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IMPACT OF PUTRESCINE AND INDOLE-3-BUTYRIC ACID IN ENHANCING CHEMICAL - BIOCHEMICAL PARAMETERS AND YIELD OF GROUNDNUT

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ABSTRACT

A field experiment was carried out during *kharif* season of 2016-17 at experimental farm of Botany section, College of agriculture, Nagpur on chemical, biochemical and yield and yield contributing parameters of groundnut (*Arachis hypogea* L.). Different concentrations of putrescine and Indole-3-butyric acid (25 ppm, 50 ppm, 75 ppm, 100 ppm) were tried during experimentation.Two foliar sprays of 100 ppm IBA showed superiority over control and all other remaining treatments under study and significantly enhanced leaf chlorophyll content, leaf NPK content and seed oil content. Yield and yield contributing parameters like number of pods plant^{-1}, weight of 100 kernels, pod yield plant^{-1}, pod yield plot$^{-1,}$ shelling percentage also increased significantly by the same treatment when compared with control and rest of the treatments under study. Harvest index was also significantly increased by the same treatment. But considering the B:C ratio treatment T_6(25 ppm IBA) gave the highest value i.e 2.78 as compared to other treatments and control, hence this treatment can be considered as a beneficial treatment.

(Key words: Groundnut, putrescine, Indole-3-butyric acid, foliar sprays, chemical-biochemical parameters,yield)

INTRODUCTION

Groundnut (*Arachis hypogea* L.) is the fore most important oil seed crop of India. In terms of area and production, it occupies an important position among the oil seed crops in the world. It has been aptly described as natures masters piece of food values containing 36 to 54 per cent oil with 21.36 per cent protein and have an energy value of 2,363 KJ 100^{-1} g. The oil is rich in unsaturated fatty acid (80%),oleic acid and linoleic acid accounting for 38 to 58 per cent and 16 to 38 per cent, respectively. Groundnut is one of the leading field legume in India. Being an oilseed crop it plays an important role in country's agricultural economy, on account of its versatile use in domestic and industrial fields. Domestically it is used as a source of edible and cattle feed etc. It has greater importance in industry as it is one of the main source of raw material for vanaspati industries in India, unlike some of western countries where other edible oils are mainly used for hydrogenation.

Plant growth regulators are shown to change leaf resistance by altering stomatal aperture, the rate of photosynthesis could be manipulated through this technology. Putrescine, IBA, IAA, GA, kinetin, phenolics and aliphatic alcohols are reported to increase and stimulate the rate of photosynthesis. The diamine putrescine occurred widely in the higher plants. It was suggested to be involved in a variety of growth and developmental processes such as cell division (Bueno and Matilla,1992), fruit set and growth (Biasi e*t al*.,1991) and senescence (Kao,1994).

IBA is a plant growth regulator, used to promote and accelerate root formation of plant clippings and to reduce transplant shock of non-food ornamental nursery stock. IBA is also used on fruit and vegetable crops, field crops and ornamental turf to promote growth development of flowers and fruit and to increase crop yields. IBA has been classified as a biochemical pesticide because it is similar in structure and function to the naturally occurring plant growth hormone indole-3-acetic acid.

MATERIALS AND METHODS

Seeds of groundnut cultivar AK-303 were collected from Dr. PDKV, Akola. The field experiment was laid out in Randomized Block Design (RBD) with three replications consisting of nine treatments comprising of different doses of putrescine and IBA (25 ppm, 50 ppm, 75 ppm, 100ppm).Seeds were sown at the rate of 100 to 125 kg ha^{-1} by dibbling method at a spacing of 45 cm x 10 cm.Data were recorded for chlorophyll, nitrogen, phosphorus, and potassium content of leaves at 20, 35, 50 and 65 DAS and oil content of seeds was recorded at harvest. Nitrogen content in leaves was estimated as per the methods suggested by Somichi*et al.* (1972),phosphorus and potassium content from the leaves were estimated as per the method suggested by Jackson (1967).Chlorophyll from leaves was estimated

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by calorimetric method as suggested by Bruinsma (1982). Estimation of oil content of groundnut was done by Soxhlet's procedure (Sankaram, 1965). Number of pods plant^{-1}, weight of 100 seeds (g), pod yield plant^{-1}(g), pod yield plot^{-1} (kg), Shelling percentage and harvest index were also calculated. The analysis of variance was performed to test the significance of differences between the treatment for all the characters as per the methodology suggested by Panse and Sukhatme (1954).

RESULTS AND DISCUSSION

Chemical and biochemical parameters

Leaf chlorophyll content

Chlorophylls have been rightly designed as "Pigments of life" because of their central role in living systems responsible for harvesting sunlight and transforming its energy into biochemical energy essential for life on earth.

The greenness of the leaf is generally considered to be a parameter contributing to yielding ability of the cultivar. Leaves constitute most important aerial organ of the plants, playing a major role in the anabolic activities by means of the so called 'green pigments or chlorophyll' is the sole medium of the photosynthetic progress which in turn is the major synthesis pathway operatives in plants.

The treatment effects were found statistically significant at 35, 50 and 65 DAS except 20 DAS.

Data regarding leaf chlorophyll content in leaves of groundnut are presented in table 1.

Data indicated that, at 35,50 and 65 DAS chlorophyll content were significantly increased in treatment T_9 (100 ppm IBA) followed by the treatments T_5 (100 ppm putrescine), T_4 (75 ppm putrescine), T_8 (75 ppm IBA) and T_3 (50 ppm putrescine) when compared with treatment T_1 (control) and remaining treatments under study. The range of chlorophyll content at 35,50 and 65 DAS in groundnut were 1.20–1.45 mg g^{-1}, 1.72–1.98 mg g^{-1}and 1.58–1.87 mg g^{-1} respectively.

Putrescine or IBA treatments might retard chlorophyll destruction and increase their biosynthesis or stabilize the thylakoid membrane. Polyamines may retard senescence and chlorophyll loss by altering the stability and permeability of membranes and protecting chloroplast from senescence (Gonzalez-Aguilar *et al*., 1997). Retention of photosynthetic pigments by PAs via interaction with thylakoid membrane was also stated by Gonzalez-Aguilar *et al*. (1997).

Deotale *et al.* (2016) tested different concentrations of putrescine and IBA (50, 75, 100, 125 and 150 ppm each) with one control on chemical, biochemical, yield and yield contributing characters of soybean and reported that two foliar sprays of 100 ppm putrescine and 100 ppm IBA at two stages i.e. before flowering and 10 days after flowering were found to be most effective in enhancing chlorophyll content in leaves.

Leaf nitrogen content

It is observed from the data that there was significant variation in leaf nitrogen content due to foliar sprays of different concentrations of putrescine and IBA at 35, 50, 65 DAS except 20 DAS. Data are presented in table 1.

At 35 and 65 DAS nitrogen content were significantly more in treatment T_9 (100 ppm IBA) followed by the treatments T_5 (100 ppm putrescine) and T_8 (75 ppm IBA) when compared with treatment T_1 (control). Whereas, treatments T_4 (75 ppm putrescine), T_3 (50 ppm putrescine) and T_7 (75 ppm IBA) were also found significantly maximum over the control. The range of N content at 35 and 65 DAS in groundnut were 3.15 - 5.28 % and 3.67-5.19 % respectively.

At 50 DAS nitrogen content was significantly maximum in treatment T_9 (100 ppm IBA) followed by the treatment T_5 (100 ppm putrescine) when compared with the treatment T_1 (control) and other treatments under study. Treatments T_8 (75 ppm IBA), T_4 (75 ppm putrescine) and T_3 (50 ppm putrescine) were also found significantly superior over control. The range of N content at 50 DAS in groundnut was 4.30-5.72 %.

From this data it is observed that leaf nitrogen content was increased up to 50 DAS and reduced thereafter, at 65 DAS. The decrease in nitrogen content might be due to fact that younger leaves and developing organs, such as grains act as strong sink demand and may draw heavily nitrogen from older leaves (Gardner *et al*., 1988). Results recorded by Poonkodi (2003) also stated that decrease in nitrogen content at later stage might be due to translocation and utilization of nutrient for flower and pod formation.

Putrescine or IBA enhances enzymatic activity and translocation processes from leaves to grains, linking or converting to other plant metabolites (Amin *et al*., 2013). Similarly IBA increases the ability of cell division in meristematic zones of plant to absorb nutritive material (Ghodrat *et al*., 2012). These might be the reasons for increase in leaf nitrogen content in the present investigation by the application of putrescine and IBA.

Habba *et al*. (2016) carried out a field experiment on *Populus euraericana* plant. They studied the effect of growing media and putrescine on chemical constituents of plant. They tried different concentrations of putrescine i.e. 50 ppm, 100 ppm and 200 ppm. Results showed that mix media and spray with putrescine at 50 ppm gave the highest values of nitrogen in leaves.

Leaf phosphorus content

Data pertaining to phosphorus content in leaves were estimated at four stages of observations i.e. 20, 35, 50 and 65 DAS. Phosphorus has been recognized as an important environmental factor limiting crop growth and production. Significant results were recorded at all the stages of observations viz., 35, 50 and 65 DAS except 20 DAS. Data are presented in table 1.

At 35 and 50 DAS significantly more leaf phosphorus content was recorded in treatment T_9 (100 ppm

IBA) followed by the treatments T_5 (100 ppm putrescine) and T_8 (75 ppm IBA) when compared with treatment T_1 (control) and other treatments under study. While, treatments T_4 (75 ppm putrescine), T_3 (50 ppm putrescine) and T_7 (50 ppm IBA) were also found significantly superior over treatment T_1 (control). The range of phosphorus content at 35 and 50 DAS in groundnut were 0.269-0.320 % and 0.278-0.337% respectively.

At 65 DAS leaf phosphorus content was significantly maximum in treatment T_9 (100 ppm IBA) followed by the treatments T_5 (100 ppm putrescine), T_8 (75 ppm IBA) and T_4 (75 ppm putrescine), when compared to treatment T_1 (Control). Treatments T_3 (75 ppm putrescine), T_7 (50 ppm IBA) and T_2 (50 ppm putrescine) were also found significantly superior over control (T_1) in a descending manner and remaining treatments under study. The range of phosphorus content at 65 DAS in groundnut was 0.273-0.313%.

The inferences drawn from the data, it is clear that leaf phosphorus content was gradually increased upto 50 DAS and reduced thereafter, at 65 DAS. The increase in phosphorus content might be because of translocation of leaf phosphorus and it's utilization for development of food storage organ. It was also known that growth hormone increases the uptake of nutrients from soil and also increases metabolic activities in the plant cell (Sagare and Naphade, 1987).

Application of putrescine or IBA increased enzymatic activity and translocation processes from leaves to grains, linking or converting to other plant metabolites (Amin *et al.*, 2013). These might be the reasons for increase in leaf phosphorus content in the present investigation by the application of putrescine and IBA.

Habba *et al.* (2016) conducted a field experiment on *Popululs euraericana* plant. They studied the effect of growing media and putrescine on chemical constituents of plant. They tried the different concentrations of putrescine (50 ppm, 100 ppm, 200 ppm). Results showed that mix media and spray with putrescine at 50 ppm gave the highest values of phosphorus in leaves.

Leaf potassium content

Data pertaining to potassium content in leaves was estimated at various stages of observations viz., 20, 35, 50 and 65 DAS. Significant results were recorded at all the stages of observations viz., 35, 50 and 65 DAS except 20 DAS. Data are presented in table 1.

At 35, 50 and 65 DAS significantly highest leaf potassium content was observed in treatment T_9 (100 ppm IBA) followed by treatments T_5 (100 ppm putrescine) and T_8 (75 ppm IBA). The ranges of potassium content at 35, 50 and 65 DAS in groundnut were 0.399-0.439%, 0.425-0.445% and 0.419-0.443% respectively.

It is clear from the data, that leaf potassium content was decreased gradually in later stage of crop growth i.e. 65 DAS. It might be because of diversion of potassium towards developing parts i.e. at the pegging stage of groundnut.

Application of putrescine or IBA increased enzymatic activity and translocation processes from leaves to grains, linking or converting to other plant metabolites (Amin *et al.*, 2013). Yamaguchi *et al.* (2006) also suggested that increase in cytoplasmic Ca^{+2} results in prevention of K^+/Na^+ entry into the cytoplasm, enhancement of K^+/Na^+ influx to the vacuole or suppression of K^+/Na^+ release from vacuole. These might be the reasons for increase in leaf potassium content in the present investigation by the application of putrescine and IBA.

Deotale *et al.* (2016) conducted a field experiment to investigate the foliar sprays of putrescine and IBA (50, 75, 100, 125 and 150 ppm each) with one control on chemical and biochemical parameters of soybean and reported that two foliar sprays of 100 ppm putrescine and 100 ppm IBA at two stages i.e. before flowering and 10 days after flowering were found to be most effective in enhancing potassium content in leaves.

Oil content in kernels

Groundnut is mainly known as oilseed crop. Oil per cent in seed is one of the important aspects in quality of seed. The data regarding oil content in seed are given in table 2.

The data related to oil content were recorded after harvesting of the groundnut crop. The oil was found maximum in treatment 100 ppm IBA (T_9) followed by treatments T_5 (100 ppm putrescine), T_8 (75 ppm IBA), T_4 (75 ppm putrescine) and T_3 (50 ppm putrescine) when compared to treatment T_1 (control) and rest of the treatments under study.

Data revealed that foliar application of 100 ppm IBA (T_9) stood first in oil content of groundnut. Oil content in groundnut in treatment T_9 (100 ppm IBA) increased by 2.95% and in treatment T_5 (100 ppm putrescine) by 2.34% over control. It is observed from the results that putrescine and IBA are more effective in seed oil content. This might be due to enhancement of enzymatic activity and translocation of metabolites to the groundnut seeds.

Mathur and Vyas (2007) conducted an experiment to study the effect of salicyclic acid (1,2 and 3Mm), sisterol as well as putrescine concentrations (0.05, 0.10,0.15 Mm) on pearl millet (*Pennisetum thyphoides*). Results showed that application of salicyclic acid at 3 mM and sisterol or putrescine at 0.15 Mm significantly increased oil content.

Deotale *et al.* (2016) studied the effect of foliar applications of putrescine and IBA (50, 75, 100, 125 and 150 ppm each) with one control on biochemical contributing characters of soybean and reported that two foliar sprays of 100 ppm putrescine and 100 ppm IBA at two stages i.e. before flowering and 10 days after flowering were found to be most effective treatments in enhancing oil content in seed.

Yield and yield contributing parameters

Number of pods plant^{-1}

Data in respect of number pods plant^{-1} was recorded at harvesting stage and are presented in table 2.

Significantly more number of pods plant^{-1} were recorded in treatment T_9 (100 ppm IBA) followed by treatment T_5 (100 ppm putrescine) when compared with treatment T_1 (control). Next to these, treatments T_8 (75 ppm IBA), T_4 (75 ppm putrescine), T_3 (50 ppm putrescine) and T_7 (50 ppm IBA) were also found significantly maximum over control.

Deotale *et al*. (2016) studied the influence of putrescine and IBA (50, 75, 100, 125 and 150 ppm each) with one control on yield and yield contributing characters of soybean and reported that two foliar sprays of 100 ppm putrescine and 100 ppm IBA at two stages i.e. before flowering and 10 days after flowering were found to be most effective treatments in enhancing number of pods plant^{-1} significantly.

Weight of 100 kernels

Data regarding weight of 100 kernels gave significant variations and are presented in table 2.

100 Kernels weight increased significantly and it was found maximum in treatment T_9 (100 ppm IBA) followed by treatments T_5 (100 ppm putrescine), T_8 (75 ppm IBA) and T_4 (75 ppm putrescine) when compared with treatment T_1 (control).

Wagh (2015) tested different concentrations of putrescine and IBA (0, 50, 75, 100, 125 and 150 ppm) on soybean. He observed that two foliar sprays of putrescine and IBA @ 100 ppm significantly increased 100 seed weight over control.

Shelling percentage

Data regarding shelling percentage gave significant variation and are presented in table 2.

Shelling percentage was significantly highest in treatment T_9 (100 ppm IBA) followed by treatments T_5 (100 ppm putrescine), T_8 (75 ppm IBA), T_4 (75 ppm putrescine) and T_3 (50 ppm putrescine) when compared with treatment T_1 (control).

Pod yield plant^{-1} (g), plot^{-1} (kg)

Data regarding yield contributing parameters gave significant variations and are presented in table 2.

The maximum pod yield plant^{-1}and plot^{-1}were significantly maximum in treatment T_9 (100 ppm IBA) followed by treatments T_5 (100 ppm putrescine) and T_8 (75 ppm IBA) when compared with treatment T_1 (control) and rest of the treatments. Treatments T_4 (75 ppm putrescine) and T_3 (50 ppm putrescine) were also found significantly superior over treatment T_1 (control).

The increase in yield and yield attributes may be due to altering the hormonal balance and improved water relation in plants. PA namely putrescine is involve in stabilization of D_1 and D_2 polypeptides of photosystem second which is the source of electron for $NADP^+$ reduction at photosysytem one (Taiz and Zeiger, 1991).

Growth regulator IBA is proved to improve effective partitioning and translocation of accumulates from source to sink in the field crops. The plant growth regulators also increases mobilization of reserve food materials to the developing sink through increase in hydrolyzing and oxidizing enzyme activities and lead to increase in yield. IBA increases the ability of cell division in meristematic zones of plant and hence, increases the ability of plant to absorb nutritive material which finally leads to the increase in grain yield (Ghodrat *et al*., 2012)

Pinkey *et al.* (2016) carried out a field experiment to study the effect of putrescine in mitigating the water stress in wheat. The experiment consist of four water stress conditions and four rates of putrescine (control,10,50,100 ppm) with four replications by using split plot design. The result showed that foliar spray of putrescine @ 100 ppm resulted in significantly higher grain, straw and biological yield.

Harvest index

Data regarding harvest index are given in table 2.

Data were found statistically significant. Significantly maximum harvest index was recorded in treatment T_9(100 ppm IBA) and minimum in control (T_1). The range of increased harvest index was 24.29% in treatment T_9 when compared to control (T_1) 20.51 per cent.

Similarly, harvest index were also significantly increased in treatments receiving 100 ppm putrescine, 75 ppm IBA, 75 ppm putrescine, 50 ppm putrescine and 50 ppm IBA over control.

Pinkey *et al.* (2016) laid out a field experiment to study the effect of putrescine in mitigating the water stress in wheat. The experiment consist of four water stress conditions and four rates of putrescine (control,10,50,100 ppm) with four replications by using split plot design. The result showed that foliar spray of putrescine @ 100 ppm resulted in significantly higher grain, straw and biological yield.

Harvest index is the proportion of biological yield represented by economic yield. It is the coefficient of effectiveness or migration coefficient. Harvest index reflects the proportion of assimilate distribution between the economic and total biomass (Donald and Hamblin, 1976). Increase in harvest index might be the result of co-ordinated interplay of growth and development characters.

The highest per cent increase in yield over control was observed in treatment 100 ppm IBA (T_9) i.e. 32.72 %. Next to this treatment, foliar spray of 100 ppm putrescine (T_5) also enhanced yield by 25.72 % over control. From overall results, it can be stated that foliar application of growth regulators such as putrescine and IBA with different concentrations improved the chemical and biochemical and yield contributing parameters might have helped in attaining better pod yield in the present investigation. Considering the B: C ratio treatment T_6(25 ppm IBA) gave the highest value i.e., 2.78 as compared to other treatments and control, hence this treatment can be considered as most effective treatment.

Table 1. Effect of putrescine and Indole-3-butyric acid on chemical-biochemical parameters of groundnut

Treatments	Leaf chlorophyll content (mg g^{-1})				Leaf nitrogen content (%)				Leaf phosphorus content(%)				Leaf potassium content(%)			
	20 DAS	35 DAS	50 DAS	65 DAS	20 DAS	35 DAS	50 DAS	65 DAS	20 DAS	35 DAS	50 DAS	65 DAS	20 DAS	35 DAS	50 DAS	65 DAS
T_1 (Control)	0.89	1.20	1.72	1.58	2.88	3.15	4.30	3.67	0.183	0.269	0.278	0.273	0.345	0.399	0.425	0.419
T_2 (25 ppm Putrescine)	0.91	1.30	1.85	1.69	3.78	3.71	4.43	3.91	0.196	0.286	0.292	0.286	0.376	0.408	0.430	0.423
T_3 (50 ppm Putrescine)	0.87	1.36	1.90	1.73	3.92	4.46	4.82	4.66	0.223	0.299	0.312	0.301	0.365	0.415	0.435	0.427
T_4 (75 ppm Putrescine)	0.99	1.38	1.93	1.78	3.43	4.65	4.83	4.76	0.216	0.301	0.318	0.307	0.366	0.422	0.439	0.432
T_5 (100 ppm Putrescine)	1.08	1.43	1.97	1.85	4.14	5.06	5.46	5.14	0.295	0.311	0.327	0.311	0.404	0.438	0.442	0.439
T_6 (25 ppm IBA)	0.89	1.26	1.84	1.65	3.10	3.43	4.37	3.71	0.213	0.278	0.288	0.282	0.341	0.405	0.428	0.421
T_7 (50 ppm IBA)	0.83	1.34	1.88	1.71	3.40	4.30	4.63	4.52	0.203	0.293	0.301	0.291	0.355	0.412	0.433	0.425
T_8 (75 ppm IBA)	1.05	1.40	1.95	1.80	4.26	5.05	5.32	5.11	0.244	0.308	0.320	0.309	0.379	0.425	0.441	0.437
T_9 (100 ppm IBA)	0.94	1.45	1.98	1.87	4.55	5.28	5.72	5.19	0.262	0.32	0.337	0.313	0.400	0.439	0.445	0.443
-	0.05	0.045	0.042	0.044	0.05	0.084	0.087	0.082	0.003	0.0059	0.0044	0.0022	0.019	0.0062	0.0046	0.0038
CD at 5%	--	0.134	0.125	0.131	---	0.251	0.260	0.245	---	0.0176	0.0130	0.0065	--	0.0185	0.0137	0.0113

Table 2. Effect of putrescine and Indole-3-butyric acid on yield and yield contributing parameters of groundnut

Treatments	Oil content(%)	No. of pods	Weight of 100 kernels	Shelling %	Yield plant^{-1}	Yield plot^{-1}	% increase in yield	B:C Ratio	Harvest index
T_1 (control)	45.96	16.91	87.33	74.63	7.67	1.69	---	2.69	20.51
T_2 (25 ppm putrescine)	46.50	17.78	96.00	75.32	8.68	1.89	12.18	2.46	21.42
T_3(50 ppm putrescine)	46.80	18.76	97.34	76.53	8.92	1.96	16.65	2.16	22.18
T_4 (75 ppm putrescine)	46.90	20.88	100.67	76.72	9.01	1.98	17.95	1.89	22.70
T_5 (100 ppm putrescine)	47.04	21.20	110.00	76.79	9.61	2.12	25.72	1.78	23.47
T_6 (25 ppm IBA)	46.48	17.34	90.00	75.29	8.51	1.88	11.30	2.78	20.59
T_7 (50 ppm IBA)	46.73	18.12	97.28	76.37	8.87	1.95	14.94	2.68	21.44
T_8 (75ppm IBA)	46.96	21.09	103.33	76.78	9.37	2.06	21.13	2.65	22.73
T_9 (100 ppm IBA)	47.32	21.66	110.67	76.81	10.15	2.23	32.72	2.73	24.29
SE (m±)	0.234	0.152	3.342	0.278	0.352	0.069	---	--	0.306
CD at 5%	0.700	0.454	10.018	0.833	1.054	0.205	---	--	0.916

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