Original Research Article

Response of Different Levels of Salicylic Acid on Growth, Chlorophyll Content, Yield Attributes and Yields of Black Gram (*Vigna mungo* L.) under Rainfed Condition

ABSTRACT

To study the response of different levels of salicylic acid on growth, chlorophyll intensity, yield attributes and yields of black gram (*Vigna mungo* L.) under rainfed condition. The field experiment was conducted at Department of Crop Physiology, Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh, India during *kharif* season in the year 2017-18. The experiment was laid out in Randomized Block Design (RBD) with 10 Treatments replicated thrice and assigned in 30 plots. The treatment comprised as T1: Control, T2: Foliar application of salicylic acid @ 50 ppm at 20 DAS, T3: Foliar application of salicylic acid @ 50 ppm at 40 DAS, T4: Foliar application of salicylic acid @ 50 ppm at 60 DAS, T5: Foliar application of salicylic acid @ 100 ppm at 20 DAS, T6: Foliar application of salicylic acid @ 100 ppm at 40 DAS, T7: Foliar application of salicylic acid @ 100 ppm at 60 DAS, T8: Foliar application of salicylic acid @ 150 ppm at 20 DAS, T9: Foliar application of salicylic acid @ 150 ppm at 40 DAS, T10: Foliar application of salicylic acid @ 150 ppm at 60 DAS. The results showed significant increases in Growth attributes, relative water content (%), chlorophyll intensity (%), yield and yield attributes viz., plant height (36.50 and 38.10 cm) at 70 DAS and maturity, number of leaves plant^{-1}(8.66, 23.66 and 22.0) at 35, 70 DAS and maturity, number of branches plant^{-1} (3.9, 8.60 and 10.33) at 35, 70 DAS and maturity, dry weight of plant^{-1}(2.76, 6.12 and 5.01) at 35, 70 DAS and maturity, dry weight of stem plant^{-1}(2.76, 7.12 and 7.96) at 35, 70 DAS and maturity, total dry weight of plant (4.96, 13.24 and 21.97) at 35, 70 DAS and maturity, total leaf area plant^{-1} (211.33 and 384.87) at pre and post flowering, Relative water content (51.50 and 43.43%) at Pre and post flowering, Chlorophyll content (49.93 and 40.90) at pre and post flowering, Number of pods plant^{-1} (46.00) at maturity, Dry weight of pods plant^{-1} (8.99g) at maturity, seed yield plant^{-1} (6.66 g), 100-Seed weight (4.41 g), Harvesting index (30.30%), Grain Yield (10.35 q/ha) with the foliar application of salicylic acid @ 150 ppm at 60 DAS while minimum in control. The addition of salicylic acid under rainfed condition resulted in significant increments in growth parameters, chlorophyll intensity, yield and yield attributes of black gram in rainfed conditions. Thus, it may be concluded that the foliar application of salicylic acid @ 150 ppm found to be optimum concentration in enhancing growth and yield of black gram over rest of treatment under rainfed condition.

Keywords: *Black gram, Urd bean, Salicylic acid, Rainfed, Growth, Yield and Chlorophyll intensity*

1. INTRODUCTION

Black gram belongs to the family Fabaceae, sub-family Papilionaceae and the genus Vigna (Berani *et al*., 2018). Only seven species of the genus Vigna are cultivated as pulse crops, five Asian species of sub genus Ceratotropis, *Vigna mungo* (urd bean), *Vigna radiata* (mung bean), *V. aconitifolia (moth bean), V. angularis (azuki bean)* and *V. umbellata* (rice bean) and two African species of subgenus Vigna, i.e., *Vigna unguiculata* (cowpea) and *V. subterranean* bambara groundnut (Dikshit *et al*., 2012). Blackgram (*Vigna mungo L. Hepper*) is a member of the Asian Vigna crop group. It is a staple crop in the central and South East Asia; however it is extensively used only in India and now grown in the Southern United States, West Indies, Japan and other tropics and subtropics (Baligar & Fageria, 2007). Blackgram is native to India and the progenitor of blackgram is believed to be *Vigna mungo* var. silvestris, which grows wild in India (Bhareti *et al*., 2019). There is a mention of blackgram in Vedic texts such as Kautilya's **"Arthashasthra"** and **"Charak Samhita".** The ancient Sanskrit name of blackgram was **masha**. Even today in Punjab, blackgram is called mash and in West Bengal it is called **mash kalaya**. In all other Indian languages, the name urd and urdbean is used, which seems to have originated from the Tamil word ulundu. *Vigna mungo* is the Latin name of black gram (**Nene, 2006).** Urdbean is one of the most highly prized pulse crop, cultivated in almost all parts of India. It has inevitably marked itself as the most popular pulse and can be most appropriately referred to as the **"king of the pulses"** due to its mouthwatering taste and numerous other nutritional qualities. Whether it be the very special **"Dal makhni"** of Punjab or the **"Vada Sambhar"** of South India, the taste rules the hearts of one and all alike. Indian immigrants have popularized the taste worldwide as well (Rana *et al*., 2017). In Japan, the health conscious people eat these seeds by soaking them in water over night and then serving them as fresh bean sprout salad which is highly nutritious. Black gram is perfect combination of all nutrients, which includes proteins (25-26%), carbohydrates (60%), fat (1.5%), minerals, amino acids and vitamins (Karamany, 2006). It stands next to soybean in its dietary protein content. It is rich in vitamin A, B_1, B_3 and has small amount of thiamine, riboflavin, niacin and vitamin C in it. It Introduction 2 contains 78% to 80% nitrogen in the form of albumin and globulin. The dry seeds are good source of phosphorus. It also has very high calorie content; 100g of blackgram has 347 calories. Therefore, black gram is the cheapest available source of protein for the poor and vegetarians (Tharanathan and Mahadevamma, 2003). The biological value improves greatly, when wheat or rice is combined with black gram because of the complementary relationship of the essential amino acids such as lysine and sulphur containing amino acids methionine and cysteine. In addition, being an important source of human food, it is also used as nutritive fodder, especially for milch animals. Black gram also has medicinal properties, like curing diabetes, sexual dysfunction, nervous disorder, hair disorders, digestive system disorders and rheumatic afflictions. It is valued for its high digestibility and freedom from flatulence effect (Fery, 2002). Being a proper leguminous crop, it is itself a mini-fertilizer factory, as it has unique characteristics of maintaining and restoring soil fertility through fixing atmospheric nitrogen in symbiotic association with Rhizobium bacteria, present in the root nodules (Chesti *et al.,* 2013). It proves to be a great rotation crop enhancing the yield of main crop as well. It is mainly cultivated in a cereal-pulse cropping system primarily to conserve soil nutrients and utilize the left over soil moisture particularly after rice cultivation. It is short duration pulse crop usually

flowering within 30-60 days of sowing and maturing within 60-90 days. It is generally cultivated as *kharif* crop but also does well in summer season as a catch crop. Black gram is annual trailing or erect plant with a height of 30-90 cm and profuse branching. The stem is slightly ridged and covered with brown hairs. The leaves are large, trifoliate and hairy generally with a purplish tinge. The flowers are axillary, racemose, complete, self-pollinated and yellow in color. The inflorescence consists of cluster of 5-6 flowers at the top of long hairy peduncle. Pods are short, erect to suberect, 4-6 cm long, brown to black in color and hairy containing about 6- 10 seeds. The seeds are generally black or dark brown with smooth seed coat and protruding hilum India is the major pulse growing country of the world, accounting roughly for one third of the total world area under pulses and one-fourth of the total world production. Pulse crops, also called grain legumes have been values as food, fodder and feed and have remained as a mainstay of Indian agriculture for centuries. Even though India has successfully achieved food security, nutritional security continues to be causes for concern. In spite of the variable uses of pulses in our diet and its important in improving soil health by way of fixing atmospheric nitrogen the increments in production is not able to maintain the place with population growth (Chongre *et al*., 2019).

Pulses are wonderful gift of nature with unique ability of biological nitrogen fixation, deep root system, mobilization of insoluble soil nutrients and bringing qualitative changes in soil properties - which make them known as soil fertility restores (Lakshmi *et al*., 2018). Black gram is one of the most important pulse crops of rainfed areas grown thought the country. This crop is grown in different cropping system as a mixed crop, catch crop, sequential crop in the country. In India black gram is very popularly grown in Andhra Pradesh, Bihar, Madhya Pradesh, Maharashtra, U.P., West Bengal, Punjab, Haryana, and Karnataka. It is used as nutritive fodder especially for milch cattle and also used as a green manuring crop. In India total black gram production was estimated 14.76 million tonnes from 23.63 million hectare area with productivity of 642 kg/ha. Under the slogan 'nutritious seeds for a sustainable future,' the United Nations, led by its Food and Agriculture Organization (FAO), today launched the 2016 International Year of Pulses to raise awareness about the protein power and health benefits of all kinds of dried beans and peas, boost their production and trade, and encourage new and smarter uses throughout the food chain (Pulses, FAO 2016). Grain legumes occupy a unique position in Indian agriculture as they provide vegetable protein for human diet, pulse are also important in our agriculture system because of their nitrogen fixing ability about 40% of the total nitrogen in the world in added by leguminous plant (Chibarabada *et al.,* 2017). They can also suit to dry farming condition because of their ability to trap moisture from deep layers of the soil by virtue of their deep penetrating root system.

The main reason of low productivity of the green gram is cultivation on marginal and sub-marginal lands with no use of recommended dose of fertilizers (Komal *et al.,* 2015). Flowering is important parameter that is directly related to yield and productivity of plants. Salicylic acid has been reported to induce flowering in a number of plants. Different plant species including ornamental plant *Sinningia speciosa* flowered much earlier as compared to the untreated control, when they received an exogenous foliar spray B of salicylic acid (Keykha *et al.,* 2014). Foliar sprays of salicylic acid in green gram increase seed yield per plant (Ali and Mahmoud, 2013)**.** In addition application of salicylic acid as a 100 ppm concentration increase number of pods per

plant , number of seeds pod B seed weight plant, and seed yield/ha (Marimuthu & Surendran, 2015). (Rathinavelu *et al.,* 2018) reported that the application of 125 ppm salicylic acid to black gram plants increase seed yield. Plant growth regulators are one of the most important factors for increasing higher yield in leafy vegetables. Application of growth regulators has good management effect on growth and yield of field crops. Hormones regulate physiological process and synthetic growth regulators may enhance growth and development of field crops there by increased total dry mass of a field crop (Zaman *et al*., 2015). These plant growth regulators (PGRs) 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). The foliar application of PGRs and urea significantly increased seed yield per plant (Patil *et al*., 2005). The objectives of the experiments were to study the effects of different foliar application of Salicylic acid on physiological growth of black gram, to study the effect of foliar application of salicylic acid on yield and yield attributes of black gram and to find out the suitable foliar application of salicylic acid for increasing productivity of black gram.

2. MATERIALS AND METHODS

2.1 Experimental site: The experiment was conducted in department of crop physiology, during *Rab*i season 2017-18 in the department of Crop physiology, C. S. Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh (Fig. 1).

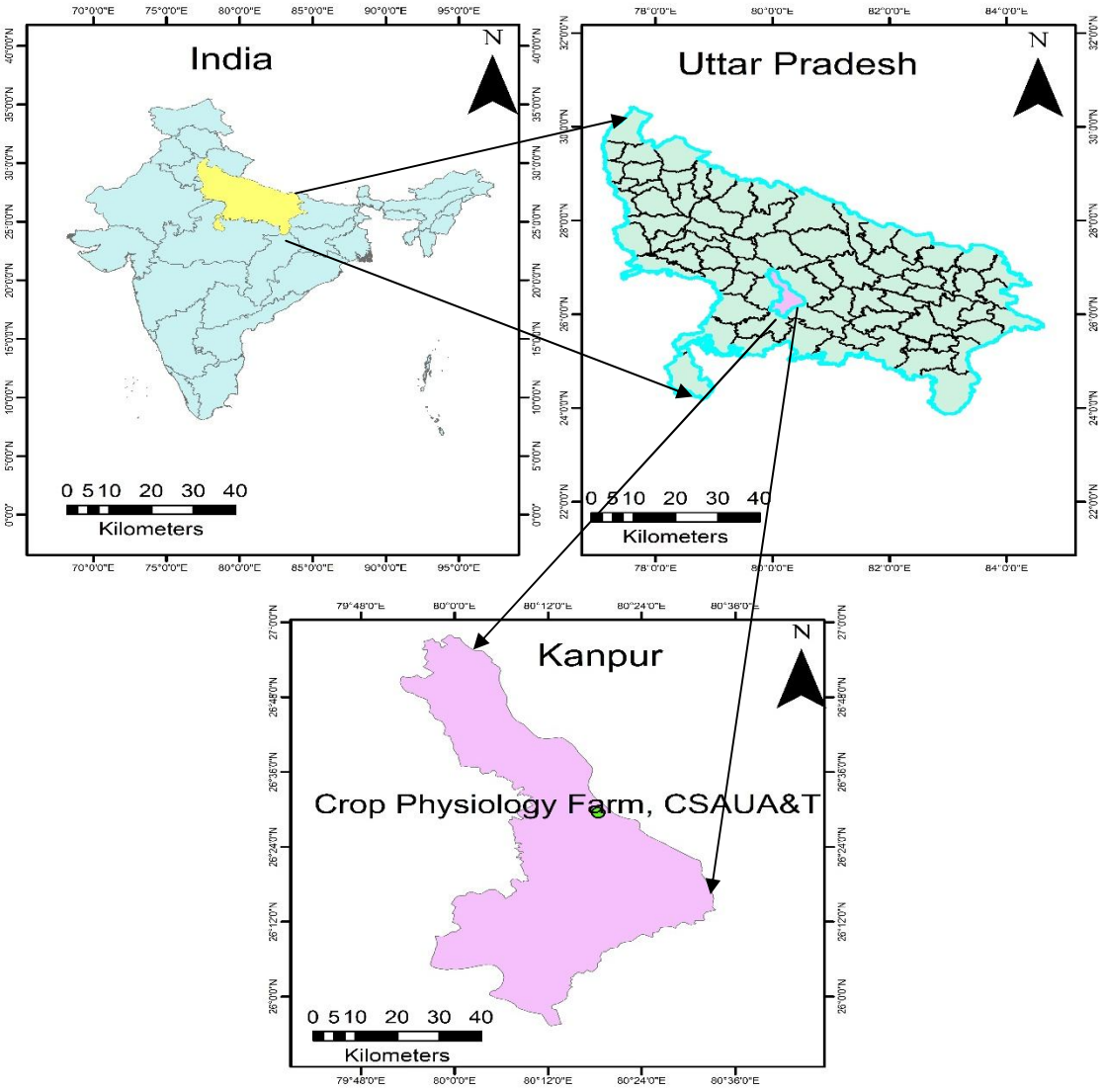

Fig. 1 LOCATION MAP OF THE STUDY AREA

2.2 Climatic conditions: Geographically, Kanpur is situated in the Central Pain Zone of Uttar Pradesh and subtropical tract of North India between latitude ranging from 25° 56' to 28° 58' North and longitude 79° 31' to 80° 34' East and is located on an elevation of about 125.9 meters above mean sea level in gangetic plain region. The seasonal rainfall of about 816 mm received mostly from second Fortnight of June or first Fortnight of July to mid-October with a few showers in winter season.

2.3 Experimental details: The experiment was laid out in Randomized Block Design (RBD) with 10 Treatments replicated thrice and assigned to 30 plots. The treatment comprised as T1: Control, T2: Foliar application of salicylic acid @ 50 ppm at 20 DAS (day after sowing), T3: Foliar application of salicylic acid @ 50 ppm at 40 DAS, T4: Foliar application of salicylic acid @ 50 ppm at 60 DAS, T5: Foliar application of salicylic acid @ 100 ppm at 20 DAS, T6: Foliar

application of salicylic acid @ 100 ppm at 40 DAS, T7: Foliar application of salicylic acid @ 100 ppm at 60 DAS, T8: Foliar application of salicylic acid @ 150 ppm at 20 DAS, T9: Foliar application of salicylic acid @ 150 ppm at 40 DAS, T10: Foliar application of salicylic acid @ 150 ppm at 60 DAS.

2.4 Fertilization: The experimental field was ploughed once with a soil turning plough and two ploughings with cultivator followed by planking for uniform level field. Basal application of 20 N, 60 P_2O_5 and 20 K_2O Kg ha^{-1} were applied uniformly in the form of urea, DAP and Muriate of potash.

2.5 Seed and Sowing: The Azad-3 variety selected for this study was released from Chandra shekhar Azad University of Agriculture & Technology (U.P.) Kanpur.

2.6 Observations recorded: The observed parameters growth, chlorophyll intensity and yield were characterized as plant height (cm) at 35, 70 DAS and maturity, number of leaves $plant^{-1}$ at 35, 70 DAS and maturity, number of branches $plant^{-1}$ at 35, 70 DAS and maturity, dry weight of leaves $plant^{-1}$ at 35, 70 DAS and maturity, dry weight of stem $plant^{-1}$ at 35, 70 DAS and maturity, total dry weight of plant at 35, 70 DAS and maturity, total leaf area $plant^{-1}$ at pre and post flowering, Relative water content (%) at Pre and post flowering, Chlorophyll intensity(%) at pre and post flowering, Number of pods plant-1 at maturity, Dry weight of pods plant-1 at maturity, Gran yield (g plant-1), 100-Seed weight (g), Harvesting index (%), Grain Yield (q/ha) had to be determined. Data obtained was exposed to the proper method for statistical analysis of variance difference among mean of different treatments as described by (Gomez and Gomez, 1976). The treatments means were compared using the Least Significant Differences (LSD) test at 5% level of probability by using the Randomized Block Design (RBD) model as obtained by SPSS (Statistical Product and Service Solutions) Version 10.0, SPSS, Chicago and IL software.

3. RESULTS AND DISCUSSION

3.1 Growth Attributes: The perusal of the data reveals that Growth attributes (Table 1) of black gram were observed significantly better with the application of different levels of salicylic acid at different stages under rainfed condition. The Growth attributes *viz.*, plant height (36.50 and 38.10 cm) at 70 DAS and maturity, number of leaves $plant^{-1}$(8.66, 23.66 and 22.0) at 35, 70 DAS and maturity, number of branches $plant^{-1}$ (3.9, 8.60 and 10.33) at 35, 70 DAS and maturity, dry weight of $plant^{-1}$(2.76, 6.12 and 5.01) at 35, 70 DAS and maturity, dry weight of stem $plant^{-1}$(2.76, 7.12 and 7.96) at 35, 70 DAS and maturity, total dry weight of plant (4.96, 13.24 and 21.97) at 35, 70 DAS and maturity, total leaf area $plant^{-1}$ (211.33 and 384.87) at pre and post flowering were found to be maximum by the foliar application of salicylic acid @ 150 ppm at 60 DAS while minimum in control. Application of salicylic acid under rainfed condition proved to be effective in enhancement of plant height, number of leaves $plant^{-1}$, number of branches $plant^{-1}$, dry weight of $plant^{-1}$, total leaf area $plant^{-1}$,etc. over control. Foliar application of BR and SA might have enhanced the CO_2 fixation, induced activity of carbohydrate synthesizing enzymes coupled with effective partitioning of dry matters into reproductive sink as reported earlier (Bera,

Maity, & Maumdar, 2008). The significant increase in growth characters of black gram might be due to application of salicylic acid and growth regulator foliar spray which play a major role in growth development and metabolism of black gram under rainfed condition. Similar results, more or less were obtained by (Amin *et al.*, 2009), (Jeyakumar *et al*., 2008), (Manjri *et al.*, 2018), (Sujatha, 2001), (Hayat *et al.*, 2007), (Chandra *et al*., 2007) and (Mady, 2009).

3.2 Relative Water content (%): A perusal of data on relative water content (RWC) as presented in Table 4 showed that different levels of salicylic acid significantly increased relative water content over control teatment at Pre and post flowering of black gram under rainfed condition. The Maximum relative water content was recorded by the foliar application of salicylic acid @ 150 ppm at 60 DAS at Pre flowering (51.50%) and post flowering (43.43%). The relative water content is a useful measure of the physiological water status of plants (Gonzalez and Gonzalez-Vilar, 2001). Our results revealed that salt stress caused reduction in relative water content of the leaves at different growth stages However treating the plants with salicylic acid caused an improvement in relative water content, the concentration of salicylic acid @150 ppm being more effective in 100 ppm and 50 ppm salicylic acid treatments induced an increase in leaf relative water content of the stressed plants compared to the non-treated plants. Similar results, more or less were obtained by (Khan, *et al*., 2003),

3.3 Chlorophyll content (SPAD meter value): The data showed that the chlorophyll intensity (Table 4) at different growth stage was significant variation observed with application different levels of salicylic acid at different stages. The chlorophyll intensity at pre-flowering (49.93) and post-flowering (40.90) were found to be maximum by the foliar application of salicylic acid @ 150 ppm at 60 DAS followed by foliar application of salicylic acid @ 150 ppm at 40 DAS at pre-flowering (49.50) and post-flowering (40.96). Similar results, more or less were obtained by (Kuttimani and Velayutham (2011), (Amin *et al.*, 2016), (Jaiswal *et al.*, 2014), **(**Yildirim et al., 2008)

3.4 Yield attributes: The data showed that the yield attributes (Table 5) of bank gram plants had significantly affected by application of different levels of salicylic acid at different stages under rainfed condition. Data showed that the highest all yield attributes i.e. number of pods plant^{-1}(46.0), dry weight of pods plant^{-1}(8.99g), seed yield plant^{-1}(6.66g), 100-seed weight (4.41g) were observed in the foliar application of salicylic acid @ 150 ppm at 60 DAS. It may be due to better growth attributes i.e. plant height, number of leaves plant^{-1}, number of branches plant^{-1}, dry weight of leaves plant^{-1}, dry weight of stem plant^{-1}, total dry weight of plant, total leaf area of plant and strong source-sink relationship in Black gram under rainfed condition through application of salicylic acid. Application of salicylic acid at 100 ppm increased number of pods plant^{-1}, number of seeds pod^{-1}, seed weigh plant^{-1}, and seed yield ha^{-1} (Sujatha, 2001). (Jeyakumar *et al*., 2008) also reported that application of 125 ppm salicylic acid to black gram plants increased seed yield. Similar results, more or less were obtained by (Matwa *et al.*, 2017) and (Shweta Jamra, 2017).

3.5 Yield: The data showed that the Foliar application of salicylic acid in different treatments had significant variation in the yield (Table 5) of black gram under rainfed condition. Among the treatments, the foliar application of salicylic acid @ 150 ppm at 60 DAS (flowering stage) recorded significantly higher grain yield (10.35 q ha^{-1}) and harvesting index (30.30 %) and minimum in control. It was comparable with all other treatment the increased in yield might be due to enhanced yield attributes like number of pods $plant^{-1}$, number of seeds pod^{-1}, Dry weight of pods $plant^{-1}$ at maturity and 100-Seed weight (g). It is due to increased uptake of nutrients by black gram by effective translocation of nutrients from sink to reproductive area of crop. It was inferred that application of salicylic acid similar result was also reported (Ali and Mahmoud, 2013) seed yield and yield components of mungbean. Similar results, more or less were obtained by, (Manjri *et al.*, 2018).

Table 1: Effect of Salicylic acid on plant height (cm) and Number of leaves $plant^{-1}$ at 35 DAS, 70 DAS and at maturity

Treatments	Plant height (cm) at 35 DAS	Plant height (cm) at 70 DAS	Plant height (cm) at maturity	Number of leaves $plant^{-1}$ at 35 DAS	Number of leaves $plant^{-1}$ at 70 DAS	Number of leaves $plant^{-1}$ maturity
T_1	12.80	20.40	23.83	5.33	12.00	11.33
T_2	14.46	22.63	25.86	6.66	13.33	13.00
T_3	13.23	24.23	26.80	6.33	14.33	12.66
T_4	13.20	24.80	27.06	6.66	15.33	14.66
T_5	14.96	25.86	28.93	7.00	16.66	16.33
T_6	13.63	27.83	30.66	7.33	18.00	17.33
T_7	13.56	30.40	31.50	7.66	19.33	18.33
T_8	16.06	34.90	35.36	8.00	21.00	19.66
T_9	13.96	35.23	36.26	8.66	22.33	21.33
T_{10}	14.16	36.50	38.10	8.66	23.66	22.00
CD	1.47	1.85	1.74	1.09	1.67	2.01
SE(D)	0.69	0.87	0.82	0.51	0.79	0.95
CV	6.11	3.79	3.30	8.78	5.50	6.99

Table 2: Effect of Salicylic acid on Number of branches and Dry weight of leaves plant^{-1} at 35, 70 DAS and at maturity

Treatments	Number of branches plant^{-1} at 35 DAS	Number of branches plant^{-1} at 70 DAS	Number of branches plant^{-1} at maturity	Dry weight of leaves plant^{-1} at 35 DAS	Dry weight of leaves plant^{-1} at 70 DAS	Dry weight of leaves plant^{-1} at maturity
T_1	1.27	3.33	4.33	0.84	3.43	3.23
T_2	1.60	4.00	5.33	0.95	3.80	3.43
T_3	2.03	4.33	6.00	1.08	4.18	3.69
T_4	2.36	5.00	6.33	1.11	4.57	3.88
T_5	2.41	5.66	7.33	1.51	4.68	4.18
T_6	2.65	6.33	7.66	1.63	5.03	4.47
T_7	2.96	7.00	8.00	1.86	5.39	4.65
T_8	3.64	7.33	9.00	2.04	5.63	4.81
T_9	3.74	8.33	9.66	2.14	5.79	4.93
T_{10}	3.90	8.66	10.33	2.20	6.12	5.01
CD	0.14	0.97	1.036	0.15	0.39	0.10
SE(D)	0.06	0.45	0.489	0.07	0.18	0.05
CV	3.06	9.35	8.027	5.91	4.62	1.47

Table 3: Effect of Salicylic acid on Dry weight of stem plant^{-1} and Total Dry weight of plant at 35, 70 DAS and at maturity

Treatments	Dry weight of stem plant^{-1} at 35 DAS	Dry weight of stem plant^{-1} 70 at DAS	Dry weight of stem plant^{-1} at maturity	Total Dry weight of plant at 35 DAS	Total Dry weight of plant at 70 DAS	Total Dry weight of plant at maturity
T_1	0.84	4.13	4.12	1.68	7.56	12.35
T_2	0.95	4.61	4.68	1.90	8.41	13.72
T_3	1.08	5.22	5.20	2.16	9.40	14.76
T_4	1.11	5.49	5.48	2.23	10.06	15.56
T_5	1.51	5.66	5.74	3.02	10.35	16.29
T_6	1.69	5.88	6.08	3.32	10.91	17.50
T_7	2.26	6.35	6.50	4.12	11.74	18.47
T_8	2.56	6.55	7.04	4.60	12.19	19.76
T_9	2.71	6.85	7.53	4.85	12.82	20.86
T_{10}	2.76	7.12	7.96	4.96	13.24	21.97
CD	0.25	0.18	0.27	0.28	0.33	1.98
SE(D)	0.12	0.08	0.13	0.13	0.15	0.93
CV	8.42	1.81	2.63	5.05	1.79	6.68

Table 4: Effect of Salicylic acid on Total leaf area plant^{-1}, Relative water content (%) and Chlorophyll intensity (%) at pre and post flowering

Treatments	Total leaf area plant^{-1} at Pre flowering	Total leaf area plant^{-1} at Post flowering	Relative water content (%) at Pre flowering	Relative water content (%) at Post flowering	Chlorophyll intensity(%) at pre flowering	Chlorophyll intensity(%) at post flowering
T_1	110.34	179.00	35.46	27.66	38.66	28.58
T_2	120.46	196.03	36.86	34.53	41.33	31.16
T_3	130.76	204.50	38.43	35.20	42.83	32.80
T_4	141.03	226.03	41.83	37.23	44.70	34.48
T_5	145.04	246.03	43.30	38.46	46.30	35.26
T_6	157.74	275.00	44.50	38.80	47.30	36.86
T_7	171.61	295.40	45.66	40.90	48.20	37.40
T_8	191.06	315.70	47.23	41.36	48.93	38.30
T_9	198.90	357.80	49.46	41.93	49.50	39.41
T_{10}	211.33	384.87	51.50	43.43	49.93	40.90
CD	5.51	7.74	3.73	1.14	3.708	1.67
SE(D)	2.60	3.65	1.76	1.01	1.751	0.79
CV	2.01	1.67	4.97	3.27	4.686	2.73

Table 5: Effect of Salicylic acid on Yield and Yield Attributes of Black gran

Treatments	Number of pods plant^{-1} at maturity	Dry weight of pods plant^{-1} at maturity	Gran yield (g plant^{-1})	100-Seed weight (g)	Harvesting index (%)	Grain Yield (q/ha)
T_1	21.00	5.00	2.44	3.24	18.21	8.20
T_2	23.66	5.61	2.62	3.32	19.08	8.40
T_3	25.00	5.86	2.98	3.52	20.18	8.90
T_4	28.00	6.19	3.23	3.59	20.75	9.30
T_5	30.33	6.36	3.59	3.70	22.02	9.45
T_6	34.66	6.93	3.97	3.76	22.68	9.85
T_7	37.66	7.32	4.52	3.94	24.46	9.95
T_8	41.33	7.90	5.49	4.03	27.77	10.10
T_9	44.33	8.39	6.06	4.27	29.04	10.20
T_{10}	46.00	8.99	6.66	4.41	30.30	10.35
CD	2.50	0.60	0.46	0.14	0.14	0.014
SE(D)	1.18	0.28	0.28	0.06	0.06	0.007
CV	4.36	5.08	6.40	2.20	0.35	0.088

4. CONCLUSION

The results obviously suggest and it may be concluded that foliar application of salicylic acid on bkack gram (urdbean) variety Azad urd-3 significantly change plant morphology, improvement in vegetative and reproductive growth to enable them for higher yield. These substances judiciously work out can be employed successfully for yield maximization of black gram under rainfed condition.

REFERENCES

Ali, E. A., & Mahmoud, A. M. (2013). Effect of foliar spray by different salicylic acid and zinc concentrations on seed yield and yield components of mungbean in sandy soil. *Asian J. Crop Sci*, *5*(1), 33-40.

Amin, B., Mahleghah, G., Mahmood, H. M. R., & Hossein, M. (2009). Evaluation of interaction effect of drought stress with ascorbate and salicylic acid on some of physiological and biochemical parameters in okra (Hibiscus esculentus L.). *Res. J. Biol. Sci*, *4*(4), 380-387.

Baligar, V. C., & Fageria, N. K. (2007). Agronomy and physiology of tropical cover crops. *Journal of Plant Nutrition*, *30*(8), 1287-1339.

Berani, N. K., Damor, M. P., & Godhani, P. H. (2018). Impact of date of sowing on lepidopteran insect pest of black gram, Vigna mungo (L.) Hepper. *Journal of Entomology and Zoology Studies*, *6*, 24-26.

Bhareti, P., Purohit, S., Singh, D. P., & Khulbe, R. K. (2019). Genetic diversity in yield and yield component in Blackgram [*Vigna mungo* (L) Hepper]. *Journal of Pharmacognosy and Phytochemistry*, *8*(2), 1369-1372.

Chandra, A., Anand, A., & Dubey, A. (2007). Effect of salicylic acid on morphological and biochemical attributes in cowpea. *Journal of Environmental Biology*, *28*(2), 193-196.

Chesti, M. U. H., Qadri, T. N., Hamid, A., Qadri, J., Azooz, M. M., & Ahmad, P. (2013). Role of Bio-fertilizers in crop improvement. In *Crop Improvement* (pp. 189-208).

Chibarabada, T. P., Modi, A. T., & Mabhaudhi, T. (2017). Expounding the value of grain legumes in the semi-and arid tropics. *Sustainability*, 9(1), 60.

Chongre, S., Mondal, R., Biswas, S., Munshi, A., Mondal, R., & Pramanick, M. (2019). Effect of Liquid Manure on Growth and Yield of Summer Green Gram (Vigna radiata L. Wilczek). *Current Journal of Applied Science and Technology*, 1-7.

Dikshit, H. K., Singh, D., Singh, A., Jain, N., Kumari, J., & Sharma, T. R. (2012). Utility of adzuki bean [Vigna angularis (Willd.) Ohwi & Ohashi] simple sequence repeat (SSR) markers in genetic analysis of mungbean and related Vigna spp. *African Journal of Biotechnology*, *11*(69), 13261-13268.

Fery, R. L. (2002). New opportunities in Vigna. *Trends in new crops and new uses*, 424-428.

Gomez KA, Gomez AA. (1976) Statistical Procedures for Agricultural Research. John Wiley & Sons, Inc. New York, 1984, 680

Hayat, S., Ali, B., & Ahmad, A. (2007). Salicylic acid: biosynthesis, metabolism and physiological role in plants. In *Salicylic acid: A plant hormone* (pp. 1-14).

Jaiswal, A. K. A. N. K. S. H. A., Pandurangam, V., & Sharma, S. K. (2014). Effect of salicylic acid in soybean (Glycine max L. Meril) under salinity stress. *Bioscan*, *9*(2), 671-676.

Jeyakumar, P., Velu, G., Rajendran, C., Amutha, R., Savery, M. A. J. R., & Chidambaram, S. (2008). Varied responses of black gram (Vigna mungo) to certain foliar applied chemicals and plant growth regulators. *Legume Research-An International Journal*, *31*(2), 105-109.

Karamany, E. L. (2006). Double purpose (forage and seed) of mung bean production 1-effect of plant density and forage cutting date on forage and seed yields of mung bean (Vigna radiata (L.) Wilczck). *Res. J. Agric. Biol. Sci*, *2*, 162-165.

Keykha, M., Ganjali, H. R., & Mobasser, H. R. (2014). Effect of salicylic acid and gibberellic acid on some characteristics in mungbean (Vigna radiata). *Int. J. Biosci*, *5*, 70-75.

Khan, W., Prithiviraj, B., & Smith, D. L. (2003). Photosynthetic responses of corn and soybean to foliar application of salicylates. *Journal of plant physiology*, *160*(5), 485-492.

Komal, S. S., & Yadav, R. S. (2015). Effect of weed management on growth, yield and nutrient uptake of greengram. *Indian J Weed Sci*, *47*, 206-210.

Kuttimani, R., & Velayutham, A. (2011). Foliar application of nutrients and growth regulators on yield and economics of green gram. *Madras Agric. J*, *98*(4), 141-143.

Lakshmi, K. V., Sree, S. P., Lakshmi, N. V., Vani, P. M., & Chandrasekhar, K. (2018). Consumptive Use of Water, Soil Moisture Use Rate and Water Productivity of Blackgram as Influenced by Foliar Nutrition under Limited Irrigation. *Int. J. Curr. Microbiol. App. Sci*, *7*(6), 2419-2424.

Mady, M. A. (2009). Effect of Foliar Application with Salicylic Acid and Vitamin E on Growth and Productivity of Tomato (Lycopersicon Esculentum, Mill.) Plant. *Journal of Plant Production*, *34*(6), 6715-6726.

Manjri Singh, A., Gupta, S. D., Bahadur, R., & Singh, A. K. (2018). Responses of Blackgram (Vigna mungo) to Foliar Applied Plant Growth Regulators. *International Journal of Current Microbiology and Applied Sciences*, *7*, 4058-4064.

Marimuthu, S., & Surendran, U. (2015). Effect of nutrients and plant growth regulators on growth and yield of black gram in sandy loam soils of Cauvery new delta zone, India. *Cogent Food & Agriculture*, *1*(1), 1010415.

Matwa, D., Rao, K. P., Dhewa, J. S., & Rajveer, R. (2017). Effect of plant growth regulators (PGRs) and micronutrients on flowering and yield parameters of green gram (*Vigna radiate* L.). *Int. J. Curr. Microbiol. App. Sci*, *6*(4), 2350-2356.

Nene, Y. L. (2006). Indian pulses through the millennia. *Asian Agri-History*, *10*(3), 179-202.

Patil, S.N; Patil,R. B. and Suyawanshi, Y.B. (2005). Effect of foliar application of plant growth regulators and nutrients on seed yield and quality attributes of mugbean (*Vigna radiata* L.) Wilezeli. Seed Res., 33: 142-145.

Pulses, F. A. O. (2016). Nutritious Seeds for a Sustainable Future. *FAO: Rome, Italy*, 1-196.

Ramesh, K. and V. Thirumurugan. (2001). Effect of seed pelleting and foliar nutrition on growth of soybean. Madras Agric. J. 88: 465-468.

Rana, A. S., Chandel, S. S., & James, A. (2017). Effect of microclimatic condition on growth and yield of black gram (Vignamungo L.) in Allahabad city, India. *International Journal of Research in Social Sciences*, *7*(12), 363-372.

Rathinavelu, S., Priya, J., & Sivabalan, N. (2018). Impact of Plant Growth Regulators and Nutrient Consortium on Growth, Superoxide Dismutase, Na^ sup+^/K^ sup+^ ratio and Yield of Blackgram under Salinity Stress. *International Journal of Agriculture, Environment and Biotechnology*, *11*(5), 791-798.

Shweta Jamra (2017). Effect of foliar application of nutrients on growth and development of black gram (*Vigna mungo* L.) under rainfed Vertisols of Central India, *International Journal of Chemical Studies* 6(1): 609-613.

Sujatha, K. B. (2001). Effect of foliar spray of chemicals and bioregulators on growth and yield of greengram (Vigna radiata L.). *M. Sc.(Ag.) Thesis. Tamil Nadu Agric. Univ., Coimbatore*.

Tharanathan, R. N., & Mahadevamma, S. (2003). Grain legumes—a boon to human nutrition. *Trends in Food Science & Technology*, *14*(12), 507-518.

Yildirim, E., Turan, M., & Guvenc, I. (2008). Effect of foliar salicylic acid applications on growth, chlorophyll, and mineral content of cucumber grown under salt stress. *Journal of plant nutrition*, *31*(3), 593-612.

Zaman, M., Kurepin, L. V., Catto, W., & Pharis, R. P. (2015). Enhancing crop yield with the use of N-based fertilizers co-applied with plant hormones or growth regulators. *Journal of the Science of Food and Agriculture*, *95*(9), 1777-1785.