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Response of foliar applied Boron and Salicylic acid on Greengram (*Vigna radiata* L.)

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Abstract

A field experiment was conducted during Zaid 2021 at Crop Research Farm, Department of Agronomy, SHUATS, Allahabad, (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), the available N, P, K fertilizers is applied through inorganic fertilizers *i.e.*, Urea, Single Super Phosphate and Murate of Potash. The treatment consisted of foliar spray of boron 0.2 and 0.5% at 20 and 35 DAS and salicylic acid 50, 100, and 150ppm at 25 and 45 DAS whose effect is observed on greengram (var. Virat). The experiment was laid out in Randomized Block Design, with 10 treatments, replicated thrice. The treatment with 150 ppm salicylic acid at 25 and 45 DAS recorded significantly higher growth parameters *viz.*, plant height (57.18 cm), number of branches per plant (8.00), number of nodules per plant (15.07), dry weight (7.16 g/plant), number of pods per plant (38.04), seed yield (1346.67 kg/ha), stover yield (2143.33 kg/ha) and harvest index (38.98%). The maximum Crop Growth Rate and Relative Growth Rate recorded with (no spray) control (4.92) and maximum RGR recorded in 0.5% Boron foliar spray at 20 and 35 DAS respectively. The maximum gross returns (97766.90 INR/ha), net returns (70954.75 INR/ha) and B:C ratio (2.64) was recorded in treatment with application of 150ppm salicylic acid at 25 and 45 DAS. Hence foliar spray of 150 ppm salicylic acid at 25 and 45 DAS found most productive and cost effective.

Keywords: Boron, foliar spray, Greengram, growth, Salicylic acid and yield

Introduction

Green gram (*Vigna radiata* L.) belongs to family leguminosae family. It is one of the protein rich major pulse crops grown in India. Green gram is short duration, drought tolerant pulse crop which also commonly known as “mung bean, moong and golden gram. It has special importance in intensive crop production system of the country. India shares about 35-37% and 27% of the total area and production of pulses, respectively in the world. The calorific value of green gram is 334 calories per 100 g. and its chemical composition is as follows: crude protein 24.0%, fat 1.3%, carbohydrate 56.6%, minerals 3.5%, lysine 0.43%, methionine 0.10% and tryptophan 0.04%. It plays an important role in maintaining and improving the fertility of soil through its ability to fix atmospheric nitrogen in the soil by root nodules. *Rhizobium* bacteria in root nodules of green gram has the ability to fix about 35 kg/ha atmospheric nitrogen. It is good green manure and erosion resisting cover crop.

In India, area under green gram is 34.4 lakh ha with the production of 14 lakh tonnes and the productivity is 406.98 kg ha⁻¹.

Boron plays vital role in plant metabolism, such as in enzymal activity, cell division, carbohydrate translocation, calcium and potassium uptake and protein synthesis, ultimately it may enhance in pod and seed formation. Boron is mainly required for reproduction of plant and germination of pollen grain. It is primarily needed to maintain the growth of apical growing point. Boron is essential for reproductive growth of plant, especially for flowering, fruiting and seed setting is more sensitive to B deficiency than vegetative growth. Boron also influences the absorption of N, P, K nutrients.

Plant growth regulators are one of the most important factors for increasing growth and higher yield of field crops. Hormones regulate physiological process and synthetic growth regulators may enhance growth and development of field crops thereby increased total dry mass of a field crop. These plant growth regulators in general, help to increase the number of flowers on the plant when applied at the time of flowering. The flower and pod drop may be reduced to some extent by spraying various growth regulators on foliage (Ramesh and Thirumuguran, 2001) [12]. Flowering is an important parameter that is directly related to yield and productivity of plants. Salicylic acid has been reported to induce flowering in number of plants. Different plant

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species including ornamental plant *Sinningia speciosa* flowered much earlier as compared to the untreated control, when they received an exogenous foliar spray of salicylic acid. Foliar sprays of salicylic acid in greengram increase seed yield per plant. In addition, application of salicylic acid as a 100ppm concentration increase number of pods/plant, number of seeds/pod, seed weight/plant and seed yield/ha (Sujatha 2001) [14]. Salicylic acid has an important role in tolerance of some environmental stresses such as heat, salts and drought stress.

Materials and Methods

An experiment was conducted during the *Zaid* 2021, at Crop Research Farm of Department of Agronomy at Sam Higginbottom University of Agriculture Technology and Sciences (SHUATS), Prayagraj which is found at 25° 24'42" N latitude, 81° 50' 56" E longitude and 98 m altitude above the mean sea level (MSL), to access the Response of foliar applied Boron and Salicylic acid on Greengram (*Vigna radiata*. L). The experiment was laid out in Randomized Block Design with Ten treatments which was replicated thrice. The treatment combination has two factors. The primary factor comprises of two levels of Boron B₁-0.2% and B₂- 0.5% foliar spray at 20 and 35 DAS while the second factor has three levels of Salicylic acid S₁-50ppm, S₂-100ppm, S₃-150ppm. The treatment combination are as following (T1) Control, (T2) 50ppm Salicylic acid foliar spray at 25 and 45DAS, (T3) 100ppm Salicylic acid foliar spray at 25 and 45 DAS, (T4) 150ppm Salicylic acid at 25 and 45 DAS, (T5) 0.2% Boron foliar spray at 20 DAS, (T6) 0.2% Boron foliar spray at 35 DAS, (T7) 0.2% Boron foliar spray at 20 & 35 DAS, (T8) 0.5% Boron foliar spray at 20 DAS, (T9) 0.5% Boron foliar spray at 35 DAS, (T10) 0.5% Boron foliar spray at 20 & 35 DAS. The Virat variety of greengram was sown with seed rate of 20 kg/ha at spacing of 30cm x 30cm. The recommended dose of fertilizer was 20-40-20 kg NPK/ha.

Chemical analysis

Composite soil samples are collected before layout of the experiment to determine the initial soil properties. The soil samples are collected from 0-15 cm depth and were dried under shade, powdered with wooden pestle and mortar, passed through 2 mm sieve and were analysed for organic carbon by rapid titration method by Nelson (1975) [11]. Available nitrogen was estimated by alkaline permanganate method by Subbiah and Asija (1956) [13], available phosphorus by Olsen's method as outlined by Jackson (1967), available potassium was determined by using the flame photometer normal ammonium acetate solution and estimating by using flame photometer (ELICO Model) as outlined by Jackson (1973) [7] and available ZnSO₄ was estimated by Atomic Absorption Spectrophotometer method as outlined by Lindsay and Norvell (1978).

Statistical analysis

The data recorded for different parameters were subjected to statistical analysis by adopting Fishers method of analysis of variance (ANOVA) as described by Gomez and Gomez (2010) [5]. Critical difference (CD) values were calculated the 'F' test was found significantly at 5% level.

Result and Discussion

Growth parameters

Observations regarding the plant height (cm) of greengram were given in Table 1 and it clearly depicts an increasing

trend in plant height during crop growing period from 15 DAS to 60 DAS. At 60 DAS significantly higher plant height was observed in treatment with the application of 150ppm Salicylic acid at 25 and 45DAS (57.18 cm) which is statistically at par to 100ppm Salicylic acid at 25 and 45 DAS (56.95 cm), 0.5% Boron foliar spray at 20 and 35 DAS (56.69cm), 0.2% Boron foliar spray at 20 and 35 DAS (56.67 cm), 0.5% Boron foliar spray at 35 DAS (56.51cm) and 0.5% Boron foliar spray at 20 DAS (56.14 cm). Increase in plant height might be due to the increased availability of nutrients without any harmful effect on plant through foliar application at 25 DAS and 45 DAS. Similar findings were also reported by Kuttamani and Velayutham (2009) [9].

In the present investigation, Number of nodules was increased with crop age upto 45 DAS and thereafter started reducing in number to 60 DAS. At 60 DAS the significantly higher number of nodules per plant was observed in 150ppm Salicylic acid at 25 and 45 DAS (15.07) which is statistically at par with the application of 100ppm Salicylic acid at 25 and 45DAS (14.60), 0.2% Boron foliar spray at 20 and 35 DAS (14.60), 0.5% Boron foliar spray at 20 and 35 DAS (14.40) and 0.5% Boron foliar spray at 35DAS (14.13). The increase in number of nodules per plant with the increasing in levels of salicylic acid might be due to the increase in net photosynthetic rate, nitrate metabolism in the plants. Similar findings were reported by Hayat *et al.*, (2012) [6].

Observations regarding the dry weight are given in table 1 and there was dry weight (g/plant) had consecutively increased from 15 DAS to 60 DAS. At 60 DAS the significantly higher dry weight was observed with the application of 150ppm Salicylic acid at 25 and 45DAS (7.16 g/plant) which is statistically at par with the application of 100ppm Salicylic acid at 25 and 45DAS (6.95 g/plant). The increase in dry weight under increasing levels of salicylic acid might be due to the promotive effect of salicylic acid on morphological characters which enhanced the photosynthetic rate and also maintained the stability of membrane thereby improving the dry matter production. Similar findings were obtained by Jeyakumar *et al.*, (2008) and Devi *et al.*, (2011) [8, 3].

Yield attributes

Observations regarding yield attributes are given in Table 2 Highest number of seeds per pod was observed with the application of 150ppm Salicylic acid at 25 and 45 DAS (10.64). Which was statistically at par with the application of 100ppm salicylic acid at 25 and 45 DAS (10.01), 0.5% Boron foliar spray at 20 and 35 DAS (9.92), 0.2% Boron foliar spray at 20 and 35 DAS (9.86) and the lowest was recorded in control-No spray (8.01). The increase in number of seeds per pod under increasing levels of salicylic acid might be due to increased mobilization of metabolites to the reproductive sinks. Similar findings were reported by Sujatha (2001) [14] and Khatun *et al.*, (2016).

The significantly higher number of pods per plant was observed in 150ppm Salicylic acid at 25 and 45 DAS (38.04). Which was statistically at par with the application of 100ppm Salicylic acid at 25 and 45DAS (37.49). The increase in number of pods per plant under increasing levels of salicylic acid might be due to reduced drop due to efficient translocation of photosynthates from source to sink. These findings were obtained by Ali and Mahmoud (2013) [2]. The higher test weight was observed in 150ppm Salicylic acid at 25 and 45 DAS (38.69 g) which was statistically at par with the application of 100ppm salicylic acid at 25 and 45 DAS (37.74 g) and lowest was observed in No spray (32.80).

Table 1: Effect of foliar applied Salicylic acid and boron on Growth Attributes of greengram

Treatments	Plant height (cm)				Number of nodules per plant				Dry weight (g/plant)			
	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS	15 DAS	30 DAS	45 DAS	60 DAS
T ₁ – No Spray (Control)	9.30	24.15	36.62	54.18	4.63	5.60	20.30	11.93	0.63	1.73	4.00	6.46
T ₂ –Salicylic acid 50ppm at 25 & 45 DAS	11.20	25.13	39.25	55.81	4.93	6.27	20.77	12.73	0.74	1.80	4.42	6.68
T ₃ –Salicylic acid 100ppm at 25 & 45 DAS	13.33	27.56	41.63	56.95	5.53	7.73	22.60	14.60	0.93	2.70	4.86	6.95
T ₄ –Salicylic acid 150ppm at 25 & 45 DAS	15.23	28.09	42.85	57.18	6.32	8.40	23.57	15.07	1.04	2.97	5.11	7.16
T ₅ –Boron 0.2% foliar spray at 20 DAS	11.07	24.05	37.60	54.36	4.73	5.87	20.33	12.33	0.66	1.60	4.27	6.56
T ₆ –Boron 0.2% foliar spray at 35 DAS	10.77	25.03	38.57	55.01	4.83	6.00	20.50	12.73	0.69	1.63	4.38	6.59
T ₇ –Boron 0.2% foliar spray at 20 & 35 DAS	12.37	27.62	40.43	56.67	5.30	6.93	20.87	14.60	0.79	2.17	4.64	6.79
T ₈ –Boron 0.5% foliar spray at 20 DAS	11.50	25.95	40.02	56.14	5.09	6.40	19.50	13.67	0.78	2.03	4.50	6.44
T ₉ –Boron 0.5% foliar spray at 35 DAS	12.23	25.97	39.70	56.51	5.27	6.73	20.10	14.13	0.78	2.10	4.59	6.77
T ₁₀ –Boron 0.5% foliar spray at 20 & 35 DAS	12.17	26.67	41.14	56.69	5.37	7.33	20.90	14.40	0.85	2.50	4.72	6.86
S.Em (±)	0.17	0.31	0.47	0.43	0.24	0.15	0.60	0.43	0.05	0.16	0.10	0.09
CD (0.05%)	0.51	0.91	1.39	1.28	0.71	0.21	1.79	1.27	0.15	0.49	0.29	0.26

Table 2: Effect of foliar applied Salicylic acid and boron on Yield Attributes and Yield of Greengram

Treatments	Yield Attributes			Yield		
	No. of Seeds/pod	No. of Pods/plant	Test weight (g)	Seed yield (kg/ha)	Stover yield (kg/ha)	Harvest index (%)
T ₁ – No Spray (Control)	8.01	32.51	32.80	1083.33	1926.67	35.98
T ₂ –Salicylic acid 50ppm at 25&45 DAS	9.01	33.81	33.83	1156.67	2023.33	36.37
T ₃ –Salicylic acid 100ppm at 25&45 DAS	10.01	37.49	37.74	1286.67	2123.33	37.45
T ₄ –Salicylic acid 150ppm at 25&45 DAS	10.64	38.04	38.69	1346.67	2143.33	38.98
T ₅ –Boron 0.2% foliar spray at 20 DAS	8.66	33.16	33.05	1110.00	1943.33	36.35
T ₆ –Boron 0.2% foliar spray at 35 DAS	8.72	33.70	33.71	1133.33	1976.67	36.44
T ₇ –Boron 0.2% foliar spray at 20 & 35 DAS	9.86	36.42	36.86	1191.67	2103.33	36.15
T ₈ –Boron 0.5% foliar spray at 20 DAS	9.53	34.30	34.54	1173.33	2053.33	36.35
T ₉ –Boron 0.5% foliar spray at 35 DAS	9.64	35.56	35.62	1153.33	2080	35.67
T ₁₀ –Boron 0.5% foliar spray at 20&35 DAS	9.92	36.86	37.24	1280.00	2146.67	37.33
S.Em(±)	0.27	0.39	0.34	23.43	18.42	0.54
CD (p=0.05)	0.82	1.15	1.02	69.63	54.76	1.61

Table 3: Influence of foliar spray of Boron and salicylic acid on economics of greengram

Treatments	Cost of cultivation (INR ha ⁻¹)	Gross returns (INR ha ⁻¹)	Net returns (INR ha ⁻¹)	B:C Ratio
T ₁ – No Spray (Control)	26482.15	75833.10	49350.95	1.86
T ₂ –Salicylic acid 50ppm at 25 & 45 DAS	26592.15	80966.90	54374.75	2.04
T ₃ –Salicylic acid 100ppm at 25 & 45 DAS	26702.15	90300.00	63597.85	2.38
T ₄ –Salicylic acid 150ppm at 25 & 45 DAS	26812.15	97766.90	70954.75	2.64
T ₅ –Boron 0.2% foliar spray at 20 DAS	26582.15	77700.00	51117.85	1.92
T ₆ –Boron 0.2% foliar spray at 35 DAS	26582.15	79333.10	52750.95	1.98
T ₇ –Boron 0.2% foliar spray at 20 & 35 DAS	26682.15	83416.90	56734.75	2.12
T ₈ –Boron 0.5% foliar spray at 20 DAS	26732.15	82133.10	55400.95	2.07
T ₉ –Boron 0.5% foliar spray at 35 DAS	26732.15	80733.10	54000.95	2.02
T ₁₀ –Boron 0.5% foliar spray at 20 & 35 DAS	26982.15	89600.00	62617.85	2.32

Yield

The significantly higher seed yield was observed with the application of 150ppm Salicylic acid at 25 and 45 DAS (1346.67 kg/ha). Which was statistically at par with the application of 100ppm salicylic acid at 25 and 45 DAS (1286.67 kg/ha), foliar spray of 0.5% Boron at 20 and 35 DAS (1280 kg/ha) and lowest seed yield was observed in No spray (1083.33 kg/ha). It was reported that the application of salicylic acid has a positive effect in ameliorating the oxidative changes in plant and increase the grain yield. Similar findings were reported by Devi *et al.*, (2011) ^[3] and Hossain *et al.*, (2015).

The higher stover yield was observed in 150ppm Salicylic acid at 25 and 45 DAS (2143.33 kg/ha). Which was statistically at par with the application of 100ppm salicylic acid at 25 and 45 DAS ((2123.33 kg/ha), foliar spray of 0.2% Boron at 20 and 35 DAS (2103.33 kg/ha) and Lowest was recorded in No spray 1926.67 (kg/ha). Increased in stover yield might be due to the growth promoting effect of salicylic

acid which increased the level of cell division within the apical meristem of seedling root and caused higher plant growth and increased the dry matter production. Similar findings were also corroborated by Ahmad *et al.*, (2014). The significantly higher harvest index was observed in 150ppm Salicylic acid at 25 and 45 DAS (38.98). which was statistically at par with the application of 100ppm Salicylic acid at 25 and 45 DAS (37.45) and lowest was recorded in control (35.98).

Economics

The maximum net return was found with the application of 150ppm salicylic acid at 25 and 45 DAS (70954.75 INR/ha). And the lowest was observed in No spray (49350.95 INR/ha). Higher B:C ratio was found in with the application of 150ppm Salicylic acid at 25 and 45DAS (2.64). The lowest was observed in No spray (1.86).

Conclusion

On the basis of one season experimentation the application of

150ppm salicylic acid at 25 and 45 DAS was found more productive (1346.67 kg/ha) as well as economics (70954.75 Rs/ha). Since the finding was based on the research done in one season it may be repeated further for confirmation and recommendation.

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