 1986, Baranisrinivasm, 2011) [7, 3]. Improved variety of different pulses crops hold premise to increase productivity by 20-25% (Ali and Gupta, 2012) [1]. An understanding of genotypic difference to water deficit stress can help in identifying cultivars that can tolerate drought with reasonable grain yield. Black gram is a perfect combination of all nutrients which include 20-25% of proteins, 40-70% of starch along with ash, fats, carbohydrates and essential vitamins. Plant growth and development of black gram are greatly influenced by various environmental factors such as temperature, light, water and nutrient availability (Borah, 1994) [6]. Under abiotic stress conditions, where the variation of above factors affect plant growth and development adversely resulting in the reduction of crop yield. Water is a primary input not only in enhancing the crop production but also involved directly changes the morphological characters of plants. Water deficit stress is the most important abiotic stresses which affect the physiological parameters and crop yield. These abiotic and biotic stresses bring changes in yield due to physiological, biochemical parameters from a mild to the larger extent (Baroowa and Gogoi, 2012, 2013) [4, 5]. The predicted global climatic changes such as increased temperature changes in rainfall pattern and the consequent availability of water to crops at critical growth stages are to affect the crop productivity in general pulse crops in particular (Ali and Gupta, 2012) [1]. Breeding for drought resistance is very complex because of stress environments are intrinsically erratic in nature and the success

of the cultivars is not predictable. However, the development of resistant cultivars is hampered by low heritability for drought tolerance and a lack of effective selection strategies (Kirigwi *et al*., 2004). Therefore, seed yield and its components remain as the major selection criteria for improved adaptation to a stressful environment in many breeding programs. Selection for drought resistance and production of tolerant cultivars with high yield potential is the main objective of breeding programmers. However, an alternative breeding approach would be to improve drought resistance in high-yielding genotypes through the incorporation of morphological and physiological mechanisms of drought resistance. Many physiological processes associated with crop growth and development is reported to be influenced by water deficits. In order to identify sources of drought tolerance, it is in order to identify sources of drought tolerance; it is necessary to develop selection and screening methods that are simple and reproducible under the target environmental conditions. The relative yield performance of genotypes in drought-stressed and more favourable environments seem to be a common starting point in the identification of genotypes related to drought tolerance and the selection of genotypes. The investigation, efforts have been made to quantify the relative performance of various yield attributing traits that determine seed yield in black gram genotypes under soil moisture stress.

Methodology

The experiment was conducted with ten black gram genotypes which were collected from the Regional Agricultural Research Station, Shillongoni, Nagaon, Assam Agricultural University, Jorhat. The experimental site is situated at 26º47/ N latitude, 94º12/ E longitude having an elevation of 86.6 m above mean sea level. The mean maximum and minimum temperature during the crop growing period ranged from 26.8 to 33.4 °C and 11.5 to 25.2 °C, respectively. The weekly average relative humidity during the morning hour ranged from 87 to 98 percent and in evening ranged from 58 to 81 percent. The lowest sunshine hours per day were obtained during the first week of September while the highest was recorded during the second week of December. The experiment was laid out in Complete Randomized Design (CRD) with three replications and two treatments. Ten varieties were considered for studies (T1 = Non-stress, T2 = Moisture stress). The experiment was conducted in the shade net house of Plant Breeding and Genetics Department of Assam Agricultural University, Jorhat in September-November, 2015. The fine soil was used to germinate the black gram seeds of different varieties in the plastic pots (28 cm height and 30 cm in diameter) filled with a mixture of soil and vermin-compost (80:20). Two moisture regimes were selected as treatment (T1-Non-stress or control and T2-Moisture stress). Control regime was watered every 7-10 day throughout the growing season till harvest time. Moisture stress was created in this rain-free environment by withholding irrigation after 15 days from sowing and giving supplementary irrigations every three weeks. Soil moisture was monitored via the gravimetric method and the control treatment (well- watered) received 13%-17% soil moisture content, while the drought experiment (severe stress) received 3%-6% soil moisture content. Soil moisture content was measured using gravimetric method (Dastane, 1972) [8]. The average moisture content of soil ranging from 14-16 percent under the irrigated condition and it was maintained between 4-6 percent under moisture stress condition during crop growth period. (Fig. 1). Seeds were planted at a depth of 2-3 cm on 9th September 2015. After planting, seeds were covered by fine soils. Harvesting of pods was done from 10th December to 12th December when pods attained maturity stage.

Observations Recorded

The following morpho-physiological parameters were recorded and the data thus obtained were used for computation of the mean value are plant height, days to first flowering, days to 50 % flowering, number of branches per plant, number of clusters per plant, number of pods plant, Pod length, number of seeds per pod, hundred Seed weight, seed yield per plant, leaf area (cm2), chlorophyll content, proline content and relative leaf water content.

Table 1: Name of genotype details with parentages

S. No.	Name of genotype	Parentages
1	AKU 10-6	TAU 2*Pant U-31
2	MU 44	Biswas x BDU 1
3	COBG 10-06	COBG 671 x ADT 5
4	VBG 11-31	ADT 5 x *vigna sylvestris*
5	VBG 11-31	U 4157 x PDB 88-31
6	SBC 40	SB 121 x PU 30
7	PU 11-14	PU-19 x KU 303
8	NDUK 13-4	NDU 25-5 x Azad 1
9	MU 06	Local sel. x T 9
10	AKU 11-8	TAU-1 x Mash 1008

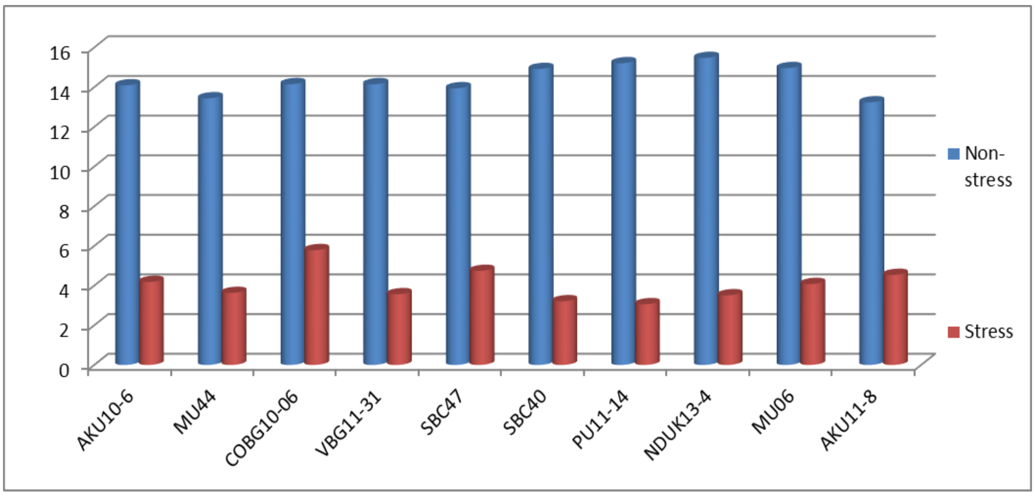

Fig 1: Average Soil Moisture Content

Statistical procedures

The correlation coefficients among various parameters at genotypic and phenotypic levels were calculated. Data were subjected to analysis of covariance and the respective correlation coefficients were computed using the following formula:

Genotypic correlation coefficient (r_{gxy}) $\frac{\sigma_{gxy}}{\sqrt{\sigma^2_{gx} \times \sigma^2_{gy}}}$

Where,
σ_{gxy} = Genotypic covariance between X and Y
σ^2_{gx} = Genotypic variance of X
σ^2_{gy} = Genotypic variance of Y

Phenotypic correlation coefficient (r_{pxy}) = $\frac{\sigma_{pxy}}{\sqrt{\sigma^2_{px} \times \sigma^2_{py}}}$

Where,
σ_{pxy} = Phenotypic covariance between X and Y
σ^2_{px} = Phenotypic variance of X
σ^2_{py} = Phenotypic variance of Y

The genotypic and phenotypic correlation coefficients were tested for significance by using'‘t’ tests as follows:

$$t = \frac{r}{\sqrt{(1-r^2)}} \times \sqrt{n-2} \text{ with } (n-2) \text{ d.f.}$$

Result and Discussion

The investigation an attempt was made to study interrelationship among yield and yield attributing character at genotypic and phenotypic levels. Genotypic and phenotypic correlation coefficients between different pairs of character including seed yield per plant are presented in table 1 and 2.

A Significant and positive correlation of seed yield was found with leaf area, chlorophyll content, seeds per pod and pods per plant under both moisture stress and non-stress situations. These indicated that improvement in seed yield could be made through improving characters like the number of pods per plant, seeds per pod, leaf area and chlorophyll content. Million Eshete *et al*. (2005) [10] found that the number of pods per plant and number of seeds per plant showed significant and positive association with seed yield under non-stress and water stress situations. Since the comparative analysis of nature of associations among different traits under stress and non-stress situations in black gram is limited, the present findings were compared with other pulse crop results. Toker (2004) [12, 13] also reported that biological yield and number of pods per plant were positively correlated with seed yield in chickpea under well watered condition. Toker and Cagirgan (2004) [12, 13] concluded biological yield and harvest index as the most important selection criteria because of their close relationship with seed yield. On the other hand, negative and significant correlations were found between days to 50% flowering and seed yield per plant under non-stress and stress situations. These results suggested that the selection of plants that take less number of days to flower would increase seed yield per plant. This finding is consistent with other findings in chickpea (Arshad *et al*., 2004; Toker, 2004; Rehman, 2009) [2, 12, 13, 11] who found the negative association between days to 50% flowering and seed yield per plant. Similarly, Proline content and 100 seed weight also showed the negative association with seed yield per plant. These findings consistent with other findings in wheat (Malik *et al*., 2010) [9] who found the negative association between proline content and seed yield per plant and they concluded that genotypes with high proline content are susceptible to drought stress, maybe, these susceptible genotype increase proline content to obtain high tolerance in stress situation.

Conclusion

The pot evaluation of the genotypes was carried out in the shade net house of Plant Breeding and Genetics of Assam Agricultural University during September 2015 to December, 2015 by showing the black gram seed under two moisture situations, one under the non-stress condition and other under drought condition. Good associations were found between seed yield and its components, like chlorophyll content, pods per plant and seeds per pod in both moisture stress and non-stress situation. Therefore, it is concluded that this trait can be used as primary selection criteria for improving black gram seed yield stability in high and low moisture level environments.

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