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YIELD, PIGMENTS AND QUALITY RESPONSES OF BUSH BEAN (*PHASEOLUS VULGARIS* L.) DUE TO GA_3 APPLICATION

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Abstract

This study aspired to investigate the effect of different doses of exogenous GA_3 (*viz.* o, 10, 30, 50, 70, 90 and 110 ppm) on leaf pigments like chlorophyll a, chlorophyll b and carotenoid, yield and proximate contents of fresh pod and dry seed of Bush bean (*Phaseolus vulgaris* L.). Different concentrations of GA_3 significantly increased chlorophyll a, chlorophyll b and carotenoid at 28 to 48 DAS growth stages. Early flowering and maturation were recorded by GA_3. It was found that number of pods/plant, pod weight, pod length and pod width also significantly increased by GA_3. All the treatments showed a significant increase of crude protein, crude fiber and ash content, whereas total carbohydrate and crude fat decreased in respect of fresh pod and dry seed of Bush bean. It had no significant effect on pod moisture compared to the control. Among all the treatments, GA_3 at 50 ppm gave the best performances in tested parameters.

Key words: Bush bean, GA_3, Pigments, Protein, Fiber, Ash

Introduction

GA_3 stimulated leaf pigments, photosynthetic activity, growth, fruit characters and quality of crops (Moneruzzaman *et al.* 2011, Fawzy *et al.* 2011and El-Shraiy and Hegazi 2009). The influence of it producing early flowering, pod setting, maturation and seed development was reported (Arora *et al.* 1988 and Ouzounidou *et al.* 2010). GA_3 with different concentrations stimulated or inhibited biochemical parameters in different plants. El-Shraiy and Hegazi (2009) reported that application of GA_3 showed significant decrease in carbohydrate and sugar content in seeds of pea plant, but on the other hand, the application of 20 to 100 mg/L GA_3 was reported to increase the total sugar content in the fruits of wax apple (Moneruzzaman *et al.* 2011). Bora and Sarma (2006) found that GA_3 at 250 µg mL^{-1} and Cycocel at 500 µg mL^{-1} were the best concentrations in enhancing the protein content in seeds of pea cultivars. Fathima and Balasubramanian (2006) sprayed GA and NAA separately or in combination on *Abelmoschus esculentus* L. and found that the yield and quality of fiber was best in GA100 + NAA 50 g mL^{-1} treated plants. No information is available regarding the effect of GA_3 on ash and fat content of crops including Bush bean. Limited number of research on Bush bean was known on

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these aspects. With this view in mind, the present work was carried out to study the effect of GA_3 on yield, pigments, pod and seed proximate contents of Bush bean.

Materials and Methods

A field experiment was performed at the research field (23°44′23.3″ N latitude and 90°23′03.8″ E longitude) of Bangladesh Council of Scientific and Industrial Research (BCSIR), Dhaka in the Rabi season of 2009 – 2010 (November to February) with the cultivar of BARI Bush bean-1. The seven treatments applied were as follows; T_0 =distilled water spray (control) and T_1, T_2 T_3, T_4, T_5 and T_6 were 10, 30 , 50, 70, 90 and 110 ppm GA_3 respectively. The foliar treatments were sprayed at 18 days after sowing (DAS). The experiment was laid out in a randomized complete block design (RCBD) with three replications. The unit plot size was 2.0 m × 1.5 m.

There were 5 rows in a plot each containing 12 plants and altogether 60 plants in a plot. Cow dung was applied at the rate of 2.0 Kg/plot, and N, P, K, S and B were applied at 58.8, 22.8, 15.0, 16.7 and 1.8 g/plot in the form of urea, triple super phosphate, muriate of potash, gypsum and borax respectively. After adding cow dung, the soil was left for two weeks to condition it. Among the fertilizers, cow dung, P, B and S were added entirely as basal doses. One third of N and K were applied as basal doses, rest two third were as top dressing on 20 and 40 days after sowing (DAS) respectively. Seeds were sown on November 15, 2009 .Two seeds were sown in a hole about 3 cm in depth, maintaining row and plant distances of 30 and 15 cm respectively. Furrow irrigation was given at an interval of 7 days. Keeping the healthy seedling at each place, the rest one was thinned out 15 days after emergence (DAE). Weeding was done at an interval of 10 days.

Days to 90% flowering and 90% maturity were counted, when respective physiological characters were attained in each treatment. For measuring yield characters like number of fresh pods/plant, pod length, pod diameter and pod weight, young pods from 10 sampled plants of each treatment were collected at seven days interval from 48 to 69 DAS and used.

Chlorophyll a, b and carotenoid content of leaves were determined at 18, 28, 38, 48 and 58 DAS for four leaves, budding, flowering, pod setting and pod filling stages respectively. The amount of chlorophyll a and b were calculated by using specific absorption co-efficient method of McKinney (1940) and the formula of Maclachalan and Zalik (1963). Carotenoid was determined by the equation of Von Wettstein (1957). For determination of pod and seed proximate, the pod samples at 58 DAS and seed samples at harvest stages were collected and oven dried. Moisture content, total carbohydrate, crude protein, ash, crude fat and crude fiber of samples were measured according to the methods of Association of Official Analytical Chemist (AOAC 2005). Data were subjected to analysis of variance and the treatment means were separated by Duncan's Multiple Range Test (DMRT), treatment means for all parameters were compared by co -

efficient of variation (CV %) and Least Significant Difference (LSD) test at 5% level of significance according to Gomez and Gomez (1984).

Results and Discussion

It was found that GA_3 treatments had significant influence on flowering of Bush bean. Maximum days to reach the 90% flowering were registered for T_0, whereas the minimum was found for T_6, followed by T_4 to T_1 (Fig. 1). GA_3 treatments induced earlier flowering in green pepper plants (Ouzounidou *et al.* 2010), which support the findings of the present study. Results obtained indicated that GA_3 with different concentrations significantly decreased days to 90% maturity of pods and ranged from 90.00 to 84.33days (Fig. 1). T_6 showed the earliest maturity (5. 67 days) compared to the control. Arora *et al.* (1988) reported that foliar application of GA_3 resulted in the early maturity of watermelon fruit.

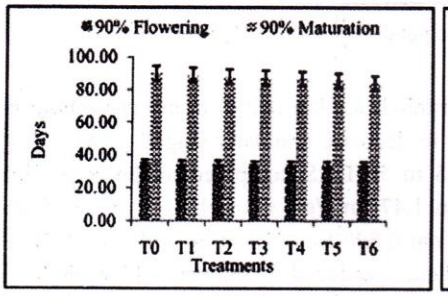

Fig. 1. Effect of GA_3 on 90% flowering and 90% maturation of Bush bean.

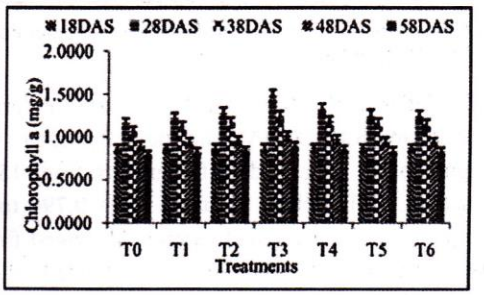

Fig. 2. Effect of GA_3 on chlorophyll a (mg/g) of Bush bean at different growth stages.

Number of fresh pods/plant ranged from 14.20 to 25.33 (Table1) and increased by 33.10 to 78.38% over the control (Table 1). Significantly highest number of fresh pods/plant was recorded for T_3, followed by T_4 and T_2. It was reported that the application of 25 ppm GA_3 increased the fruit number in watermelon (Gopalkrishnan and Choudhary 1978).

GA_3 with 30 to 70 ppm significantly increased pod length in Bush bean (Table 1). The maximum pod length was recorded for T_3 while the minimum was found for T_0. Similar findings were reported by Arun *et al.* (1997) for brinjal. The data revealed that pod diameter significantly varied in GA_3 treated plants except T_1 and T_5. It was highest for T_3 in comparison with the control. Previous observations that GA_3 increased fruit diameter in cucumber (Singh and Singh 1984) and bulb diameter in onion (Hye *et al.* 2002) support the present study.

The pod weight was found to range from 4.88 to 6.25g (Table 1). All the GA_3 treated plants yielded significantly higher fruit weight than the control. GA_3 with 50 ppm showed the highest pod weight, which was 28.07% more over the control. The results found are

in agreement with the findings of Moneruzzaman *et al.* (2011) who observed that, GA_3 significantly influenced the fruit weight as well as yield of wax apple.

Table1. Effect of GA_3 on fruit characters of Bush bean.

Treatments	No. of fresh pods / plant	Pod length (cm)	Pod diameter (cm)	Pod weight (g)
T_o	14.20g	13.66e	2.60e	4.88c
T_1	18.90f	13.80de	2.67de	6.02b
T_2	20.37c	14.20c	2.77bc	6.06b
T_3	25.33a	15.00a	3.17a	6.25a
T_4	21.47b	14.53b	2.83b	6.08b
T_5	19.43d	13.89d	2.70cd	6.05b
T_6	19.10e	13.88d	2.67de	6.05b
LSD (0.05)	0.15	0.17	0.09	0.16
CV %)	15.93	3.26	6.67	7.54

*Means in a column followed by the same letter do not differ significantly at 5% level;
**a=Highest level; g=Lowest level;

The foliar application of GA_3 increased chlorophyll a, chlorophyll b and carotenoid in leaf from 18 to 28 DAS and thereafter began to decrease gradually (Figs.2, 3 and 4). It significantly enhanced leaf pigments from 18 to 58 DAS compared to the respective controls. Chlorophyll a ranged from 0.794 to 1.477 mg/g, chlorophyll b ranged from 0.277 to 0.395 mg/g and carotenoid ranged from 0.890 to 2.321 mg/g at 18 to 58 DAS respectively. GA_3 with 50 ppm treated plants produced maximum chlorophyll a, chlorophyll b and carotenoid (1.477, 0.395 and 2.321 mg/g), followed by GA_3 at 70 and 30 ppm treatments respectively (Figs. 2, 3 and 4). Similarly, El-Shraiy and Hegazi (2009) reported that GA_3 gradually increased total chlorophyll contents at 45 DAS and thereafter decreased in pea leaves.

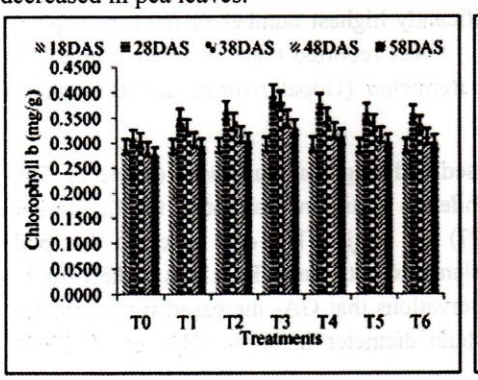

Fig. 3. Effect of GA_3 on chlorophyll b (mg/g) of Bush bean at different growth stages.

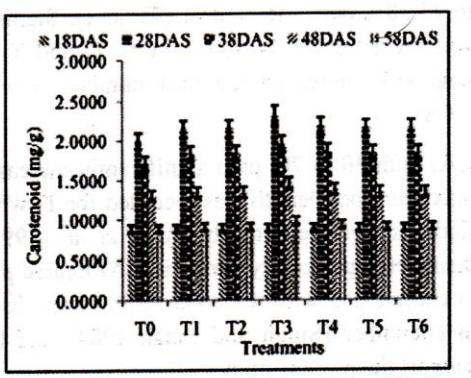

Fig. 4. Effect of GA_3 on carotenoid (mg/g) of Bush bean at different growth stages.

Total carbohydrate content of pods and seeds from the plants treated with GA_3, were statistically lower than the control. Pod total carbohydrate ranged between 8.159 to 5.760 % of fresh weight at 58 DAS. For seed, it ranged from 64.257 to 68.336 % of dry weight at harvest (Tables 2 and 3). It was highest for T_0 and the lowest was for T_3, followed by T_4 treatments. The observation that GA_3 significantly decreased seed total carbohydrate is in close agreement with the findings of El - Shraiy and Hegazi (2009).

GA_3 treatments significantly increased fresh pod and dry seed crude protein compared to the control. T_3 produced significantly highest pod and seed crude protein, which was followed by T_4 and T_2 respectively (Tables 2 and 3). That GA_3 increased protein content was reported for peas (Bora and Sarma 2006). GA_3 significantly increased fresh pod and dry seed crude fiber of Bush bean compared to the control (Tables 2 and 3). The maximum values were recorded from T_3, followed by T_4 respectively (Tables 2 and 3). The report stating that GA_3 increased fruit fiber in okra (Fathima and Balasubramanian 2006) supports the increase in fiber content of Bush bean in this study.

Table 2. Effect GA_3 on fresh pod proximate contents (% of fresh wt.) of Bush bean.

Treatments	Total carbo-hydrate (%)	Crude protein (%)	Crude fiber (%)	Ash (%)	Crude fat (%)	Moisture (%)
T_0	8.159a	1.987g	1.543g	0.611g	0.170a	87.530e
T_1	7.092b	2.436f	1.563f	0.706f	0.163b	88.040d
T_2	6.731e	2.536c	1.733c	0.738c	0.162b	88.100c
T_3	5.760g	2.650a	1.841a	0.830a	0.149d	88.770a
T_4	6.263f	2.584b	1.752b	0.763b	0.158c	88.480b
T_5	6.821d	2.519d	1.670d	0.728d	0.162b	88.100c
T_6	6.931c	2.513e	1.613e	0.720e	0.163b	88.060d
LSD(0.05)	0.032	0.002	0.018	0.007	0.003	0.030
CV%	10.346	8.444	6.167	8.585	3.849	0.418

*Means in a column followed by the same letter do not differ significantly at 5% level;
**a= Highest level; g= Lowest level;

Fresh pod and dry seed ash indicated that GA_3 had significant influence on it. It ranged from 0.611to 0.830 % at 58 DAS for pod and 4.225 to 4.64 % for seed at harvest (Tables 2 and 3). The maximum ash was observed for T_3, followed by T_4, T_2 and T_5 treatments, while the minimum was found for T_0. Fawzy *et al.* (2011) reported that in snap bean 75 ppm GA_3 increased potassium content over the control. In this study, it is assumed that due to the increase in pod ash, the seed ash may also increase. Similar results were obtained by Ibrahim *et al.* (2007) in faba bean. However, PGRS enhanced ash or minerals contents, effective in decreasing the risk of some diseases like inflammatory diseases, rheumatoid arthritis, asthma and regulates diabetes, increases essential metabolic activities and building of body tissues.

Table 3. Effect of GA_3 on dry seed proximate contents (% of dry wt.) of Bush bean at harvest.

Treatments	Total carbo-hydrate (%)	Crude protein (%)	Crude fiber (%)	Ash (%)	Crude fat (%)
T_0	68.336a	20.160f	5.432f	4.225f	1.846a
T_1	67.354b	20.870e	5.570e	4.400e	1.806b
T_2	66.458e	21.260c	5.950c	4.530c	1.802b
T_3	64.257g	22.570a	6.830a	4.640a	1.703d
T_4	65.715f	21.680b	6.270b	4.570b	1.765c
T_5	66.971d	21.100d	5.635d	4.490d	1.804b
T_6	67.152c	20.980e	5.583e	4.480d	1.805b
LSD(0.05)	0.113	0.118	0.030	0.0352	0.008
CV%	1.870	3.351	8.055	2.861	2.396

*Means in a column followed by the same letter do not differ significantly at 5% level;
* *a= Highest level; g= Lowest level;

GA_3 at different concentrations significantly decreased the fresh pod and seed crude fat of Bush bean. It was lowest for T_3, while the highest was recorded for T_0 treatment (Tables 2 and 3). No other reports were found in literature regarding the effect of GA_3 on fat content of crops.

GA_3 had no significant effect on pod moisture. It was the maximum due to T_3, and minimum for the control (Table 2).

On the basis of the results, it can be concluded that GA_3 with 10 to 110 ppm has significant effect on leaf pigments, flowering, maturity, number of fresh pods/plant, pod diameter, pod weight, pod and seed proximate compared to the control. Foliar application of 50 ppm GA_3 was found to be more effective among all the treatments.

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