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Effect of foliar application of acetyl salicylic acid, ascorbic acid and riboflavin on growth, yield and yield component of French bean (*Phaseolus vulgaris* L Cv. Arka Arjun)

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Abstract

The present experiment was carried out to assess the influence of foliar application of antioxidants on growth, yield and yield component of French bean cv. Arka Arjun. This experiment consisted of 7 treatment viz. Distilled water spray (T₁), Acetyl Salicylic Acid @ 100ppm (T₂), Acetyl Salicylic Acid @ 200 ppm (T₃), Ascorbic Acid @ 100 ppm (T₄), Ascorbic Acid @ 200ppm (T₅), Riboflavin @ 200 ppm (T₆) and Riboflavin @ 400 ppm (T₇). Five plants in each plot were randomly selected for recording the growth, yield observation and its parameters. Data was collected on different traits such as Plant height, Number of branches per plant, Number of leaves per plant, Leaf Area Index, Number of pods per plant, Pod weight of ten fruits, Pod length, Pod diameter, Pod yield per plant, Protein content of pod. The salient findings of the present investigation have been summarized as under: such as Plant height was significantly influenced by various treatments. The maximum Plant height was recorded in the treatment T₅ (Ascorbic Acid @ 200ppm). Maximum number of branches per plant was observed for treatment T₅ (Ascorbic Acid @ 200ppm). The maximum number of leaves per plant was recorded in the treatment T₅ (Ascorbic Acid @ 200ppm). Maximum Leaf Area Index was recorded in the treatment T₅ (Ascorbic Acid @ 200ppm). The maximum number of pods per plant was recorded in the treatment T₃ (ASA @ 200ppm). Maximum pod weight of ten fruits was recorded in the treatment T₅ (Ascorbic acid @ 200ppm). The maximum fruit length was recorded in the treatment T₅ (Ascorbic acid @ 200ppm). Highest Pod yield per plant was recorded in the treatment T₅ (Ascorbic acid @ 200ppm) also. Maximum value of protein content was observed for treatment T₃ (ASA @ 200ppm). These results prove that foliar applications of Ascorbic Acid at concentrations of 200 ppm (T₅) were beneficial for the growth and development of French bean. Maximum yield per plant was recorded with the treatment application of Ascorbic acid at concentrations of 200 ppm (T₅) and was found to be superior over Acetyl Salicylic Acid concentrations. Maximum protein content was recorded with the treatment application of Acetyl Salicylic Acid at concentrations 200 ppm (T₃) and was found to be superior over Ascorbic Acid concentrations.

Keywords: Foliar application, acetyl salicylic acid, ascorbic acid, riboflavin, growth and yield component of French bean

Introduction

French bean *Phaseolus vulgaris* L. (2n = 22) is an important legume vegetable belonging to family Fabaceae. French bean a short duration leguminous vegetable crop is better known for its mature dry seeds as well as immature tender green pods. In World, French bean is grown over an area of 1.48 million ha with annual production of 17.65 million MT and the productivity is 11.95 t per ha. In India, its cultivation is in 0.21 million ha with production of 0.58 million MT and productivity is 2.8 t per ha (FAO Stat, 2010). Being a most popular vegetable for its protein, carbohydrates, mineral content, crude fiber, vitamins A and C, it's becoming more popular and gaining lot of importance both in producers and consumers. Added to its short duration and high production potential it also possesses some useful medicinal properties in diabetes.

Besides, good agronomic practices like growing high yielding varieties, providing proper spacing, irrigation, use of fertilizers, optimum sowing time and some advanced crop improvement techniques like application of antioxidants and appropriate plant protection measures ought to be essentially followed in order to increase the productivity.

Increasing the production of French bean pods with high quality could be achieved through using the foliar application of antioxidants, i.e. Ascorbic Acid, Acetyl Salicylic Acid and Riboflavin. Antioxidants are naturally occurs in plants in very low amounts and participate in the regulation of physiological processes in plant such as stomata closure, nutrient uptake, chlorophyll synthesis and protein synthesis (Khan *et al.* 2003 and Shakirova *et al* 2003) ^[11, 14]. It has shown many important functions in the plant and can change physiological behavior of plant. Foliar application with relatively low concentrations of acetyl salicylic acid also promoted and influenced the growth, development, differentiation of cells and tissues of plants and enhanced the plants growth parameters. Antioxidants promote some physiological processes and inhibiting others depending on its concentration, plant species, development stages and environmental conditions. Ascorbic acid as an abundant component of plants functions as an antioxidant and an enzyme cofactor. It participates in a variety of processes including photosynthesis, cell wall growth and cell expansion, resistance to environmental stresses and synthesis of ethylene, gibberellins, anthocyanine and hydroxyl proline. Salicylic Acid is assigned diverse regulatory roles in the metabolism of plants. SA has direct involvement in plant growth, thermogenesis, flower induction and uptake of ions. It affects ethylene biosynthesis, stomatal movement and also reverses the effects of ABA on leaf abscission. Enhancement of the level of chlorophyll, photosynthetic rate and modifying the activity of some of the important enzymes are other roles assigned to SA.

Vitamins as bio-regulators can at certain concentrations exert a profound effect upon plant grow through regulation of primary and secondary metabolism (Abd El-Aziz *et al.* 2007; Amin & Ismail 2015) ^[6]. Riboflavin is considered a key contributor to many metabolic enzymes and electrons transport as well as it has an important role in the cycle of citric acid, oxidation of fatty acids, photosynthesis and DNA repair (Fischer and Bache, 2005). Cultivation of French bean is limited and less work has been done on these aspects. Therefore, it is right time to give more emphases on the effect of foliar application of some antioxidants on growth performance, yield potential and quality improvement. But, there is hardly any precise and conclusive information available on the effect of antioxidant and growth regulators on various physiological processes and productivity potential in French bean. Hence, the present investigation entitled "Effect of Foliar Application with Acetyl Salicylic acid, Ascorbic acid and Riboflavin on growth, yield and yield component of French Bean (*Phaseolus vulgaris* L. cv Arka Arjun)" was carried out to know the effect of foliar application of some anti oxidants on growth, yield and yield components and protein content in French bean.

Materials and Methods

The experiment with respect to the mentioned title was carried out in the Winter Season of 2018-2019 in the Agricultural Experimental Farm of Calcutta University at Baruipur, South 24 Parganas district (Coastal Alluvial Zone), West Bengal. The present investigation was carried out on the cultivated French bean variety "Arka Arjun". The experiment was carried out in a Randomized Block Design with three replications using Acetyl Salicylic Acid (100 and 200 ppm), Ascorbic Acid (100 and 200 ppm) and Riboflavin (200 and 400 ppm) sprayed after 30 days, 45 days and 50 days after sowing. The stock solutions were prepared fresh at the time of each spraying and dilutions to the required concentrations

were made using stock solution. All the solutions were procured from laboratory of Department of Horticulture, Institute of Agricultural Science, University of Calcutta. All the Chemicals used were laboratory reagents and not commercial formulations. The experimental land was ploughed and cross-ploughed 2-3 times followed by laddering to obtain good tilth. Stubbles and weeds were removed from the field. The entire experimental land was levelled and divided into plots, each measuring 4 m x 1.25 m, with a 1 m wide drainage-cum-irrigation channel in between each row. Manures like FYM @ 25 kg/ha was applied as basal dose during the time of ploughing along with NPK at 10 : 26 : 26 ratio. Before sowing, the seeds were soaked overnight in water. The seeds were directly sown in the field on first week of December 2018. The seeds were sown in plots with a spacing of 45cm x 25cm between row to row and plant to plant respectively. The crop was sprayed with different treatments during morning hour. Five plants in each plot were randomly selected. The selected plants were subjected to observation pertaining to growth and yield observations and its parameters. Data was collected on different traits such as Plant height (cm), Number of branches per plant, Number of leaves per plant, Leaf Area Index, Number of pods per plant, Pod weight of ten fruits (g), Pod length(cm), Pod diameter(cm), Pod yield per plant(g), Protein content of pod(mg/100g).

Plant height (cm): Plant height of the plants was recorded at the end of fruiting stage. It was measured from the base of the plant to the terminal bud with a measuring tape.

Number of branches per plant: Number of primary branches arising from the main axis of the plant was recorded and their average was worked out.

Number of leaves per plant: The number of fully opened leaves in each of five randomly selected and tagged plants were recorded and mean was worked out.

Leaf Area Index: Leaf area Index was determined by the instrument (Leaf area meter 211, systronics).

Number of pods per plant: Number of pods per plant was recorded and their average was worked out.

Pod weight of ten fruits (g): All the pods were weighed with the help of a digital balance on attainment of edible maturity and their average derived.

Pod length (cm): The length of the pods was measured by a measuring scale. Average length was finally worked out.

Pod diameter (mm): The diameter of the pods was recorded with the help of a vernire caliper scale. Average diameter was finally worked out.

Pod yield per plant (g): The pod yield per plant was calculated by multiplying the pod weight by the total number of pods per plant.

Protein content of pod (mg/100g): Protein content was estimated according to the method suggested by Lowry's method (1951).

Experimental Details: The experimental details are as follows: Crop-French Bean, Variety-Arka Arjun, Season-Summer, Total number of plot-21, Plot size-4m x 1.25 m, Path between replication: 1.00 m, Total area-250 square meter.

Number of Treatments with Their Different Concentrations

Treatment 1 - Control (Distilled Water)

Treatment 2 - Acetyl Salicylic Acid @ 100 ppm,

Treatment 3 - Acetyl Salicylic Acid @ 200 ppm,

Treatment 4 - Ascorbic Acid @ 100 ppm,

Treatment 5 - Ascorbic Acid @ 200 ppm,

Treatment 6 - Riboflavin @ 200 ppm and

Treatment 7 - Riboflavin @ 400 ppm.

Experimental Design: All the treatments were replicated three times and Randomized Block Design was used as the design of experiment. Help of an online statistical software was taken for the study (Sheoran *et al.*, 1998).

Results and Discussion

Results of the experiment entitled "Effect of foliar application of Acetyl Salicylic acid, Ascorbic acid and Riboflavin on growth, yield and yield component of French Bean (*Phaseolus vulgaris* cv Arka Arjun)" presented in this chapter. The data concerning the different parameters as affected by Acetyl Salicylic acid, Ascorbic acid and Riboflavin have been presented in Table- 1 & 2 and pictorially depicted in Fig. 1 & 2.

Plant height (cm): A perusal of data clearly indicates that there was a marked variation on Plant height due to foliar application of Acetyl Salicylic Acid, Ascorbic Acid and Riboflavin. Plant height was significantly influenced by various treatments having a range of 31.30 cm to 43.42 cm. The maximum Plant height (43.42 cm) was recorded in the treatment T₅ (Ascorbic Acid 200ppm) followed by treatment T₄ (Ascorbic Acid 100ppm) with a value of (40.43cm) whereas, minimum Plant height (31.30) was observed in the treatment T₆ (Riboflavin 200).

Number of branches per plant: The data reveals that the maximum number of branches per plant was significantly influenced by various treatments, maximum value (15.63) of this trait was observed for treatment T₅ (Ascorbic acid 200ppm) followed by (14.02) treatment T₄ (Ascorbic acid 100ppm) while, minimum value (10.98) for this trait have been observed in the treatment T₁ (control).

Number of leaves per plant: It is obvious from the table that the number of leaves per plant markedly influenced by foliar applications. The maximum number of leaves per plant (46.36) was recorded in the treatment T₅ (Ascorbic Acid 200ppm) followed by treatment T₄ (Ascorbic Acid 100ppm)

having a value of (42.48) whereas, minimum value (28.60) for this trait was recorded for treatment T₁ (control).

Leaf Area Index (sq. cm): Results showed maximum Leaf Area Index (6.48) in the treatment T₅ (Ascorbic Acid 200ppm) followed by (6.17) treatment T₄ (Ascorbic Acid 100ppm) whereas, Leaf Area Index (5.03) was observed in the treatment T₁ (control).

Number of pods per plant: It is obvious from the table that the number of pods per plant markedly influenced by foliar applications. The maximum number of pods per plant (18.83) was recorded in the treatment T₃ (ASA 200ppm) followed by treatment T₂ (ASA 100ppm) having a value of (16.13) whereas, minimum value (12.64) for this trait was recorded for treatment T₁ (control).

Pod weight of ten fruits (g): The data presented in mean summary table clearly shows that there was a significant differences on pod weight of ten fruits due to foliar application. The foliar application of Ascorbic acid 200ppm (Table 3) showed the maximum pod weight of ten fruits (57.30 g) was recorded in the treatment T₅ (Ascorbic acid 200ppm) followed by treatment T₄ (Ascorbic acid 100ppm) having value of 53.90 g whereas, minimum fruit weight (42.10 g) was recorded in the treatment T₁ (control).

Pod length (cm): The data pertaining to effect of micronutrients showed significant difference on fruit length of French bean. The maximum fruit length (15.90cm) was recorded in the treatment T₅ (Ascorbic acid 200ppm) followed by (14.30cm) treatment T₄ (Ascorbic acid 100ppm) while, minimum fruit length (10.50 cm) was recorded in the treatment T₆ (Riboflavin @ 200 ppm).

Pod diameter (mm): Results showed maximum fruit diameter (1.11) in the treatment T₅ (Ascorbic acid 200ppm) followed by (1.10) treatment T₄ (Ascorbic acid 100ppm) whereas, minimum fruit diameter (0.98) was observed in the treatment T₂ (Acetyl Salicylic Acid @ 100 ppm).

Pod yield per plant (gm): It is obvious from the data that the foliar feeding of various treatments brought significant improvement towards the fruit yield. Results revealed that, highest Pod yield per plant (92.50) was recorded in the treatment T₅ (Ascorbic acid 200ppm) followed by treatment T₃ (ASA 200ppm) having value of 80.14 which is followed by T₄ (Ascorbic acid 100ppm) having value of (78.30) as compared to lowest yield (63.10) in treatment T₁ (control).

Protein content (mg/100g): The data reveals that the protein content was significantly influenced by various treatments, maximum value (2.45) of this trait was observed for treatment T₃ (ASA 200ppm) followed by (2.14) treatment T₂ (ASA 100ppm) while, minimum value (1.54) for this trait have been observed in the treatment T₁ (control).

Table 1: Effects of Antioxidants on various parameters of French bean

Treatments	Height of the plant (cm)	No of branches / plant	No of leaves / plant	Leaf Area Index (sq. cm)	No of pods/plant
T ₁	32.80d	10.98d	28.60f	5.03c	12.64d
T ₂	36.80c	11.30d	37.30d	5.73b	16.13b
T ₃	37.70c	12.98c	38.20c	5.70b	18.03a
T ₄	40.43b	14.02b	42.48b	6.17a	14.53c
T ₅	43.42a	15.63a	46.36a	6.48a	15.34bc
T ₆	31.30e	10.97d	29.56e	5.10bc	14.60c

T ₇	32.50d	10.99d	28.62g	5.20b	12.73d
SE (m)	0.35	0.30	0.28	0.18	0.38
CD at 5%	1.03	0.88	0.83	0.68	1.12

Table 2: Effects of Antioxidants on various parameters of French bean

Treatments	Pod weight of ten fruits (gm)	Length of Pod (mm)	Diameter of Pod (mm)	Pod yield / plant (gm)	Protein content (mg/100g)
T ₁	42.10f	11.43d	1.02a	63.10d	1.54d
T ₂	46.20d	12.30c	0.98a	70.05c	2.14ab
T ₃	51.60c	13.98b	0.99a	80.14b	2.45a
T ₄	53.90b	14.30b	1.10a	78.30b	1.95bc
T ₅	57.30a	15.90a	1.11a	92.50a	1.86bcd
T ₆	43.40f	10.50e	1.03a	66.53d	1.63cd
T ₇	44.50e	11.20de	1.00a	63.40d	1.59d
SE (m)	0.46	0.23	0.09	1.07	0.11
CD at 5%	1.36	0.67	0.28	3.15	0.31

The application of antioxidants can help in improving growth, yield, yield related attributes and quality attributes in most of the crops through correction of deficiencies of secondary nutrients, micronutrients. A use of antioxidants offers an excellent alternative strategy for effective control of various diseases, augmentation of nutrient availability in the rhizosphere and thereby increases the yield potential. With this background the present investigation was carried out to find out the “Effect of foliar application of Acetyl salicylic acid, Ascorbic acid and Riboflavin on growth, yield and yield component of French Bean (*Phaseolus vulgaris* L. cv. Arka Arjun)”.

Foliar application of antioxidants thrice at 30, 45 and 50 days after sowing resulted significantly improve towards growth, yield and biochemical attributes in French Bean as compare to control. Highest plant height was recorded in treatment T₅ (Ascorbic Acid @ 200ppm). The increase in plant height was possibly attributed to synthesis of higher photosynthates due to the essential role of Ascorbic acid on enhancing cell division as well as the biosynthesis of organic foods, natural hormones and plant pigments are indicated by Gad El-Hak (2012) [12] in Pea, and Tohamy *et al.* (2008) [5].

Number of leaves per plant differed significantly among the treatments. Maximum number of leaves and leaf area index was recorded in T₅ (Ascorbic Acid @ 200ppm). The number of branches per plant differed significantly among the treatments. Highest number of branches per plant was recorded in T₅ (Ascorbic Acid @ 200ppm). Here maximum number of leaves maximum leaf index and branches per plant might be due to cell division and cell elongation by Ascorbic acid. Similar findings were reported by Tohamy *et al.* (2008) [5] in Eggplant and Amal *et al.* (2009) in Pea.

Foliar application of ASA @200 ppm proved to very effective in producing highest number of pods per plant attributed due to the direct involvement in plant growth, flower induction and uptake of ions. ASA inhibits ethylene production leading to increasing fruit numbers. The Similar findings has also been made by Leslie and Romani (1986), Sanna *et al.* (2001) [13].

Weight of ten pods per plant and length of pods also varied significantly. Highest weight of ten pods per plant, pods length and pod diameter were noticed in T₅ (Ascorbic acid@ 200ppm). Increased weight, often pods per plant, pod length and pod diameter might be attributed to bio-regular effect of ascorbic acid on physiological and biochemical reactions in plants. The present result were in agreement with those of Tohamy *et al.* (2008) [5], Thomson *et al.* (2017) [19] and Amal *et al.*

The maximum increase in pod yield per plant due to foliar application of antioxidants was observed in T₅ (Ascorbic acid @200 ppm). Pod yield per plant differs significantly among the treatments. The increased yield might be attributed to the ion uptake, cell elongation, cell division, cell differentiation, sink and source regulation, enzymatic activities, photosynthetic activity as well as increase in antioxidant capacity of plant. The result of present experiment is in consonance with the findings of Amal *et al.* (2008), Hussein and Alva (2014) [10], Thomson *et al.* (2017) [19].

The protein content is one of the parameter to assess the quality of pods. Highest protein content was noticed in T₃ followed by T₂. This might be due to application of ASA as foliar spray resulted in better accumulation of food reserves like protein as opined by Sanna *et al.* (2001) [13], Sarangthem and Singh (2003) [14] and Thomson *et al.* (2017) [19].

Conclusion

From the study it was found that, on the basis of results obtained and discussion made so far it may be concluded foliar application of Ascorbic acid at concentrations 200 ppm (T₅) were beneficial for the growth and development of French bean . Maximum yield per plant was recorded with the treatment application of Ascorbic Acid 200 ppm (T₅) and was found to be superior over Acetyl Salicylic Acid concentrations. Maximum protein content was recorded with the treatment application of Acetyl Salicylic Acid 200 ppm (T₃) and was found to be superior over Ascorbic Acid concentrations.

Fig 1: Experimental Plots

Fig 2: Matured harvested pods of French bean

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