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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 5(4): 401-403, 2002

Effects of Gibberellic Acid (GA_3) on Physiological Contributing Characters of Mungbean (*Vigna radiata* L.)

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Abstract: Two varieties of mungbean (*Vigna radiata* L.) were compared for effects of seed treatment and foliar application of GA_3 at 0, 50, 100 and 200 ppm on the growth contributing characters. Seed treatment with GA_3 at 50 ppm increased the leaf area index, total dry matter, crop growth rate, while 200 ppm increased relative growth rate and net assimilation rate. Foliar application of GA_3 at 200 ppm had higher relative growth rate, while that at 100 ppm had greater leaf area index, total dry matter, crop growth rate and net assimilation rate. Between the mungbean varieties, V_1 (BARI-4) performed better than V_2 (BARI-5) while the seeds were treated and an opposite result was found with foliar application of GA_3. Significant varietal differences were observed in terms of physiological characters. The study indicates a high potentiality to increase the yield of mungbean in Bangladesh by the application of GA_3

Key words: Mungbean, *Vigna radiata* L., physiology, GA_3

Introduction

Mungbean (*Vigna radiata* L.) is an important pulse crop of global economic importance. It ranks fifth in acreage and sixth in production in Bangladesh (BBS, 1994). Total production of mungbean in Bangladesh in 1998-99 was 34,000 tons from an area of 1,37,000 acres (BBS, 1999). It is considered as poor man's meat because it is a good source of protein (Kaul, 1982). It provides invaluable supplemental protein to a rice- based diet and can improve the nutritional value of food. It is easily digestible, good for all age groups and does not have any adverse effect on known diseases. Like other pulses, it is widely used as 'Dal' in Bangladesh and in other SAARC countries. Mungbeans are generally grown without chemical fertilizers. It cannot withstand waterlogged conditions.

It has a reputation for drought tolerance. Mungbean, being usually deep rooted plant, opens up soil by their penetrating root system where the roots decay and improve aeration, water perculation and add nitrogen to the soil resulting in the increase of soil fertility. Production of pulses should be increased urgently to meet the demand of the people, to avoid import and save foreign currency, and to increase pulse consumption. The daily consumption of pulses in Bangladesh is only 10 grams per head as compared with 45 grams in India (FAO, 1984). In spite of its importance and well adaptability in the agroclimatic conditions of Bangladesh, the acreage production is decreasing gradually because of mounting competition from other profitable cereals, especially irrigated boro rice in medium high land (Ahmed, 1984). The crop has received very little attention by the researchers in comparison with other cereals and grain crops. However, it is of utmost necessity to improve the quantitative and qualitative values of mungbean. Various practices may help to achieve this goal. Application of growth regulators seem to be the most significant one in view of convenience, cost and labour efficacy.

Gibberellic acid (GA_3) can manipulate a variety of growth and developmental phenomena in various crops. It was reported to stimulate stem elongation (Deotale *et al.*, 1998; Abd El-Fattah, 1997) and increase dry weight (Hore *et al.*, 1988) as well as yield (Deotale *et al.*, 1998). In Bangladesh, very limited works have been carried out regarding the use of growth regulators in our climatic conditions that could provide useful information to increase mungbean production. Therefore, present work was designed to study the effect of GA_3 on physiological growth and development of mungbean.

Materials and Methods

The experiment was conducted at the Field Laboratory of the Department of Crop Botany, Bangladesh Agricultural University, Mymensingh during the period from October, 2000 to February, 2001. Two varieties of mungbean namely BARI moog-4 (V_1) and BARI moog-5 (V_2) collected from Bangladesh Agricultural Research Institute, Joydebpur, Gazipur were used in study.

The land of the experimental site was first opened with a power tiller. After ploughing and laddering all the stubbles and uprooted weeds were removed to make the land ready for sowing and the basal dose of fertilizers was incorporated thoroughly before planting (BARC, 1997). The two factors experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The whole area was divided into 3 blocks and each block into 16 unit plots. The size of the unit plot was $2m^2$ and the distance between plots was 0.5m. The plots were raised up to 15cm from the soil surface. The seeds of mungbean were sown in rows made by hand plough on October 24, 2000. The distances between rows and seeds were 30cm and 15cm, respectively and 2 seeds were placed in each point at 2-3cm depth. Seedlings were transferred to fill up the gaps where seeds failed to germinate. Irrigation was done as per necessity. The crop field was weeded twice: First weeding followed by thinning was done at 15 days after sowing (DAS) and second weeding was done at 45 DAS. Dimecrone 50 EC was sprayed @ 1 L/ha to prevent pod borer infestation as and when required. GA_3 solution was prepared two times first for seed treatment and second for spray according to the procedure of Roy *et al.* (1991).

The first crop sampling was done on 15 days after sowing (DAS) and it was continued at an interval of 10 days till on 55 DAS. At the time of each harvest, five plants were selected randomly from each plot. The sampling was done until maturity. Physiological characters like- leaf area index, total dry matter, crop growth rate, relative growth rate and net assimilation rate were recorded. The data collected on different parameters under the experiment were statistically analyzed to obtain the level of significance using the MSTAT-computer package programme developed by Russel (1986). The differences between pairs of means were compared by Duncan's Multiple Range Test (DMRT).

Results and Discussion

The leaf area index (LAI) was recorded at 10 days interval starting from 15 days after sowing (DAS) to 55 DAS. It revealed that both seed treatment and foliar spray of GA_3 had stimulatory effect on leaf area index (Table 1). The lowest concentration (50 ppm), however, finally became superior to 100, 200 ppm and the control (Table 1). Moreover, 50 ppm GA_3 became the best treatment with the highest LAI at the later stages, although the same treatments were more effective at early stages. Seed treated plants of BARI-4 had the highest LAI at all the growth stages except 15 DAS. While foliar application on the seedlings of BARI-5 had higher LAI than BARI-4 throughout the entire growth stages except 15 DAS (Table 2). This difference indicates a differential responsiveness of the

Table 1: Physiological characters of mungbean as influenced by pre-sowing seed treatment and foliar spray with GA_3

Treatments	Leaf area index					Total dry matter (g/plant)				
	15 DAS	25 DAS	35 DAS	45 DAS	55 DAS	15 DAS	25 DAS	35 DAS	45 DAS	55 DAS
Pre-sowing seed treatment										
T_1	0.020 c	0.073 d	0.223 c	0.210 c	0.370 c	0.053 b	0.191 d	0.585 b	1.63 b	2.29 d
T_2	0.025 a	0.093 b	0.329 a	0.321 a	0.503 a	0.056 a	0.240 b	0.755 a	2.14 a	2.44 c
T_3	0.026 a	0.077 c	0.228 b	0.177 d	0.370 c	0.048 c	0.253 a	0.585 b	1.55 b	3.17 a
T_4	0.021 b	0.114 a	0.222 d	0.221 b	0.409 b	0.048 c	0.201 c	0.763 a	1.61 b	2.56 b
LSD	0.0006	0.0056	0.0006	0.0006	0.0006	0.0006	0.0072	0.0230	0.2578	0.0563
CV (%)	3.53	4.57	2.49	1.80	1.31	5.76	1.54	2.03	8.44	1.46
Foliar spray										
T_1	0.025 b	0.089 c	0.223 d	0.302 b	0.342 d	0.044 d	0.223 b	0.883 a	1.68 d	3.00 b
T_2	0.026 a	0.091 b	0.301 b	0.307 a	0.486 a	0.060 a	0.303 a	0.875 a	2.10 b	2.43 d
T_3	0.026 a	0.089 c	0.313 a	0.206 d	0.401 c	0.057 b	0.292 a	0.921 a	2.18 a	3.52 a
T_4	0.026 a	0.100 a	0.282 c	0.274 c	0.461 b	0.048 c	0.308 a	0.726 b	1.91 c	2.71 c
LSD	0.0006	0.0006	0.0005	0.0006	0.0162	0.0006	0.0162	0.0796	0.0598	0.1378
CV (%)	1.59	4.52	1.58	1.10	1.65	7.95	2.46	4.59	1.13	2.65

Figures followed by different letters within a column differ significantly by DMRT NS = Not significant T_1 = Control
T_2 = 50 ppm of GA_3 T_3 = 100 ppm of GA_3 T_4 = 200 ppm of GA_3

Table 2: Physiological characters of mungbean cultivars grown after seed treatment and foliar spray with GA_3

Variety	Leaf area index					Total dry matter (g / plant)				
	15 DAS	25 DAS	35 DAS	45 DAS	55 DAS	15 DAS	25 DAS	35 DAS	45 DAS	55 DAS
Pre-sowing seed treatment										
V_1	0.021 b	0.089	0.280 a	0.260 a	0.465 a	0.048	0.231 a	0.752 a	1.87 a	2.90 a
V_2	0.025 a	0.089	0.221b	0.205 b	0.361 b	0.055	0.212 b	0.593 b	1.59b	2.33 b
LSD	0.0006	NS	0.0006	0.0006	0.0006	NS	0.0079	0.0230	0.2578	0.0563
CV (%)	3.53	4.57	2.49	1.80	1.31	5.76	1.54	2.03	8.44	1.46
Foliar spray										
V_1	0.026 a	0.077 b	0.248 b	0.246 b	0.418	0.050 b	0.246 b	0.760 a	1.81 b	2.51 b
V_2	0.025 b	0.108a	0.311 a	0.299 a	0.428	0.055 a	0.317 a	0.943 b	2.12 a	3.31 a
LSD	0.0006	0.0006	0.0005	0.0006	NS	0.0006	0.0162	0.0796	0.0598	0.1378
CV (%)	1.59	4.52	1.58	1.10	1.65	7.95	2.46	4.59	1.13	2.65

Figures followed by different letters within a column differ significantly by DMRT
NS = Not Significant V_1 = BARI- 4 V_2 = BARI -5

Table 3: Physiological characters of mungbean as influenced by pre-sowing seed treatment and foliar spay by GA_3

Treatments	Relative growth rate (mg day^{-1})				Crop growth rate (mg cm^{-2} day				Net assimilation rate (mg cm^{-2} day^{-1}			
	25 DAS	35 DAS	45 DAS	55 DAS	25 DAS	35 DAS	45 DAS	55 DAS	25 DAS	35 DAS	45 DAS	55 DAS
Pre-sowing seed treatment												
T_1	0.138c	0.107b	0.077b	0.037c	0.036a	0.091a	0.155d	0.133c	0.573b	0.514b	0.720b	0.479c
T_2	0.145b	0.114a	0.101a	0.040b	0.033ab	0.093a	0.247a	0.146bc	0.604ab	0.626a	0.751b	0.513b
T_3	0.156a	0.110ab	0.098a	0.040b	0.026b	0.071b	0.172c	0.184a	0.605ab	0.506b	0.884a	0.477c
T_4	0.146b	0.107d	0.101a	0.046a	0.027b	0.069b	0.183b	0.171ab	0.658a	0.437c	0.836a	0.560a
LSD	0.0025	0.0056	0.0056	0.0056	0.0079	0.0079	0.0079	0.0249	0.0558	0.0079	0.0509	0.0230
CV%	4.23	1.76	1.71	4.46	4.06	1.41	2.52	1.24	3.55	1.23	2.57	2.70
Foliar spray												
T_1	0.150b	0.106b	0.062c	0.031b	0.031d	0.103b	0.134d	0.146b	0.607b	0.674a	0.524d	0.378bc
T_2	0.161b	0.099b	0.093ab	0.027b	0.044b	0.102b	0.220b	0.118c	0.846a	0.549b	0.825b	0.361c
T_3	0.163b	0.114a	0.090b	0.055a	0.042c	0.113a	0.233a	0.234a	0.849a	0.641a	0.899a	0.774a
T_4	0.192a	0.120a	0.096a	0.034ab	0.047a	0.090c	0.211c	0.144b	0.859a	0.555b	0.765c	0.400b
LSD	0.0162	0.0079	0.0019	0.0228	0.0006	0.0008	0.0033	0.0227	0.0789	0.0455	0.0162	0.0230
CV (%)	5.52	4.82	6.30	8.60	8.44	1.36	3.31	5.38	3.81	3.03	1.24	2.46

Figures followed by different letters within a column differ significantly by DMRT
NS = Not Significant T_1 = Control T_2 = 50 ppm of GA_3 T_3 = 100 ppm of GA_3 T_4 = 200 ppm of GA3

Table 4: Variation in physiological character in different cultivars of mungbean as a result of seed treatment and foliar spray with GA_3.

Variety	Relative growth rate (mg day^{-1}				Crop growth rate (mg cm^{-2} day^{-1}				Net assimilation rate (mg cm^{-2} day^{-1}			
	25 DAS	35 DAS	45 DAS	55 DAS	25 DAS	35 DAS	45 DAS	55 DAS	25 DAS	35 DAS	45 DAS	55 DAS
Pre-sowing seed treatment												
V_1	0.158a	0.117a	0.090b	0.045a	0.033a	0.093a	0.200a	0.184a	0.703a	0.564 a	0.736b	0.549a
V_2	0.134b	0.103b	0.099a	0.037b	0.028b	0.068b	0.178b	0.132b	0.517b	0.478 b	0.860a	0.465b
LSD	0.0018	0.0025	0.0056	0.0056	0.0177	0.0079	0.0079	0.0249	0.0558	0.0079	0.0509	0.0230
CV (%)	4.23	1.76	1.71	4.46	4.06	1.41	2.52	1.24	3.55	1.23	2.57	2.70
Foliar spray												
V_1	0.158b	0.112	0.088a	0.033b	0.035b	0.092b	0.188b	0.126b	0.755b	0.620 a	0.789a	0.401b
V_2	0.175a	0.108	0.083b	0.41a	0.046a	0.112a	0.211a	0.195a	0.825a	0.589 b	0.717b	0.556a
LSD	0.0162	NS	0.0019	0.0079	0.3281	0.0006	0.0033	0.0227	0.0563	0.0455	0.0162	0.0230
CV (%)	5.52	4.82	6.30	8.60	8.44	1.36	3.31	5.38	3.81	3.03	1.24	2.46

Figures followed by different letters within a column differ significantly by DMRT
NS = Not Significant V_1 = BARI- 4 V_2 = BARI -5

cultivars at different stages of growth to GA_3 and its mode of application. GA_3 was reported to increase leaf area in seed treatment (Deotale *et al.*, 1998) as well as in foliar application (Naidu and Swamy, 1995).

Total dry matter accumulation was significantly enhanced by the application of GA_3 at all the growth stages (Table 1). However, no single dose was found to be clearly superior to the others. The data revealed that the highest total dry matter (3.17) was recorded at 55 DAS with 100 ppm of GA_3 and the lowest one at 15 DAS with the same concentration of GA_3 in case of seed treated plants (Table 1). Highest total dry matter (3.52) was found at 55 DAS with 100 ppm of GA_3 while the lowest was resulted in control at 15 DAS when foliar application was made. The two varieties of mungbean differed significantly in their ability to accumulate dry matter at all growth stages (Table 2) except 15 DAS in pre-sowing. The difference was lower at early growth stages but remarkably higher at later stages. The data revealed that V_1 had superiority over V_2 in accumulating dry matter throughout the entire growing season in seed treated plants (Table 2); while in foliar spray, V_2 was superior to V_1 at all growth stages except for 35 DAS (Table 2). Application of 100 ppm of GA_3 was reported to increase the total dry matter in french bean (Gabal *et al.*, 1990) and soybean (Deotale *et al.*, 1998). The present study also shows that GA_3 efficiently influenced dry matter accumulation in mungbean.

The various concentrations of GA_3 significantly regulated relative growth rate (RGR) at different growth stages (Table 3). The data revealed that RGR was maximum at 25 DAS and decreased with the advancement of crop growth in all treatments (Table 3). The treated plants had higher RGR over their respective control. No treatment could be identified having the highest RGR value at all growth stages. However, 50 ppm had higher RGR at 35 & 45 DAS, 200 ppm had higher at 45 and 55 DAS; while 100 ppm had the highest RGR (0.156) at 35 DAS (Table 3). In foliar spray, 200 ppm GA_3 had the highest RGR except only the final stage (55 DAS) when 100 ppm superceeded it (Table 3). Difference of mungbean varieties on relative growth rate was found significant at all the growth stages (Table 4) except at 35 DAS in foliar spray. Maximum RGR in pre-sowing treatment was found in V_1 at all stages except 45 DAS. V_2 had higher RGR than V_1 at 25 and 55 DAS in foliar spray; while V_1 had higher RGR at 35 and 45 DAS.

Crop growth rate (CGR) was estimated at 10 days interval starting from 25 DAS to 55 DAS. In all treatments, CGR increased gradually with the advancement of crop growth, maximized at 45 DAS and thereafter decreased slightly (Table 3). Crop growth rate increased due to the influence of GA_3 applied as seed treatment and foliar spray. However, 50 ppm was superior among the seed treatments; while 100 ppm was the most effective dose as foliar spray .It was interesting to note that BARI-4 responded better than BARI-5 in seed treatment, while BARI-5 had higher CGR values than BARI-4 due to the influence of foliar spray of GA_3 (Table 4). Similar increase of CGR was reported at all the treatments over control (Katiyar, 1980). The final decrease of CGR at 55 DAS might be due to the approach of crop maturity.

The effect of GA_3 was significant as was observed on net assimilation rate (NAR) at all growth stages (Table 3). The data revealed in seed treatment that the highest NAR in pre-sowing was obtained by 200, 50, 100 and 200 ppm at 25, 35, 45 and 55 DAS, respectively. In the foliar spray, the highest NAR was found with 200 ppm and control at 25 and 35 DAS, respectively and with 100ppm at 45 and 55 DAS. Difference of varieties on net assimilation rate of mungbean was found significant at all growth stages (Table 4). The data showed that V_1 had higher NAR values than V_2 at all growth stages except 45 DAS in seed treatment. In foliar spray V_2 had higher NAR at 25 and 55 DAS and those of BARI-4 had higher NAR at 35 and 45 DAS. Maximum NAR (230mg g^{-1} day^{-1}) in green gram was reported with 150 ppm GA_3 (Suma Bai *et al.*, 1987). The present study is in agreement with the above report.

The results of the present study indicate that physiological parameters of mungbean can be favourably influenced by the application of GA_3 with a consequent yield increase. This result shows potential application of GA_3 for the increase of mungbean yield in Bangladesh.

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