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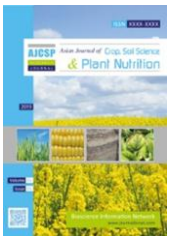

Response of mungbean growth and yield to GA_3 rate and time of application

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ABSTRACT

Mungbean (Vigna radiata L.) is a high protein content pulse crop in Bangladesh. Gibberellic acid (GA_3) is a phytohormone that accelerates the plant growth and development which is helping to increase yield. A field experiment was conducted at the Agronomic Research Field, Hajee Mohammad Danesh Science and Technology University, Dinajpur during April to August 2018 in order to investigate the effect of GA_3 application time and different concentrations on morpho-physiological, yield and yield contributing characters of mungbean cv. BARI mung-8. The experiment comprised three application time of GA_3 viz. 15, 30 & 45 DAS and three concentration viz. 0, 100 & 200ppm. Mungbean cv. BARI mung-8 (Sunamung) was used as an experimental crop. The research experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. Most of the growth and yield contributing characteristics of BARI mung-8 was significantly influenced by different times and concentration of GA_3. Among the time of application and concentrations of GA_3 at 30 DAS with 200ppm of GA_3 produced the tallest plant and number of branches plant^{-1}. At 200ppm of GA_3 application only increased vegetative growth, but concentration @100 ppm of GA_3 application showed the best performance on yield and yield contributing characters. So, 100ppm of GA_3 produced the longest pod, highest number of pods plant^{-1}, number of seed pod^{-1}, 1000 seed weight, seed yield, stover yield, biological yield and harvest index. The highest seed yield (1.14 t ha^{-1}) was obtained from 30 DAS whereas the lowest one (0.84 t ha^{-1}) recorded from 15 DAS. The seed yield increase with increasing concentration of GA_3 up to 100ppm and then yield was reduced. The maximum seed yield (1.35 t ha^{-1}) and biological yield (4.12 t ha^{-1}) was recorded from 100ppm GA_3 applied at 30 DAS, whereas no application of GA_3 produced the minimum seed yield (0.73 t ha^{-1}) and biological yield (2.77 t ha^{-1}). The present study reveals that BARI mung-8 performed the best with the application of GA_3 @100ppm at 30 DAS for enhancing growth and getting maximum yield.

***Key words**: Gibberellic acid (GA_3), Application time and rate, Morpho-physiological and Yield attributes, Mungbean*

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I. Introduction

Mungbean (*Vigna radiata* L.) is a short-season summer growing legume grown as dry land crop in the center and northeast of Asia (Thomas et al., 2004). Among the pulse crops, it has a special importance of intensive crop production due to its short growth period like maize (Ahmed et al., 1978 and Alam et al., 2019a). It is also a drought tolerant crop which performs well under low moisture condition (Chauhan, 2012). It is an important pulse crop which has economic importance in Bangladesh. The pulse crop, mungbean is the best important conventional pulses grown in Bangladesh. It is an important herbaceous, annual, self–pollinated pulse crop under the family Leguminosae. Within pulses crops, mungbean is an fourth as ranks in acreage production and the first in market price (BBS, 2012). It's having high nutritional values and rich in protein content (Tahir et al., 2013). It grown all over country due to it's high nutritive value, digestibility and non-flatulent behavior. It contributed 6.5% of the total pulse production in our country and average yield was about 0.28 MT per acre (BBS, 2012). It contains 26% protein, 62.5% carbohydrates, 1.4% fat, 4.2% fibers, minerals and vitamins (Ali and Gupta, 2012). To meet the requirement it is necessary to boost up the production through varietal selection, proper fertilizer management and application of different plant growth hormone such as gibberellic acid, Idole-3-Acetic Acid (IAA), Cytokine and Ethylene is prerequisite for increasing the production of mungbean.

Gibberellic acid (GA_3) is a phyto-hormone that is needed for elongation and develops the plant growth with the help of small quantities at low concentration. Gibberellin or gibberellic acid (GA_3) was initially isolated from fungus *Gibberella fujikuroi.* GA_3 increased bud & flower in three variety of strawberry (Seascape, Laguna, Camarosa) especially in Seascape species. GA_3 is the most important growth regulator, which is involved in mungbean. It breaks seed dormancy, stems elongation, promotes germination, internodal length, hypocotyls growth and cell division in cambial zone and increases the size of leaves, flowers and pods (Deotale et al., 1998). It is well established that gibberellic acid causes a dramatic increase in growth of mungbean. It increase dry weight (Hore et al., 1988) as well as seed yield (Maske et al., 1998). So, favorable condition may be induced by applying growth regulator exogenously in proper concentration at a proper time in a specific crop by GA_3. The people of other's country may not apply directly on his existence cultivar because of varied weather and soil conditions. Therefore, on the effects of growth regulators in our climatic condition could provide useful information in the improvement of yield of mungbean. Considering the above fact, this present study deals with the response of mungbean to GA_3 in relation to morphological and yield contributing attributes, such as height of plant, number of branches per plant, pod length, pods per plant, 1000 seed weight, stover yield, seed yield, biological yield and harvest index.

II. Materials and Methods

Experimental site and soil: The mungbean (*vigna radiata* L.), also known as sunamung in Bengali, is in the Legume family of plants and closely related to cowpea. It is an important pulse crop on base of global economic importance. The experiment was conducted at the Agronomy Research Field in Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur, during the month of April to August, 2018 in order to study the determine between different time and rate of gibberellic acid (GA_3) on morpho-physiology and yield attributes of mungbean *cv.* BARI mung-08(Sunamung). The experimental site belongs to the Agro Ecological Zones (AEZ-01) "Old Himalayan Piedmont Plain". The information of weather regarding temperature, relative humidity and rainfall prevailed at the experimental site during the study period is presented in Table 01. The weather information was recoded from research field, HSTU, Dinajpur. The research field was a medium high land having well drained silty-loam texture with pH value 5.41 and moderate fertility level with 1.48% organic matter content and others nutrient components well (Table 02).

Experimental treatments and design: The experimental treatments i) the rate of gibberellic acid (GA_3) *viz.* 0, 100 & 200 ppm and ii) time of application of gibberellic acid (GA_3) *viz.* 15, 30 & 45 days after sowing (DAS) were used as experimental treatments. The experiment was laid out in a randomized complete block design (RCBD) with three replications i.e. each replication contains nine (09) plots. So, total number of plots in the field experiment was 27. The size of unit plot was $4m^2$ (2m x 2m) and plot to plot distance was 25cm. The total area of the experiment was $168m^2$. The experimental field was divided into 3 blocks. The block to block distance was 25cm.

Table 01. Meteorological data recorded at the experimental site during the study period (April to August, 2018)

Months	Average Temperature (^{0}C)			Average Relative Humidity (%)	Average Rainfall (mm)
	Maxi.	Min.	Average		
January	27.3	15.7	21.5	75.9	00.00
February	29.67	18.97	24.32	77.2	00.30
March	30.54	19.87	52.41	76.5	166.70
April	34.1	20.7	27.4	66.0	128.8
May	35.1	23.0	29.5	78.0	176.0
June	37.0	25.3	31.2	70.0	211.4
July	36.0	26.3	31.2	82.0	142.0
August	36.3	25.4	31.3	84.0	254.6
September	36.9	26.3	31.2	80.0	98.20
October	35.4	20.6	28.0	62.0	06.00
November	33.8	15.0	24.4	70.0	0.000
December	28.9	10.6	19.8	66.0	01.00

Source: Wheat Research Centre (WRC), Nashipur, Dinajpur

Table 02. Details status of Soil Agronomy Research field, Department of Agronomy, Hajee Mohammad Danesh Science and Technology University (HSTU), Dinajpur during the study period (April to August, 2018).

Sites	pH	OM (%)	Total N (%)	(meq/100g soil)			(ug/g soil)				
				Na	K	Mg	P	S	Ca	Zn	B
HSTU Campus	5.41	1.48	0.08	0.06	0.10	2.3	11.2	17.29	2.48	1.37	0.35

Source: Soil Resources Development Institute, Dinajpur (2018)

Plant materials used: Mungbean *namely* BARI mung-08 (Sunamung) was used as experimental planting material, which was developed by Bangladesh Agriculture Research Institute (BARI), Gazipur and this plant material was collected from the division of Pulse Research Centre, Shibganj, Bogura. It is a component division of BARI, Gazipur. On the other hand, Gibberellic Acid-3 (GA_3) was used as experimental treatment, which was collected from local market of Dinajpur district.

Crop husbandry: A well-drained and medium high land was selected as experimental site. Land was prepared well through six (06) ploughing. The fertilizers were used in right proportion way. Total amount of all fertilizers were applied during land preparation except urea and MOP. One-fourth of urea and MOP were applied at the time of final land preparation. Some important fertilizers *namely* nitrogen, phosphorus, potassium, sulphur and zinc fertilizers were applied in form of urea, triple super phosphate, muriate of potash, gypsum and zinc sulphate at the rate of 220, 100, 60, 60 and 10 kg ha^{-1}, respectively (Alam et al., 2014; 2015a,b,c; 2019b; Mollah et al., 2015). Seeds were treated with the help of Acataf-57 before sowing for preventing from seed and soil borne diseases. After treated of seed of experimental variety, seeds were sown continuously in line on 15 April, 2018 where the distance of row to row was 25cm and maintains the rate of seeds was 40kg ha^{-1}. Remaining urea and MOP were applied three equal installments at pre-vegetative stage, full vegetative stage and early fruiting stage. Weeding, irrigation and other intercultural operation were done as and when necessary. About 80% of the pods were become turned blackish, the crops were assessed to attain maturity.

Preparation of solution for treatments and application: For preparing of working solution, 0.1g of GA_3 was added in 100ml water for preparing of 100 ppm and also 0.2g of GA_3 was added in 200ml water for preparing of 200ppm solution. This prepared GA_3 (PGRs) solution was applied in treatment wise by hand sprayer at the rate of 0, 100 and 200 ppm in the 15, 30 and 45 days after of sowing of mungbean. The applications of treatments were made at early morning to avoid dehydration effect at mid-day.

Harvesting and Plant sampling: When the matured seed (about 95% seed matures) of mungbean turned into blackish in color. The plant sample was collected from each plot in treatment wise with proper tagged. Five randomly selected plants were taken from each plot for getting accurate data. After threshing and cleaning of pods, pods were sun dried for three (03) consecutive days for getting the moisture level below 14%.

Morpho-physiological characters and yield & yield attributes: Morpho-physiological characters *namely* plant height (cm) and number of branch plant^{-1} was measured with the help of scale meter. Morpho-physiological characters were analyzed by standard method. On the other hand, yield and yield attributes *viz.* pod length (cm), pod plant^{-1}, number of seeds pod^{-1}, 1000 seed weight, seed yield (t ha^{-1}), biological yield (t ha^{-1}), stover yield (t ha^{-1}) and harvest index (%) were determined by the standard method. Any height, length, number and yield were measured by using the manual count and scale meter. Seed yield and stover yield were all together regarded as biological yield. Biological yield was calculated with the following formula:

Biological yield (t ha^{-1})= Seed yield (t ha^{-1}) + Stover yield (t ha^{-1}).

Harvest index was determined by dividing the economic yield (seed yield) to the biological yield (seed + stover yield) from the same area and then multiplied by 100. Harvest index (HI) was calculated on dry basis with the help of following formula:

$$\text{Harvest Index (\%)} = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

Data analysis

The obtained data were analyzed by MSTAT-C Statistical computer package program using the Analysis of variance technique and mean differences were adjudged by Duncan Multiple Range (DMRT) Test (Gomez and Gomez, 1984).

III. Results and Discussion

Application time and concentration of GA_3 influence on morpho-physiological characters of mungbean

Morpho-physiological characters i.e. plant height and number of branches plant^{-1} of mungbean were directly influenced by the single and combined application time and concentration of GA_3 and significant data variation at 30, 45 and 60 days after sowing (DAS) of mungbean but not at 15DAS shown in Table 03.

Application time of GA_3 influence: Considering in both factors, plant height gradually increased with the advancement of crop growth and reached maximum growth at 60DAS. Besides, number of branches plant^{-1} increased up to 45DAS but decreased in 60DAS. The highest plant height and number of branches plant^{-1} were recorded with the application time of GA_3 at 30DAS which was statistically different from other application time of GA_3. Application of gibberellic acid at 30 days after sowing performed best. It produced tallest plants at 30DAS, 45DAS and 60DAS were 40.14cm, 63.11cm and 70.67cm, respectively. The second highest plant height was found in the application time of GA_3 at 45DAS at different days after sowing of mungbean i.e. the second highest plant height at 30DAS, 45DAS and 60DAS were 39.19cm, 59.50cm and 65.65cm, respectively, which were statistically similar with GA_3 application time at 15 days after sowing. On the other hand, number of branches plant^{-1}, application of gibberellic acid at 30 days after sowing performed best. It produced highest number of branches plant^{-1} at 15DAS, 30DAS, 45DAS and 60DAS were 4.07, 10.34, 11.31 and 4.07, respectively. The second highest number of branches plant^{-1} was found in the application time of GA_3 at 45DAS at different days after sowing of mungbean i.e. the second highest number of branches plant^{-1} at 15DAS, 30DAS, 45DAS and 60DAS were 3.71, 9.27, 9.79 and 3.71, respectively, which were statistically similar with GA_3 application time at 15 days after sowing (Table 03).

Concentration of GA_3 Influence: The highest plant height and number of branches plant^{-1} were recorded with the concentration of GA_3 at 200ppm which was statistically different from other concentration of GA_3 (Table 03). Concentration of gibberellic acid at 200ppm performed best. It produced tallest plants at 30DAS, 45DAS and 60DAS were 37.92cm, 62.28cm and 68.31cm, respectively, which was statistically similar to concentration of GA_3 at 100ppm. The lowest plant height was observed at the concentration of GA_3 at control treatment (0 ppm) i.e. the lowest plant height at 30DAS, 45DAS and 60DAS were 35.85cm, 55.90cm and 65.02cm, respectively. Besides, number of branches plant^{-1}, concentration of gibberellic acid at 200ppm performed best. It produced tallest plants at 15DAS, 30DAS, 45DAS and 60DAS were 4.16, 11.01, 11.63 and 4.16, respectively,

which was statistically similar to concentration of GA_3 at 100ppm. The lowest plant height was recorded at the concentration of GA_3 at control treatment (0 ppm) i.e. the lowest plant height at 15DAS, 30DAS, 45DAS and 60DAS were 3.22, 7.17, 7.70 and 3.22, respectively.

Application time and concentration of GA_3 Combine influence: Significant influence was found in plant height and number of branches plant^{-1} due to the combined effect of different application of time and different concentrations of GA_3 application (Table 03). Among the interactions, the most effective interaction level was $T_2 \times D_3$ (30DAS×200ppm) for plant height and number of branches plant^{-1}. In contrast, the lowest plant height and number of branches plant^{-1} were found from interaction of $T_1 \times D_1$ (15DAS×0ppm) treatment. Interaction influence on plant height, the tallest plants at 30DAS, 45DAS and 60DAS were 41.71cm, 66.07cm and 73.03cm, respectively, while the shortest plants at 30DAS, 45DAS and 60DAS were 31.37cm, 53.72 cm and 64.19 cm, respectively. On the other hand, interaction influence on number of branches plant^{-1}, the maximum number of braches plant^{-1} at 15DAS, 30DAS, 45DAS and 60DAS were 4.60, 12.29, 13.24 and 4.60, respectively, whereas the minimum number of branches plant^{-1} at 15DAS, 30DAS, 45DAS and 60DAS were found at 3.06, 6.93, 7.49 and 3.06, respectively. GA_3 is well known for its effective role in stem elongation in many crops. Foliar spray of GA_3 significantly increased plant height in beans (Beall et al., 1996). Seed of mungbean were treatment with GA_3 also was reported to increase plant height (Kumer et al., 1996). In case of number of branches per plant, the present finding agreed with the view of Kumer et al. (1996) and Gabal et al. (1990) in which the author recorded the highest number of branches per plant in French bean. It also agreed with the finding of Abd El-Fattah (1997).

Table 03. Morpho-physiological characters influenced by application of time and concentration of GA_3 at different days after sowing (DAS)

Treatments	Plant height (cm) at				Number of branches plant^{-1} at			
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS
Application of time (DAS)								
15	16.26a	31.85 b	57.11b	64.37 b	3.68b	8.73c	9.63b	3.68b
30	16.37a	40.14 a	63.11 a	70.67 a	4.07a	10.34a	11.31a	4.07a
45	16.33a	39.19 a	59.50 b	65.65 b	3.71b	9.27b	9.791b	3.71b
Level of significance	NS	**	**	**	**	**	**	**
CV (%)	5.04	2.93	5.44	3.74	6.85	8.85	8.02	6.85
Concentration of GA_3 (ppm)								
0	16.39a	35.85 b	55.90 b	65.02 b	3.22b	7.17c	7.70b	3.22b
100	16.39a	37.41 a	61.53 a	67.35ab	4.08a	10.15b	11.41a	4.08a
200	16.36a	37.92a	62.28 a	68.31 a	4.16a	11.01a	11.63a	4.16a
Level of significance	NS	**	**	*	**	**	**	**
CV (%)	5.04	2.93	5.44	3.74	6.85	8.85	8.02	6.85
Application time × Concentration of GA_3								
$T_1 \times D_1$	16.23 a	31.37d	53.72c	64.19 b	3.06e	6.93c	7.49c	3.06e
$T_1 \times D_2$	16.71a	36.99 c	57.33bc	66.27 b	3.20e	7.16c	7.84c	3.20e
$T_1 \times D_3$	16.54 a	32.04 d	56.66bc	64.58 b	3.40de	7.43c	7.76c	3.40de
$T_2 \times D_1$	16.49 a	40.18ab	61.6ab	64.30 b	4.10bc	9.89b	10.75b	4.10bc
$T_2 \times D_2$	16.28 a	39.91ab	59.11bc	65.06 b	3.80cd	10.86ab	10.90b	3.80cd
$T_2 \times D_3$	16.11 a	41.71 a	66.07 a	73.03 a	4.60a	12.29a	13.24a	4.60a
$T_3 \times D_1$	16.05 a	32.13d	60.19ab	64.22b	3.90c	9.38b	10.67b	3.90c
$T_3 \times D_2$	15.21 a	40.69a	65.92a	72.69a	4.43ab	11.54a	12.86a	4.43ab
$T_3 \times D_3$	16.33 a	38.52bc	58.48bc	67.69b	3.93c	9.53b	10.70b	3.93c
Level of significance	NS	*	**	*	*	*	*	*
CV (%)	5.04	2.93	5.44	3.74	6.85	8.85	8.02	6.85

In column, means followed by different letters are significantly different, In column, means followed by same letters are not significantly different, *means at 5% level of probability, **means at 1% level of probability, NS means non-significance. DAS=means Day after sowing, CV=Co-efficient of variance; T_1=15 DAS, T_2=30 DAS, T_3=45 DAS; D_1=0 ppm, D_2= 100 ppm, D_3= 200 ppm

Application time and concentration of GA_3 influence on yield and yield attributes of mungbean

Yield and yield attributes *viz.* pod length, pod plant^{-1}, number of seeds pod^{-1}, 1000 seed weight, seed yield, biological yield, stover yield and harvest index of mungbean were directly influenced by the

single and combined application time and concentration of GA_3 and significant data variation at 15, 30, 45 and 60 days after sowing (DAS) of mungbean shown in Table 04.

Application time of GA_3 influence: Application time of GA_3 exerted significant influence on yield and yield contributing characters of mungbean *cv.* BARI mung-8 (Sunamung) (Table 04). Pod length, pod plant^{-1}, number of seeds pod^{-1}, 1000 seed weight, seed yield, biological yield, stover yield and harvest index were significantly affected by different application time of GA_3. The highest biological yield (3.67 t ha^{-1}) and seed yield (1.14 t ha$^{-1)}$ were recorded in 30DAS due to highest number of pod plant^{-1} (37.80), number of seed pod^{-1}(10.76), 1000 seed weight (32.14 g), length of pod (8.59cm), stover yield (2.53 t ha^{-1}) and harvest index (30.89%) (Table 04), which was statistically similar with the application time of GA_3 at 45DAS. The lowest yield related all attributes was observed in the application time of GA3 at 15DAS.

Concentration of GA_3 Influence: Concentration of GA_3 exerted significant influence on yield and yield contributing characters of mungbean *cv.* BARI mung-8 (Sunamung) (Table 04). Pod length, pod plant^{-1}, number of seeds pod^{-1}, 1000 seed weight, seed yield, biological yield, stover yield and harvest index were significantly affected by different application time of GA_3. The highest seed yield (1.13 t ha^{-1}) and biological yield (3.80 t ha^{-1}) were recorded from 100ppm due to highest number of pod plant^{-1} (32.81), maximum number of seed pod^{-1}(10.54), 1000 seed weight (32.48g), length of pod (8.31cm), stover yield (2.66 t ha^{-1}) and harvest index (29.86%) (Table 04), which was statistically similar with the concentration of GA_3 at 200ppm. The lowest yield related all attributes was found in the concentration of GA_3 at control treatment (0 ppm).

Table 04. Yield and yield attributes influenced by application of time and concentration of GA_3 at different days after sowing (DAS)

Treatments	Pod length (cm)	Pods plant^{-1} (No.)	Seeds pod^{-1} (No.)	1000 seed weight(g)	Stover yield (t ha^{-1})	Seed yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest Index (%)
Application of time (DAS)								
15	7.66b	23.38c	9.29b	30.25 b	2.27b	0.84 b	3 .14b	26.83c
30	8.59a	37.80a	10.76a	32.14 a	2.53a	1.14 a	3.67a	30.89a
45	8.34a	31.10b	10.42a	31.48 ab	2.46ab	1.02 ab	3.50a	29.21b
Level of significance	**	**	**	*	*	**	**	**
CV (%)	3.86	6.38	7.94	8.63	8.31	7.42	7.31	4.14
Concentration of GA_3 (ppm)								
0	8.00c	29.04b	9.58b	29.12 b	2.04b	0.8 b	2.84b	28.00b
100	8.31a	32.81a	10.54a	32.48 a	2.66a	1.13 a	3.80a	29.86a
200	8.27b	30.42b	10.35ab	32.28 ab	2.57a	1.07 ab	3.68a	29.07ab
Level of significance	*	**	*	**	**	*	**	*
CV (%)	3.86	6.38	7.94	6.98	8.31	7.60	7.31	4.14
Application time × Concentration of GA_3								
$T_1 \times D_1$	7.22 d	20.93c	8.76c	27.96 f	2.02c	0.73 f	2.77e	26.55e
$T_1 \times D_2$	8.49ab	30.07abc	10.23abc	30.09 e	2.07c	0.85de	2.92de	29.06bcd
$T_1 \times D_3$	8.30abc	35.33ab	9.75abc	29.57 ef	2.03c	0.81def	2.83e	28.40cde
$T_2 \times D_1$	7.98bc	27.47bc	9.40bc	31.60 d	2.47ab	0.91d	3.38bc	27.08de
$T_2 \times D_2$	8.673a	39.53a	11.01a	33.40 a	2.78a	1.35 a	4.12a	32.85a
$T_2 \times D_3$	8.30abc	38.53ab	10.63ab	32.42 cd	2.74a	1.14 c	3.89a	29.66bc
$T_3 \times D_1$	7.77 c	21.73c	9.72abc	31.45 de	2.30bc	0.88 de	3.29cd	26.85e
$T_3 \times D_2$	8.63a	31.80abc	11.00a	32.92 b	2.76a	1.22 b	3.99a	30.79b
$T_3 \times D_3$	8.42ab	31.43abc	10.86ab	32.47 c	2.63ab	1.11 c	3.78ab	29.58bc
Level of significance	*	*	**	**	*	**	*	*
CV (%)	3.86	6.38	7.94	6.02	8.31	6.87	7.31	4.14

In column, means followed by different letters are significantly different, In column, means followed by same letters are not significantly different, *means at 5% level of probability, **means at 1% level of probability, NS means non-significance. DAS=means Day after sowing, CV=Co-efficient of variance; T_1=15 DAS, T_2=30 DAS, T_3=45 DAS; D_1=0 ppm, D_2= 100 ppm, D_3= 200 ppm

Application time and concentration of GA_3 Combine influence: Interaction of application time and concentration of GA_3 was significant for pod length, pod plant^{-1}, seed pod^{-1}, stover yield, biological yield and harvest index (Table 04). The highest seed yield (1.35 t ha^{-1}), 1000 seed weight (33.40 g), pod length (8.67cm), pods plant^{-1} (39.53), seeds pod^{-1} (11.01), stover yield (2.78 t ha^{-1}), biological yield (4.12 t ha^{-1}) and harvest index (32.85%) was found in $T_2 \times D_2$ (The application time of GA_3 at 30DAS and concentration of GA_3 at 100ppm). On the other hand, the lowest seed yield (0.73 t ha^{-1}) and biological yield (2.77 t ha^{-1}) was found from the interaction of application time of GA_3 at 15DAS and concentration of GA_3 at 0 ppm due to the lowest number of pod number plant^{-1}(20.93), minimum number of seed pod^{-1} (8.76), 1000 seed weight (27.96g), pod length (7.22cm), stover yield (2.02 t ha^{-1}) and harvest index (26.55%). Hoque (2001), Rahman et al. (2018), Alam et al. (2018), Uddin (1999) and Beall et al. (1996) was found significant effect of GA_3 on pod length, pod plant^{-1}, number of seeds pod^{-1}, 1000 seed weight, seed yield, biological yield, stover yield and harvest index. They were reported that 100ppm of GA_3 produced the longest pod, highest number of pod plant$^{-1,}$ number of seeds pod^{-1}, 1000 seed weight, maximum seed yield & biological yield, stover yield and harvest index in mungbean.

IV. Conclusion

The present research confirms that application time of GA_3 at 30DAS and concentration of GA_3 at 100 ppm interact significantly effect on plant height, pod plant^{-1}, seed pod^{-1} & harvest index and consequently to increase yield of BARI mungbean-8. Based on the results of this study, it may be concluded that for obtaining higher yield of BARI mung-8 (Sunamung) should be applied time of GA_3 at 30DAS and concentration of GA_3 at 100ppm in the study area.

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