EFFECTS OF WATER STRESS ON YIELD ATTRIBUTES AND YIELD OF DIFFERENT MUNGBEAN GENOTYPES

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Accepted for publication: 12 January 2010

ABSTRACT

Hossain, M. B., Rahman, M. W., Rahman M. N., Anwar, A.H.M. N. and Hossen, A.K.M.M. 2010. *Effects of water stress on yield attributes and yield of different Mungbean genotypes.* int. J. Sustain. Crop Prod. 5(1)19-24.

A field experiment was conducted at the experimental field of Bangabandhu Shiekh Mujibur Rahman Agricultural University, Gazipur during April to June 2004 to characterize different plant parameters related to yield performance of twenty seven Mungbean (*Vigna radiata* L.) genotypes under water stress condition. A wide diversity among the genotypes in their physio-morphological characters including yield was recorded. Genotypes varied from 26.67 to 34.0 days to initiate first flower. They differed remarkably in producing seed yield (g/plant) and the difference in yield was attributed due to a great variation in yield attributes. Pods number per plant was highest in GK 37 (29.40) and lowest in GK 27 (8.80). The highest number of seeds per pod was obtained from the genotypes GK 35 (9.52), which was closely followed by GK 30 (9.44), GK 25 (9.27), GK 37 (9.14) and GK 11 (9.00) respectively, while GK 27 (7.39) produced the lowest. The highest seed yield (g /plant) was obtained from GK 37 (10.71g), followed by GK 19 (10.33g) and GK 11 (10.13g). The lowest yielder GK 27 (3.27g) was closely followed by two genotypes, GK 24 (5.87g) and GK 25 (5.92g). Seven genotypes appeared to be intermediate that was about 26% genotypes of the total. The correlation coefficient of variation were high for no. of branches per plant, pods per plant, days to 50% flowering, plant height, seeds per pod as well as seed yield g/plant that indicated a wide variability and better scope for selection.

Keywords: water stress, yield attributes and yield, Mungbean genotypes

INTRODUCTION

Among the pulse crops, Mungbean (*Vigna radiata* L.) has special importance in intensive crop production of the country for its short growing period (Ahmed *et al.*, 1978). Mungbean is the fifth important pulse crop of Bangladesh and it occupies about 43680 ha of land producing 25655 tons of dry grain annually (BBS, 2005). Climatic conditions of Bangladesh favour growth of Mungbean on well-drained soil almost throughout the year, even though its cultivation still remains concentrated mainly in the post monsoon dry season. The crop being normally grown under non-irrigated condition, encounters waters of varying degrees at different growth stages depending on soil moisture condition. The crop is potentially useful in improving cropping pattern as it can be grown as a catch crop due to its rapid growth and early maturing characteristics. It can also fix atmospheric nitrogen Mungbean roots and soil bacteria and thus improves soil fertility. It may play an important role to supplement protein in the cereal-based low-protein diet of the people of Bangladesh, but the acreage and production of Mungbean is steadily declining (BBS, 2005).

Plant performance under conditions of water shortage has been extensively studied. Water stress affects various physiological processes associated with growth, developed and economic yield of a crop (Hsiao and Acevedo, 1974; Begg and Turner, 1976). Water deficit disturbs normal turgor pressure, and the loss of cell turgidity may stop cell enlargement that causes reduced plant growth. Water deficit may change the pattern of growth. Often root shoot ratio increases, leaf area index decreases and the thickness of cell walls and amount of cutinization and lignifications increase by water stress. The pre-monsoon period, however, has erratic rainfall leading to water deficit stress in some years and water logging in others. Water logging affects the emergence, establishment, growth and productivity legume crops (Timsina et al. 1993, 1994). Mungbean is reported to be more susceptible to water deficits than many grain legumes (Pandey *et al*., 1984). Water stress reduces photosynthesis, which are the most important physiological processes that regulate development and productivity of crop plants. A number of researchers reported that reduction in crop photosynthesis and development of water stressed plant is due to reduction in leaf area and dry matter accumulation (Pandey *et al.*, 1984; Kriedemann 1986; Hamid *et al.*, 1990b). Although water stress imposed at any growth stage causes reduction in dry matter but their effects on seed yield differ depending on growth stage when exposed to stress (Agrawal *et al*., 1976). Sadasivan *et al.* (1988) reported that stress during vegetative phase reduce grain yield through reducing plant size, limiting root growth, and leaf area, restricting dry matter accumulation, number of pods and harvest index. Water deficits at the flowering and the post-flowering stages have been found to have a greater adverse impact than at the vegetative stage (Cortes and Suidaria, 1986). The reproductive stage is well known for its sensitivity to drought stress (Brown *et al*., 1985); the seed yield and harvest index being most sensitive to water stress treatment imposed at post flowering and pod development stages (Uprety and Bhatia, 1989). An understanding of genotypic differences to water stress can aid in identifying cultivars that can tolerate drought and produce reasonably high seed yield. The present experiment was conducted to identify yield related parameters under water stress condition those are tightly related to grain yield.

MATERIALS AND METHODS

A field experiment was conducted at the experimental field of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur during the kharif season (April to June 2004). The experimental site is located at the centre of Madhupur Tract (24^o 09' N latitude and 90^o 26' E longitude) having an elevation of 8.2 m from sea level (Anonymous, 1989). The experiment was conducted under rain free shed condition. The field was possible to cover by a moving house made by stainless steel frame and transparent polythene sheet was used as shed. The soil type of the experimental field belongs to the Shallow Red Brown Terrace type under Salna Series of Madhupur Tract (Brammer, 1971; Saheed, 1984) of Agro Ecological Zone (AEZ) 28, which is characterized by silty clay with pH value of 6.5. Twenty seven Mungbean genotypes collected from Asian Vegetables Research and Development Centre (AVRDC), Taiwan were included in the present investigation. The accession numbers of the genotypes were GK 11, GK 13 GK 15, GK 16, GK 17, GK 18, GK 19, GK 22, GK 23, GK 24, GK 25, GK 26, GK 27, GK 28, GK 29, GK 30, GK 32, GK 33, GK 35, GK 37, GK 38, GK 39, GK 40, GK 42, GK 43, GK 45 and GK 47. The sowing was done on 17 April, 2004 with slight watering in the line just to supply sufficient moisture need for quick germination. The fertilizers were applied as per recommendation of Fertilizer Recommendation Guide 1997. At physiological maturity, dry pods were harvested at different days after sowing (DAS) for different genotypes. The data of different physio-morphological, reproductive, seed yield and related attributes were recorded from the present investigation to obtain the precise information pertaining to genotypic differences.

Shoot of five Mungbean plants form each line was carefully separated at mature stage. Fresh weight of fully expanded third trifoliate leaves from the top was taken. The leaf and stem were kept immersed in distilled water for 24 h at room temperature in the dark. The turgid weights of the leaf and stem were then measured. Afterwards the materials were oven-dried at 80^{o}C for 72h to take dry weight. The fresh, turgid and dry weights of the leaf and stem were used to determine relative water content (RWC) of leaf using the following formula.

$$\text{Relative Water Content (RWC)} = \frac{\text{Fresh weight} - \text{dry weight}}{\text{Turgid weight} - \text{dry weight}} \times 100$$

The statistical analysis for various characters under investigation was done and the analysis of variance for each of the characters was performed by F (variance ratio) test. The treatment means were separated by Duncan's New Multiple Range Test (Steel & Torrie, 1960).

RESULTS AND DISCUSSION

Growth characters of Mungbean genotypes

Days to first flowering

In respect of days required first flower, significant differences among the genotypes were observed (Figure1). Genotype GK 27 took minimum days (26.67) to first flower, where as genotypes GK 26 and GK 28 (34.00) took the maximum days. Maximum number of genotypes (19) took 30.33 to 33.00 days, while rest of the genotypes took 28.67 to 30.00 days to attain first flowering stage. The genotypic difference in terms of days required to first presumably flowering stage might be due to genetical factors of genotypes concerned as well as environmental factors.

Days to first pod maturity

Genotypic differences were observed in case of days required to first pod maturity (Figure 1). The genotypes GK 25 and GK 39 took minimum days (42.67) to first pod maturity followed by GK 16 (43.67) and GK 27 (44.67). The maximum days required for the genotype GK 26 (52.33), which was closely followed by GK 24 (51.00) and GK 40 (49.33). It was also appeared from the Figure 1, which around seventy percent of the total genotypes were first harvest within 45 to 50 days after sowing.

Plant height

The genotypes varied enormously in plant height (Figure 2). The longest plant (74.50 cm) was

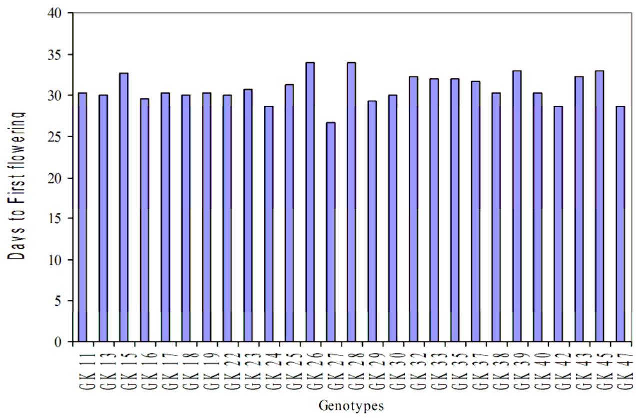


Figure 1. Effect of water stress on days to first flowering in twenty seven Mungbean genotypes

obtained from GK 45 and the lowest (46.90 cm) from GK 27. The appreciating variation was observed in plant height among the genotypes due to difference in genetical constituents as well as environmental effects. The three genotypes namely GK 40, GK 42 and GK 45 performed better in respect to plant height under water stress condition. About 66 per cent of the total genotypes under trial were within 50 to 60 cm. Sadasivam (1988) reported that moisture stress during the vegetative stage reduced plant height in mugbean.

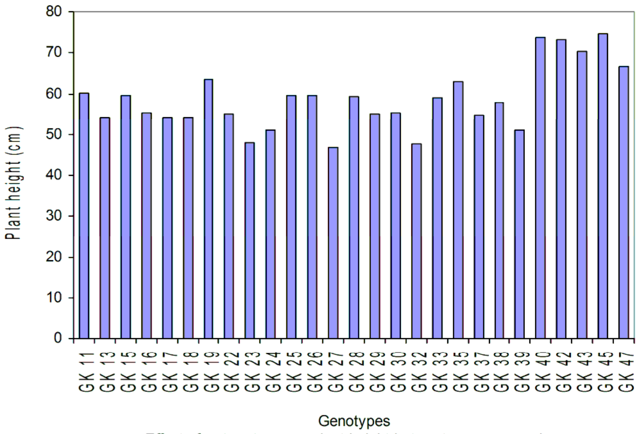


Figure 2. Effect of water stress on plant height in twenty seven mungbean genotypes

Number of branches plant^{-1}

Number of branches plant^{-1} was significant affected by genotypes and that varied from 1.0 to 2.4 (Figure 3). The highest number of branches (2.4) was recorded in GK 26 followed by GK 33, GK 35, GK 37 and GK 45 (2.2) while the lowest was in GK 18, GK 23 and GK 24 (1.0). In respect of number of branches plant^{-1} 72 per cent genotypes produced 1.2 to 2.0 branches. The flowers and pods are directly related to the seed yield of Mungbean. A decrease in number of branches may result in decreased seed yield.

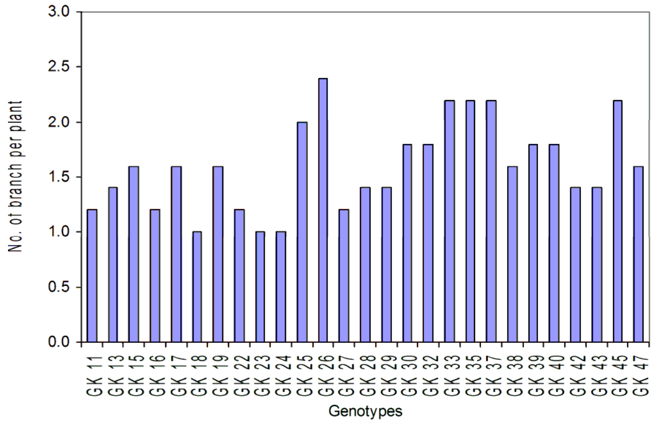


Figure 3. Effect of water stress on number of branch per plant in twenty seven

Yield and Yield contributing characters

Pods plant^{-1}

High variation in from 8.80 to 29.40, number of pods plant $^{-1}$ among the genotypes was observed and varied (Figure 4). The highest number of pods plant^{-1} was produced by genotype GK 37(29.40). Considering the number of pods plant^{-1} three genotypes namely, GK 30 (23.60), GK 39 (23.40) and GK 38 (22.60) were closer, appeared to be intermediate. The genotype GK 27 (8.80) produced the lowest number of pods plant $^{-1}$ which was followed by GK 24 (12.40) and GK 25 (13.00); More than forty four percent of the total genotypes under study (thirteen genotype) had pods plant $^{-1}$ that varied from 15.20 to 20.00. Seven genotypes (25.92%) ranged from 22.20 to 21.40 in terms of pods plant $^{-1}$. The difference in number of pods plant $^{-1}$ among the genotypes under trial was remarkable from practical point of view. Sadasivam *et al*, (1988) reported that stress during vegetative phase reduces grain yield through reducing the number of pods in Mungbean. Hamid *et al* (1990) found a similar result in Mungbean plants due to water stress. Water stress at flowering reduced pod formation, increased pod shedding and decreased grain yield in field bean (Grazesiak *et al*., 1989).

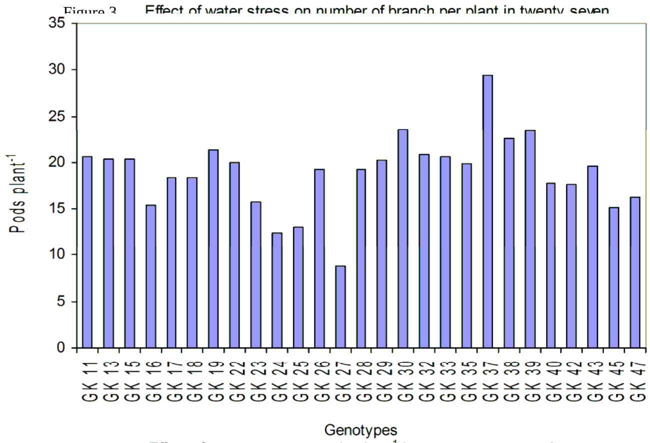


Figure 4. Effect of water stress on pods plant^{-1} in twenty seven mungbean genotypes

Pod Length (cm)

Pod length was significantly affected by genotype and that varied from 6.40 to 8.43 cm (Figure 5). The longest pod (8.43cm) was recorded in GK 15 followed in decreasing order by GK 16 (8.39cm), GK 26 (8.25cm) GK 29 (8.19cm), GK 11 (8.15cm) and GK 47 (8.12cm), while the shortest one was in GK 32 (6.40cm). The pod length in more than fifty

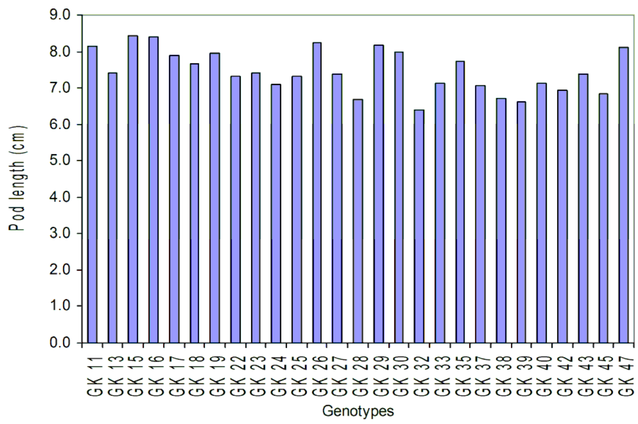


Figure 5. Effect of water stress on Pod length (cm) in twenty seven mungbean genotypes

five percent (fifteen) genotypes varied from 6.40 to 7.50cm. The pod length of rest five genotypes that made about eighteen percent of the total ranged from 7.66 to 7.98 cm. The differences in pod length might be due to the differential genetic configuration of the genotypes.

Seeds pod^{-1}

Seeds per pod were significantly affected by genotypes (Figure 6). The highest number of seeds per pod was obtained from the genotype GK 35 (9.52) which was closely followed by GK 30 (9.44), GK 25 (9.27), GK 37 (9.14) and GK 11 (9.00). The genotype GK 27 (7.39) produced the lowest number of seeds per pod. Among the genotypes three genotypes which include11.11 percent of the total had minor variation number of seeds pod^{-1}, and the ranged was from 7.65 to 7.97. The seeds pod-1 of about 66.66 per cent of the total genotypes (eighteen genotypes) under study varied from 8.06 to 8.96.

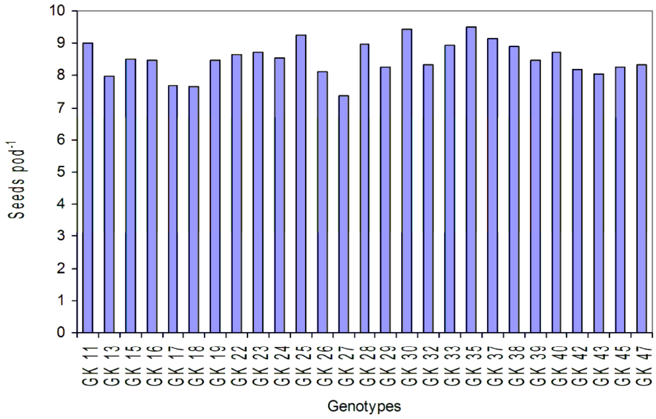
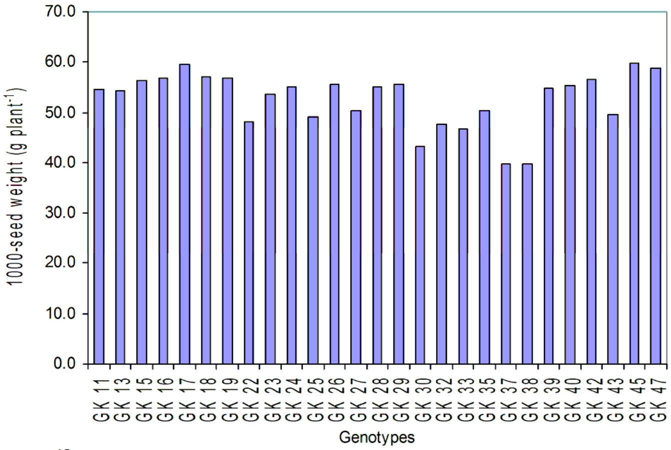


Figure 6. Effect of water stress on seeds pod^{-1} in twenty seven mungbean genotypes

1000 Seed weight (g)

A great deal of genotypic variation in 1000-seed weight was observed (Figure 7) and the range varied from 39.67g to 59.80g. The highest 1000-seed weight was recorded in GK 45(59.80g), which was closely followed by GK 17 (59.50g) and GK 47 (58.90g), The minimum 1000-seed weight was obtained from the genotype GK 38 (39.67g) followed by GK 37 (39.82g) and GK 30 (43.26g). About fifty nine percent of the genotypes under study which made up of sixteen genotypes had the seed size in the range of 50.40 to 57.10g and that in rest of the five genotypes varied from 46.71g to 49.73g. Seed weight is an important attribute that significantly contributes to the final seed yield in legumes.



Seed yield plant $^{-1}$ (g)

Genotypes of Mungbean under investigation had displayed a wide range of variability in respect of seed yield plant^{-1}. It ranged from 3.27g in GK 27 to 10.71g in GK 37 (Figure 8). Seed yield of another two genotypes viz. GK 19(10.33g) and GK 11 (10.13.g) was also closer to the highest yielder GK 37. The lowest yielder GK 27 (3.27 g/plant) was closely followed by two genotypes namely GK24 (5.87g) and GK 25 (5.92g). Seven genotypes which made up 25.92% of the total namely GK 38 (7.97g), GK 47 (7.96g), GK 43 (7.77g), GK 35 (7.61g), GK 45 (7.50g), GK 16 (7.43g), and GK 23 (7.38g) had a minor variation was observed. The seed yield per plant of about fifty percent (fourteen genotypes) of the genotypes ranged from 8.04 to 9.81 g/plant.

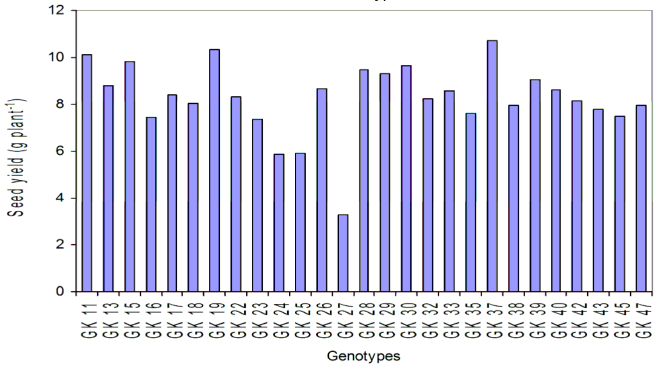


Figure 8. Effect of water stress on Seed yield (g plant^{-1}) in twenty seven mungbean genotypes

Total dry weight

Remarkable variation of total dry weight was observed in different Mungbean genotypes due to water stress. The highest total dry weight (33.59 g plant^{-1}) was recorded in genotype GK 37, followed by GK 26 (32.89 g plant^{-1}) and GK

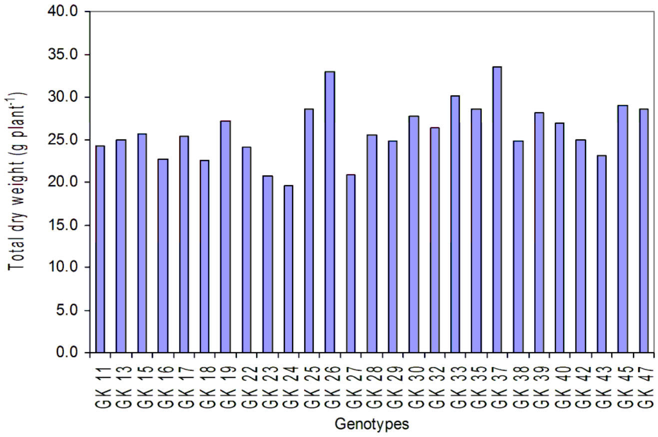


Figure 9. Effect of water stress on total dry weight (g plant^{-1}) in twenty seven mungbean genotypes

45 (28.99 g plant^{-1}). The lowest total dry weight (19.63 g/plant) was observed from the genotype GK 24. The dry weight of thirteen genotypes (48.14%) ranged from 20.74 to 25.47 g plant^{-1} and that of nine genotypes (33.37%) from 25.67 to 28.62 g plant^{-1} (Figure 9). The reduction in total dry weight was attributed due to reduced leaf dry weight by the stress.

Relative water content (WRC)

Genotypic differences were observed in case of relative water content (RWC) in leaf. The higher RWC was recorded in GK 27 (91.11) and GK 16 (91.10), which was closely followed by GK 17 (89.74) and GK 22 (89.13). The genotype GK 47 (73.33) and GK 25 (73.52) had lower RWC, which were followed by GK 37 (74.19) and GK 45 (76.74). It was also appeared that about seventy percent genotypes had 79.31 to 87.09 RWC (Figure10). Intestinally, RWC did not show any relationship with the grain yield. For example GK37 had the highest seed though it had minimum RWC.

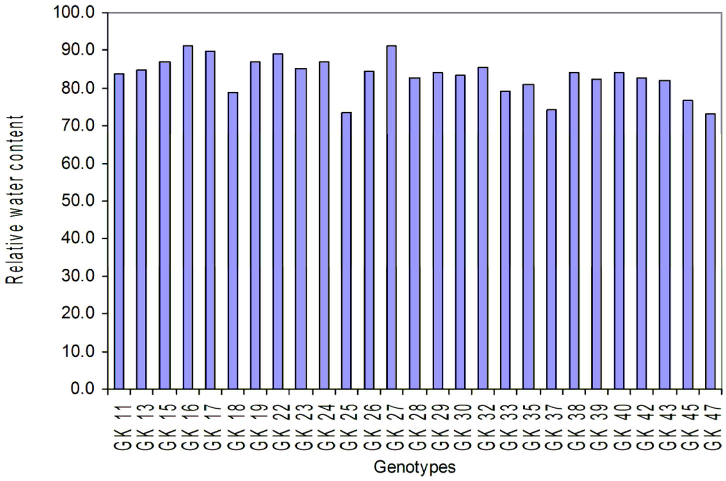


Figure 10. Effect of water stress on relative water content in twenty seven mungbean genotypes

Correlation coefficients among different characters of Mungbean genotypes

Correlation coefficient between different characters in Mungbean are presented in Table 1. Seed yield showed significantly positive correlation with days to first flowering, number of pod plant^{-1} and seeds pod^{-1} (Table 1). Plant height significantly correlated with number of branches plant^{-1} and total dry matter production (Table 1).Number of branches plant^{-1} showed significant positive correlation with pods plant^{-1}, seeds pod^{-1} and total dry matter production and negative correlation with pods length and 1000-seed weight. A highly positive significant correlation between pods plant^{-1} and seed yield was also observed. Negative correlation was found between pods plant^{-1} and pods length. Positive correlation between seeds pod^{-1} and seed yield was observed. Positive correlation of number of pods plant^{-1} and seeds pod^{-1} with seed yield has been reported in several studies (Sindhu and Prasad, 1987; Singh *et al*., 1988; Sandu *et al*., 1991).

Table 1. Correlation coefficients between different characters in Mungbean

Name of the characters	Days to first pod maturity	Plant height (cm)	No. of branches plant^{-1}	No. of pods plant^{-1}	Pod length (cm)	Seeds pod^{-1}	1000 seed weight (g)	Seed yield (g plant^{-1})	Total dry weight (g plant^{-1})
Days to first flowering	0.129	0.175	0.588**	0.426*	-0.209	0.306	-0.048	0.437*	0.568**
Days to first pod maturity		0.221	0.144	0.065	0.025	-0.147	0.047	0.122	0.106
Plant height(cm.)			0.324*	-0.003	0.025	0.107	0.275	0.189	0.340*
No. of branches plant^{-1}				0.363*	-0.113	0.368*	-0.262	0.241	0.933**
Pods plant^{-1}					-0.062	0.391*	-0.458**	0.857**	0.492**
Pod length (cm.)						-0.067	0.346*	0.176	0.00
Seeds Per Pod							-0.505**	0.337*	0.366*
1000 seed wt. (g)								0.039*	-0.182
Seed yield (g /p)									0.449**

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Based on the results of this study, it was concluded that genotypes GK 37, GK 19 and GK 11 performed better under water stress condition

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