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Influence of Salicylic Acid and Gibberellic Acid on Biochemical Parameters, Yield and Yield Contributing Parameters of Black Gram

Anjali Devidas Sable[1*], P.V. Shende[2], S.A. Patil[3] and Vandana Kalamkar[4]

[1]P.G. Student, Department of Plant Physiology, Dr. PDKV University Akola, College of Agriculture Nagpur (Maharashtra), India.
[2]Associate Professor, Dr. PDKV University Akola, College of Agriculture, Nagpur (Maharashtra), India.
[3]Assistant Professor, Dr. PDKV University Akola, College of Agriculture, Nagpur (Maharashtra), India.
[4]SRA, Department Agriculture Botany Dr. PDKV University Akola, College of Agriculture Nagpur (Maharashtra), India.

(Corresponding author: Anjali Devidas Sable)*
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ABSTRACT: In *Kharif* 2022, a field experiment was conducted at Research farm of Agricultural Botany section, College of Agriculture, Nagpur. The experiment was laid out in RBD with three replications consisting often treatments. The treatments composed of foliar spray of two plant growth regulators of different concentrations *viz.*, Gibberellic acid (50 ppm, 100 ppm, 150 ppm and 200 ppm) and Salicylic acid (50 ppm, 100 ppm, 150 ppm and 200 ppm) along with control spraying was done at 25 DAS. Results showed that foliar application of salicylic acid and gibberellic acid sprayed at 25 DAS significantly improved biochemical parameters like nitrogen content in leaves, protein content in seed, total chlorophyll content in leaves and yield parameters like number of pods plant^{-1}, test weight, seed yield ha^{-1}, harvest index and B:C ratio. Treatment T_9 (Salicylic acid @ 150ppm) showed significantly higher results in all parameters under study. Effect of salicylic acid and gibberellic acid application was influenced by various environmental conditions and for accurate conclusion it is essential to understand the sensitivity of the black gram variety to prevailing conditions. The timing of salicylic acid and gibberellic acid application is critical and sophisticated analytical techniques are required for accurate measurement of biochemical parameters. To overcome these challenges, well-controlled experiments should be designed by considering multiple factors in collaboration with experts in plant physiology and biochemistry.

Keywords: *Vigna mungo*, salicylic acid, gibberellic acid, biochemical parameters, yield contributing parameters, growth regulators.

INTRODUCTION

Black gram (*Vigna mungo* L. Hepper) is one of the most important pulse crop grown throughout the India. Ithas chromosome number 2n = 24 and belong to the family "Leguminosae". It is also known as "Urd bean". In India, black gram traditionally grown in *Kharif*, but in south it is also grown as *Rabi* crop. It contains higher protein (25-26%), carbohydrate (60%), fat (1.5%), minerals, amino acids and vitamins. It contains more vitamin A, B1, B3 and has small amount of thiamine, riboflavin, niacin and vitamin C and 78% to 80% nitrogen in the form of albumin and globulin. Major source of phosphorus is dry seed (Anonymous, 2020).

The productivity of black gram is less to full fill the domestic demand of the fast-growing Indian population. Hence, there is an urgent need for increasing the productivity of black gram (Jadhav *et al*., 2020). Foliar application is a preferred solution when quick supply of nutrient is hindered or the soil condition is not conductive for the absorption of nutrient (Salisbury and Ross 1985). Salicylic acid plays an important role in plant growth and development, photosynthesis, transpiration, ion uptake and transport. Salicylic acid is phenolic phytohormone which induces specific changes in leaf anatomy and chloroplast structure (Hayat *et al.*, 2010). It has a defensive mechanism against abiotic as well as biotic stress in the plants. The positive impacts on the productivity as well as the nutritional value of black gram obtained by manipulating the level of exogenous application of salicylic acid (Hasan and Rasul 2023).

The plant growth and development are affected by gibberellic acid which induces metabolic activities and regulate nitrogen utilisation (Sure *et al*., 2012). It performs a significant role in seed germination, endosperm mobilisation, stem elongation, leaf expansion, reducing the maturation time and increasing flower and fruit set and their composition (Roy and Nasiruddin 2011). GA_3 also delays senescence,

increases growth and development of chloroplasts, and intensifies photosynthetic efficiency which ultimately increases yield (Yuan and Xu 2001).

MATERIAL AND METHODS

In *Kharif* 2022, a field experiment was conducted to assess the Influence of foliar sprays of Salicylic acid and Gibberellic acid on biochemical parameters and yield of black gram at Research farm of Agricultural Botany section, College of Agriculture, Nagpur. The experiment with three replications was laid out in randomized block design consisting of ten treatments i.e. T_1 (control), T_2 (Water spray), T_3 (Gibberellic acid @ 50 ppm), T_4 (Gibberellic acid @ 100 ppm), T_5 (Gibberellic acid @ 150 ppm), T_6 (Gibberellic acid @ 200 ppm), T_7 (Salicylic acid @ 50 ppm), T_8 (Salicylic acid @ 100 ppm), T_9 (Salicylic acid @ 150 ppm), T_{10} (Salicylic acid @ 200 ppm). At 25 DAS the foliar application of salicylic acid and gibberellic acid was given to black gram. The observations like nitrogen content in leaves, protein content in seed, total chlorophyll content in leaves were recorded at 30, 50 and 70 DAS. Yield and yield contributing attributes *viz*., number of pod plant^{-1}, seed yield ha^{-1}, test weight, harvest index and B:C ratio were also recorded at harvest. Statistical method suggested by Panse and Sukhatme (1954) were utilized for data analysis.

RESULTS AND DISCUSSION

Nitrogen content in leaves. Leaf nitrogen content showed significant variation in the observed data, due to foliar spray of salicylic acid and gibberellic acid at various concentrations in 30, 50 and 70 DAS. (Table 1). The data obtained for nitrogen content in leaves was increased from 30 DAS to 50 DAS and it decreased thereafter at 70 DAS. The younger leaves and developing organs, such as grains act as strong sink demand and may heavily draw nitrogen from older leaves and leaves are generally responsible for decrease in nitrogen (Gardner *et al*., 1988).

At 30, 50 and 70 DAS nitrogen content in leaves was recorded maximum (2.21, 2.84 and 1.13%) with foliar application of Salicylic acid @ 150 ppm over other treatment and control (1.06, 1.87 and 0.90 %). Similarly, the findings of Kumar *et al.* (2018) suggest that the maximum photosynthetic efficiency was observed in Salicylic acid @ 150 ppm treated plants asevidencedbythehighernitratereductaseactivityinblackgram.GA_3 @ 150 ppm also increases nitrogen content in leaves. The higher nitrogen content in leaves and protein content in seeds obtained with salicylic acid 150ppm attributed with increased in structural component of RNA molecules of amino acids and also salicylic acid causes marked increase in DNA, RNA and protein synthesis in ribosome which is known as site of protein synthesis in plants. The increasing nitrogen content in leaves is due to contribution of RNA molecules and nucleic acid.

Table 1: Effect of salicylic acid and gibberellic acid on biochemical parameter of black gram.

Treatments	Total chlorophyll content in leaves (mgg^{-1})			Nitrogen content in leaves (%)			Protein content in seeds (%)
	30 DAS	50 DAS	70DAS	30DAS	50DAS	70DAS	
T1(Control)	1.22	1.29	1.19	1.06	1.87	0.90	24.13
T2(Water Spray)	1.23	1.30	1.20	1.13	1.92	0.95	24.31
T3 (Gibberellic acid@ 50 ppm)	1.29	1.59	1.38	1.33	2.01	1.03	24.98
T4 (Gibberellic acid@ 100 ppm)	1.32	1.65	1.40	1.44	2.31	1.05	25.18
T5 (Gibberellic acid@ 150 ppm)	1.36	1.80	1.43	2.16	2.77	1.11	26.50
T6 (Gibberellic acid@ 200 ppm)	1.35	1.73	1.40	1.78	2.59	1.06	25.25
T7 (Salicylic acid @ 50 ppm)	1.27	1.54	1.31	1.21	2.12	0.97	24.87
T8(Salicylic acid @ 100 ppm)	1.34	1.77	1.47	1.57	2.42	1.04	25.08
T9 (Salicylic acid @ 150 ppm)	1.37	1.95	1.50	2.21	2.84	1.13	26.63
T10 (Salicylic acid @ 200 ppm)	1.25	1.79	1.35	1.86	2.67	1.09	25.44
SE(m)±	**0.03**	**0.03**	**0.04**	**0.07**	**0.05**	**0.05**	**0.50**
CDat5%	**0.10**	**0.10**	**0.12**	**0.20**	**0.15**	**0.14**	**1.50**

Total chlorophyll content in leaves. Foliar sprays at various concentrations of salicylic acid and gibberellic acid showed significant variation in total chlorophyll content in leaves at 30, 50 and 70 DAS of observed data (Table 1).

Up to 50 DAS chlorophyll content in leaves was increased but thereafter, it decreased at 70 DAS. At 30,50 and 70 DAS higher chlorophyll content in leaves observed (1.37,1.95 and 1.50 mg g^{-1}) with foliar application of salicylic acid @ 150 ppm over other treatment including control (1.22,1.29 and 1.19mg g^{-1}).

It was also supported by Kumar *et al*. (2018) where biochemical parameters in mung bean (*Vigna radiata* L.) was affected by the foliar application of Salicylic acid and GA_3. Chlorophyll content in leaves significantly increased by 150ppmsalicylic acid followed by 150 ppm GA_3 than control.

Protein content in seeds. Significant variation was observed in protein content in seeds due to foliar sprays at various concentrations of salicylic acid and gibberellic acid (Table 1).

Protein content in seeds provide significant variation among different treatments. However, treatment T_9 (Salicylic acid @ 150 ppm) recorded the highest value of protein content i.e., 26.63%, while control (T_1) treatment recorded minimum i.e., 24.13% protein content.

It is observed from the result that salicylic acid increases structural component of RNA molecules of amino acids and also it causes marked increase in protein synthesis in ribosome which is known as site of protein synthesis in plants.

These results are in accordance with Kumar *et al.* (2018) who reported that Salicylic acid @ 150 ppm treated plants resulted in higher soluble protein. Seed protein content was also found improved due to GA_3 @ 150 ppm application.

However, Mishra *et al.* (2021) observed the effect of foliar application of GA_3on growth and biochemical changes in green gram and proposed that GA_3 75 ppm estimated the higher protein content in seeds.

Yield parameters

Number of pod plant^{-1}. Number of pod plant^{-1} at harvest ranged from 27.91-49.26. Significantly highest number of pods plant^{-1} was found in T_9 (Salicylic acid @ 150 ppm) (Table 2).

According to the results of Pasarla *et al.* (2021) application of 150 ppm GA_3 showed significantly higher number of pods per plant in green gram.

The findings of the present investigation are in accordance with Islam *et al*. (2023) who obtained the results on yield attributing characters such as number of pods were recorded significantly higher with application o f GA_3 200 ppm.

Seed yield plant^{-1} (g), Plot^{-1} (kg) and ha^{-1} (q). Seed yield is final result of physiological activities of plant which is the economic yield. The part of biomass that is converted into economic product called an economic yield (Nichiporovic, 1960). Significantly maximum seed yield plant^{-1}, plot^{-1}andhect are^{-1} were produced in treatment T_9 (Salicylic acid @ 150 ppm). The range of increase in seed yield plant^{-1}, plot^{-1} and hectare^{-1} was 4.78g,0.54 kg and11.99 q in treatment T_1 (control) and 5.54g, 0.64 kg and 14.22 q in treatment T_9 (Salicylic acid @ 150 ppm) respectively (Table 2).

The result further verified by Pasarla *et al*. (2021) who reported that the highest seed yield was obtained in the treatments where the crop was sprayed with $GA_3$100 ppm in greengram.

Similarly, Hasan and Rasul (2023) reported that the maximum seed yield ha^{-1} was observed at 150 ppm salicylic acid in green gram than any other treatment.

Table 2: Effect of salicylic acid and gibberellic acid on yield parameter of black gram.

Treatments	Number of pods plant^{1}	Seed yield plant^{-1}(g)	Seed yield plot^{-1} (kg)	Seed yield ha^{-1} (q)	Test weight (g)	Harvest index (%)	B:C ratio
T_1(Control)	27.91	4.78	0.54	11.99	4.05	29.96	1.98
T_2(Water Spray)	28.23	4.85	0.55	12.22	4.07	30.56	1.99
T_3(Gibberellic acid @ 50 ppm)	34.66	4.89	0.58	12.88	4.28	32.45	2.16
T_4(Gibberellic acid@ 100 ppm)	39.49	5.09	0.62	13.77	4.49	35.81	2.27
T_5(Gibberellic acid@ 150 ppm)	46.84	5.48	0.63	13.99	5.02	37.20	2.54
T_6(Gibberellic acid@ 200 ppm)	44.61	5.21	0.59	13.10	4.65	36.31	2.40
T_7(Salicylic acid @ 50 ppm)	36.18	4.99	0.57	12.66	4.38	34.43	2.21
T_8(Salicylic acid @ 100 ppm)	42.76	5.21	0.61	13.55	4.54	36.12	2.38
T_9(Salicylic acid @ 150 ppm)	49.26	5.54	0.64	14.22	5.23	39.14	2.64
T_{10}(Salicylic acid @ 200 ppm)	44.80	5.29	0.62	13.77	4.78	37.64	2.47
SE(m)±	**1.61**	**0.14**	**0.02**	**0.40**	**0.19**	**1.31**	-
CDat5%	**4.77**	**0.43**	**0.05**	**1.19**	**0.56**	**3.89**	-

Test weight. The test weight recorded after harvest ranged from 4.05-5.23 g. Significantly highest test weight was found in T_9 (Salicylic acid @ 150 ppm) (Table 2).

Prakash *et al.* (2019) reported similar results that spraying Salicylic acid 100 ppm showed significant increase in1000seedweightingreengram followed by GA_3 100 ppm.

The findings of the present investigation are also in accordance with the observations of Islam *et al*. (2023) who obtained the results on yield characters such as test weight were recorded significantly higher with application of GA_3 200 ppm.

Similarly, Hasan and Rasul (2023) reported that the highest test weight was observed at Salicylic acid 150 ppm in green gram than any other treatment.

Harvest Index. The harvest index obtained was 29.96 in control to 39.14 in treatment receiving Salicylic acid @ 150 ppm. The study showed significantly higher harvest index was exhibited by treatment T_9 (Salicylic acid @ 150 ppm) than remaining (Table 2).

The significant effect of GA_3 100 ppm to increase in harvest index of mung bean was confirmed by Pasarla *et al.* (2021).

The findings of the present investigation are in accordance with the observations of Islam *et al*. (2023)

who reported that highest harvest index was recorded with application of GA_3 200 ppm.

Similarly, Hasan and Rasul (2023) reported that the higher harvest index was observed at Salicylic acid 150 ppm in green gram than any other treatment.

Benefit cost ratio. The treatment T_9 (Salicylic acid @ 150 ppm) recorded highest Benefit cost ratio over rest of the treatments followed by T_{10} (Salicylic acid @ 200 ppm) whereas lowest Benefit cost ratio was recorded with Control (0.97) (Table 2).

CONCLUSIONS

Application of Salicylic acid @ 150 ppm showed highest result in biochemical and yield parameters. The application of foliar nutrition helps to overcome the specific occurrence of stress and as a result of maximum vegetative growth due to optimized nutrition of the plant.

FUTURE SCOPE

Salicylic acid and GA_3 influence varied physiological processes like germination, growth, flowering, senescence and confer resistance to plant against various abiotic stresses and ultimately influence the seed yield. Salicylic acid and GA_3 are easily available to farmers and their foliar sprays are beneficial for improving growth and yield of the plant.

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