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Influence of plant growth regulators on biochemical changes of mungbean (*Vigna radiata* L. Wilczek)

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Abstract
The present investigation entitled "Influence of plant growth regulators on biochemical changes of mungbean (*Vigna radiata* L. Wilczek)" was conducted during *kharif* season, 2015 at the Instructional Farm of Narendra Deva University of Agriculture & Technology, Kumarganj, Faizabad (U.P.), India in randomized block design with ten treatments, three replications and variety Narendra mung-1. The treatments were comprised of foliar spray of two plant growth regulators (PGRs) of different concentrations *viz*., Salicylic acid (50, 100, 150 and 200 ppm) and GA_3 (50, 100, 150 and 200 ppm) along with untreated control (distilled water spray) & spraying was done at 25 DAS. The observations were taken on biochemical parameters like chlorophyll, nitrate reductase, protein and nitrogen content. All the PGRs *viz*., salicylic acid and GA_3induced positive influence on chlorophyll, nitrate reeducates, protein and nitrogen content in plants but the foliar spraying of SA 150 ppm at 25 DAS was found more profound among all treatments. On the basis of above investigation it may be concluded that foliar spray of PGRs at 25 DAS may be used as a potential tool to improve growth and yield of mungbean.

Keywords: Mungbean, GA_3, SA, biochemical

Introduction

Pulses stand a strategic position in the agriculture economy of our country. They contain high percentage of quality protein three times more than cereals. Pulses contain vitamin B, minerals and also contain a certain quality fibers, which is desirable in human diet because of medical consideration.Pulse crops enrich the soil through symbiotic nitrogen fixation from atmosphere. Besides being a rich source of protein, they maintain soil fertility through biological nitrogen fixation in soil and thus, play a vital role in sustainable agriculture. Mungbean (*Vigna radiata* L. wilezek) is also known as green gram, it is an important pulse crop of India and grown in *Rabi* (South India), *Kharif* and *Zaid*seasons. It is green with husk and yellow when dehusked. The beans are small, ovoid in shape and green in color. Average area under mung bean in India is 3.02 m ha with a production of 1.50 m tones and productivity 298.0 kg/h. In U.P., it occupies 88.0 ha area with production of 46.0 tones and productivity 523.0 kg/h. (Anonymous, 2015-16).

Plant growth regulators can improve the physiological efficiency including photosynthetic abilityand thereby helping in effective flower formation, fruit and seed development and ultimately enhance productivity of the crops (Solamani*et al*. 2001). Foliar feeding of plants can effectively supplement soil fertilization. It has been found that element foliar application is more influential compared to soil application (Kazemi 2013).Seeding date is an important factor affecting growth and yield traits which vary depending on the environmental conditions associated with the agriculture, particularly temperature, light and humidity which determines the best time for Mung bean cultivation. Growth is affected negatively or positively by plant growth regulators including salicylic acid which works to improve the productivity of crop through its effect on the important physiological process in the plant such as growth, photosynthesis, flowering and drought resistance.

Salicylic acid is a phenolic phytohormone and is found in plants with roles in plant growth and development, photosynthesis, transpiration, ion uptake and transport. Salicylic acid also induces specific changes in leaf anatomy and chloroplast structure. Salicylic acid (SA) is an endogenous plant growth of phenolic nature that possesses an aromaticring with a hydroxyl group or its hormone plays a vital role in plant growth, ion uptake and transport (Hayat *et al.* 2010). Enhanced germination and seedling growth were recorded in wheat, when the grains were subjected to pre-sowing seed-soaking treatment in salicylic acid (Shakirova 2007). However, numerous studies have demonstrated that the effect of exogenous SA depends on various factors, including the species and developmental stage, the mode of application and the concentration of SA used (Vanacker*et al.* 2001; Horvth*et al.* 2007).

Fariduddin*et al.* (2003) also eported that the dry matter accumulation was significantly increased in *Brassicajuncea*, when lower concentrations of salicylic acid were sprayed. However, higher concentrations of salicylic acid had an inhibitory effect. Khodary (2004) observed a significant increase in growth characteristic, pigment contents and photosynthetic rate in maize, sprayed with salicylic acid.

Gibberellic acid (GA_3) is an important PGR that affects plant growth and development by induc-ing metabolic activities and regulating nitrogen uti-lisation (Sure *et al*. 2012). It also plays a significant role in seed germination, endosperm mobilisation, stem elongation, leaf expansion, reducing the matu-ration time and increasing flower and fruit set and their composition (Roy &Nasiruddin 2011). GA_3 delays senescence, improves growth and develop-ment of chloroplasts, and intensifies photosynthetic efficiency which could lead to increased yield (Yuan &Xu 2001). The applications of gibberellins increase theseed germination percentage by attributing the fact that they increase the amino acid content in embryo and cause release of hydrolytic enzyme required for digestion of endospermic starch when seeds renew growth at germination.

Materials and Methods

The present investigation was carried out in the Student Instructional Farm (SIF) Narendra Deva University of Agriculture & Technology, Kumarganj Faizabad (U.P.) under Normal condition during *Kharif* season of 2015.The hormonal solutions were prepared by dissolving in organic solvent then maintained the desired concentration in distilled water. Solution of salicylic acid (50, 100, 150 and 200 ppm) and GA_3 (50, 100, 150 and 200 ppm) were prepared at 25 days after sowing and sprayed on the foliage of plants with the help of hand sprayer "Ganesh" as per treatment. While in untreated control distilled water was sprayed. Chlorophyll and nitrogen content were measured with the help of SPADE Model:X55/M-PEA.Nitrate reductase activity was assayed according to the method of Jaworski (1971) and expressed as µ g nitrite produce g^{-1} fresh weight.Protein content was estimated by using method of Lowery *et al.* 1951.

Results and Discussions

The mean data pertaining to chlorophyll content showed in Table 1. Higher chlorophyll content (12.56, 14.75, 15.53 and 13.36 SPAD value) at 40, 50, 60 DAS and at physiological maturity was analyzed with foliar spray of salicylic acid 150ppm, followed by foliar spray of salicylic acid 200 ppm over other treatments including control (8.20, 9.24, 10.88 and 8.78) at 40, 50, 60 DAS and at physiological maturity, respectively.It was also supported by Salama*et al* (1994) confirmed that salinity caused swelling of membranes in chloroplasts of sensitive plants which affects their chlorophyll content. Islam *et al.* (2010) also reported that application of GABA (mixture of GA_3 and ABA) at 1.0 mg/l increased total chlorophyll content in *Vigna mungo*.

The mean data pertaining to nitrate reductase under various treatments presented in Table 2. Data indicated that all treatments showed a significant increase in nitrate reductase activity at all the stages of observations over control. The maximum increase in nitrate reductase activity (174.10, 188.82, 196.63 and 169.48µg nitrate produce g^{-1} fresh weighthours^{-1}) was recorded with foliar spray of salicylic acid 150 ppm at 40, 50, 60 DAS and at physiological maturity stages, respectively. The minimum increase in nitrate reductase activity (146.63, 157.34, 165.45 and 143.43 µg nitrate produce g^{-1} fresh weight hours^{-1}) was recorded with control at 40, 50, 60 DAS and at physiological maturity stage, respectively.In this experimentation higher chlorophyll and protein content was also observed which might be due increased NR activity. Similar finding has been reported by Senthil*et al.* (2003), that response of foliar spray of Brassinosteroid (BR), salicylic acid, NAA, IAA and kinetin on biochemical parameters such as chlorophyll content, soluble protein, NR activity and peroxidase activity of soybean (var. CO-5) was significantly higher over the control. These findings are in close conformity with Sarangthem and Sarangthem (2006) conducted the experiment on *Vigna mungo.* They reported enhanced the activity of nitrate reductase.

The data pertaining to the protein content in seed under the various growth regulators treatments presented in Table 3. Data indicated that the protein content in grains influenced due to various treatments. The maximum increase in protein content (25.07%) was recorded with foliar spray of salicylic acid 150 ppm, which found significantly superior over control (22.56%). The minimum protein content was recorded due to foliar spray of salicylic acid 50 ppm in compared to control (23.24%).The increase in protein content was also supported by Senthil*et al.* (2003) reported that foliar spray of brassinosteroides, salicylic acid, NAA, IAA and Kinetin significantly increased soluble protein in soybean.

The mean data pertaining to nitrogen content in leaves under different treatments have been presented in Table 4. Data indicated that treatments showed increase in nitrogen content in leaves at 40, 50, 60DAS. At physiological maturity, it was recorded in decline order. The maximum increased in nitrogen content (1.66, 1.82, 1.98 and 1.77 SPAD value) was observed with salicylic acid 150 ppm at 40, 50, 60 and at physiological maturity stages, respectively. Whereas, minimum nitrogen content in leaves (1.50, 1.61, 1.71 and 1.56 SPAD value) was recorded in control at 40, 50, 60 DAS and at physiological maturity stages, respectively.The higher nitrogen content in leaves and protein content in seeds achieved with salicylic acid 150ppm which attributed with increased in structural component of RNA molecules of amino acids and also salicylic acid cause marked increase DNA, RNA and protein synthesis in ribosome which is known as site of protein synthesis in plants. It is fact that RNA molecules and nucleic acid contributes in increasing nitrogen content in leaves.

Table 1: Effect of plant growth regulators on Chlorophyll content (SPAD value) in leaf of mungbean during *kharif*season

Treatment	40 DAS	50 DAS	60 DAS	At physiological maturity
T_1 : Control	8.20	9.24	10.88	8.78
T_2 : Salicylic acid 50 ppm	9.26	11.53	12.14	10.54
T_3 : Salicylic acid 100 ppm	10.80	12.36	13.86	11.46
T_4 : Salicylic acid 150 ppm	12.56	14.75	15.53	13.36
T_5 : Salicylic acid 200 ppm	11.39	13.47	14.04	12.04
T_6 : GA_3 50 ppm	9.93	10.04	11.42	8.93
T_7 : GA_3 100 ppm	9.60	10.22	11.56	9.15

T_8 : GA_3 150 ppm	10.86	12.04	13.18	11.15
T_9 : GA_3 200 ppm	9.69	10.42	11.92	9.40
SEm ±	0.48	0.57	0.68	0.42
CD at 5%	1.44	1.70	1.96	1.26

Table 2: Effect of plant growth regulators on Nitrate reductase activity (µg nitrate produced g^{-1} fresh weight $hours^{-1}$) in leaf of mung bean during *kharif* season

Treatment	40 DAS	50 DAS	60 DAS	At physiological maturity
T_1 : Control	146.63	157.34	165.45	142.43
T_2 : Salicylic acid 50 ppm	166.20	180.64	188.62	160.52
T_3 : Salicylic acid 100 ppm	170.12	184.35	192.49	165.32
T_4 : Salicylic acid 150 ppm	174.10	188.82	196.63	169.48
T_5 : Salicylic acid 200 ppm	172.20	186.76	194.85	167.28
T_6 : GA_3 50 ppm	150.12	163.62	171.43	150.43
T_7 : GA_3 100 ppm	155.80	168.55	175.21	155.52
T_8 : GA_3 150 ppm	161.20	172.12	181.64	160.28
T_9 : GA_3 200 ppm	159.43	170.42	178.92	157.93
SEm ±	2.80	1.94	3.36	2.38
CD at 5%	8.40	5.83	10.07	7.15

Table 3: Effect of plant growth regulators on protein content in seed of mungbean during *kharif* season

Treatments	Protein content (%)
T_1 : Control	22.56
T_2 : Salicylic acid 50 ppm	23.24
T_3 : Salicylic acid 100 ppm	24.18
T_4 : Salicylic acid 150 ppm	25.07
T_5 : Salicylic acid 200 ppm	24.67
T_6 : GA_3 50 ppm	23.86
T_7 : GA_3 100 ppm	24.08
T_8 : GA_3 150 ppm	24.63
T_9 : GA_3 200 ppm	24.32
SEm ±	0.38
CD at 5%	1.14

Table 4: Effect of plant growth regulators on Nitrogen content SPAD value in leaves of mungbean during *kharif* season

Treatments	40 DAS	50 DAS	60 DAS	At physiological maturity
T_1 : Control	1.50	1.61	1.71	1.56
T_2 : Salicylic acid 50 ppm	1.55	1.71	1.88	1.67
T_3 : Salicylic acid 100 ppm	1.60	1.76	1.92	1.71
T_4 : Salicylic acid 150 ppm	1.66	1.82	1.98	1.77
T_5 : Salicylic acid 200 ppm	1.62	1.78	1.94	1.73
T_6 : GA_3 50 ppm	1.54	1.70	1.86	1.65
T_7 : GA_3 100 ppm	1.59	1.75	1.90	1.69
T_8 : GA_3 150 ppm	1.65	1.81	1.94	1.74
T_9 : GA_3 200 ppm	1.63	1.79	1.92	1.71
SEm ±	0.06	0.04	0.04	0.03
CD at 5%	NS	0.11	0.13	NS

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