J. Soils and Crops 27 (1) 114-119, June 2017 **ISSN 0971-2836**

MORPHO-PHYSIOLOGICAL AND YIELD RESPONSES OF MAIZE PLANT TO FOLIAR SPRAYS OF POLYAMINE (PUTRESCINE) AND IBA

Brij Bihari Pandey[1], R. D. Deotale[2], V.R. Jaybhaye[3], Y. A. Chinmalwar[4], V. Suryavanshi[5] and P. N. Davhale[6]

ABSTRACT

Growth regulators have previously been documented to enhance growth, morpho-physiological and yield parameters of plants. This paper documents the effect of polyamine (putrescine) and IBA (indole-3-butyric acid) on morpho-physiological and yield parameters of maize plant. Field experiment was carried out at the botany farm of college of agriculture, Nagpur during *kharif* 2015-2016 to evaluate the potentiality of growth regulators. During investigation both the growth regulators putrescine and IBA were applied at (0, 25, 50, 75 and 100 ppm) vegetative stage along with water spray. The results indicate that all foliar application of growth regulators showed promising effect on maize plant. However, the significantly highest effect on morpho-physiological parameters *viz.,* plant height, leaf area, dry matter accumulation, days to 50% tasseling and silking, RGR, NAR and yield characters *viz.,* yield ha^{-1} and harvest index was recorded by 100 ppm IBA comparing with control and putrescine treated plants with different concentrations. It is inferred that IBA is benifical and economical and can be implicated to improve the growth and yield of maize plant in current scenario of high cost of cultivation of crops. Considering the Benifit:Cost ratio 25 IBA ppm was found more economical having B:C ratio of 2.47 as compared to 2.09 in control.

(Key words: Maize, putrescine, IBA, foliar application, morpho physiological parameters, yield)

INTRODUCTION

Maize (*zea mays*) is the third most important cereal crop next to rice and wheat. It has the highest production potential among the cereals for diversification and value addition of maize as well as growth of food processing industries. Maize is a versatile crop grown over a range of agro climatic zones.

In fact the suitability of maize to diverse environments is unmatched by any other crop. However, the major maize production areas are located in temperate regions of the globe. The United States, China, Brazil and Mexico account for 70% of global production. India has 5% of corn acreage and contributes 2% of world production.

Considering the importance of maize from nutritional and production point of view, it becomes necessary to cultivate maize crop with expectation of higher yield. The crop productivity can be increased through physiological approaches by co-ordinating plant process to synthesize dry matter and partitioning its major quantum of effective yield contributing factors. The yield of maize may be enhanced through physiological manipulation such as foliar application of putrescine and IBA.

Growth mainly refers to quantitative increase in the plant body whereas, 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

Considering the above fact present work was undertaken to study the response of putrescine and IBA on morphological parameters and yield of maize. Experiment was laid out during *kharif* season in 2015-16 at experimental farm of Agricultural Botany Section, College of Agriculture, Nagpur with the object to know the influence of foliar sprays of plant growth regulators on morpho- physiological and yield parameters of maize cv. PKVM-shatak. Plots of the experiment were demarcated in RBD design with 3 replications and two meters away from adjacent field. Experiment made in 9 treatments along with water spray (control). In this experiment, foliar sprays of two growth regulators putrescine and IBA each at 0, 25, 50, 75 and 100 ppm along with water sprays applied. The practice of applying foliar sprays of putrescine and IBA onto the foliage of maize plant was done at vegetative stage (30-35 DAS). The potentiality of growth regulators were assessed by observing growth paramertes *viz*., plant height, leaf area,

1, 3, 4, 5 and 6. P.G. Students, Botany Section, College of Agriculture, Nagpur
2. Professor, Botany Section, College of Agriculture, Nagpur

dry matter accumulation, days to 50% tasseling and silking, RGR and NAR and yield parameters *viz.,* yield ha^{-1} and harvest index. Five plants were selected randomly from each net plot and tagged. At 30, 45, 60 and 75 DAS all biometric observations were recorded from tagged plant.

RESULTS AND DISCUSSION

Growth characters

As shown in table 1 the effect of putrescine and IBA on growth characters exhibited that foliar application of both growth regulators significantly increased plant height. Both putrescine and IBA have a promoting effect on plant height under treatments which received 100 ppm concentrations respectively. But the maximum plant height was recorded with 100 ppm IBA at three sampling stages (45, 60 and 75 DAS). At 45 and 75 DAS treatments T_9 (100 ppm putrescine), T_4 (75 ppm IBA), T_8 (75 ppm putrescine), T_7 (50 ppm putrescine) and treatment T_3 (50 ppm IBA) found superior over control and other treatments. Treatments T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with control. Whereas, at 60 DAS treatments T_9 (100 ppm putrescine), T_4 (75 ppm IBA), T_8 (75 ppm putrescine) and T_7 (50 ppm putrescine) gave superior results over control and rest of the treatments. Treatments T_3 (50 ppm IBA), T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control).

Data recorded at 30 DAS found non significant because foliar sprays were given at 30 DAS. Interestingly, the increase in plant height concomitantly with an increase in the circumferences of stems parallel to the increase in putrescine and IBA concentrations could be achieved due to enhances production of RNA and DNA leads to increased cell division because Putrescine application may act as source of nitrogen. At lower concentrations, it is comparable to that endogenous promoters like auxins, cytokinins and gibberllins stimulate growth by increasing these promoters (Mulkey , 1982). Smiliarly, IBA is a synthetic auxin. Auxins are used commercially for enhancing crop production and regulation of plant growth and development such as shoot tissue, young leaves and developing grains. It is also found promotive in lateral root development (Nagel, 2001). It is worthy to mention that similar results were also recorded by Amin *et al.* (2013) in chickpea. Amin *et al.* (2013) tested two plant growth regulators putrescine and Indole-3-butyric acid (IBA) @ 25, 50 and 100 mg l^{-1} applied either alone or in combinations. Spraying of putrescine and IBA @ 100 mg l^{-1} significantly enhanced nitrogen of chickpea (*Cicer arientinum* L.).

Findings of increased plant height was also noticed by Shraiy and Hegazi (2009), who studied the effect of acetylsalicylic acid (ASA) @ 10 and 20 ppm, indole-3-butyric acid (IBA) @ 50 and 100 ppm and gibberellic acid (GA) @ 50 and 100 ppm on pea (*Pisum sativum* L.). Results revealed that application of ASA and IBA 25 and 35 DAS significantly enhanced plant height. On the other hand, although putrescine and IBA has induced effect on leaf area in maize plant. It was noticed that leaf area significantly increased under influence of 100 ppm IBA followed by 100 ppm putrescine. Data regarding leaf area was recorded at 30, 45, 60 and 75 DAS. Apart from 30 DAS data, data recorded at various dates (45, 60 and 75 DAS) found statistically significant at 5% level. Like, at 45 DAS treatments T_9 (100 ppm putrescine) and T_4 (75 ppm IBA) also found superior over control and remaining treatments. But treatments, T_8 (75 ppm putrescine), T_7 (50 ppm putrescine), T_3 (50 ppm IBA), T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control). Data recorded at 60 and 75 DAS showed that treatments T_9 (100 ppm putrescine), T_4 (75 ppm IBA) and T_8 (75 ppm putrescine) gave maximum leaf area when compared with treatment T_1 (control) and remaining treatments under study. Minimum leaf area was noticed in treatments T_7 (50 ppm putrescine), T_3 (50 ppm IBA), T_6 (25 ppm putrescine) and T_2 (25 ppm IBA). These treatments were found at par with treatment T_1 (control). The positive effect of these substances also recorded in wheat plant (El-Bassiouny *et al.*, 2008). Leaf area depends upon the number and size of leaves. Leaves play an important role in the absorption of light radiations and using it in photosynthetic process. Leaf size is influenced by light, moisture and nutrients. Hence, yield is depends on leaf area of crop. Physiological role of putrescine and IBA was also documented by several scientists. Wagh (2015) also studied the effect of two foliar sprays (30 and 45 DAS) of putrescine and IBA @ 0, 50, 75, 100, 125, 150 ppm on soybean. He reported that two foliar sprays of putrescine and IBA @ 100 ppm significantly increased leaf area.

With our present work it is revealed that exogenous application of putrescine and IBA significantly increased total dry matter accumulation in maize plant over unsprayed plants. At 60 and 75 DAS significantly increase in dry matter was recorded in treatment T_5 (100 ppm IBA) followed by the treatments T_9 (100 ppm putrescine), T_4 (75 ppm IBA) and T_8 (75 ppm putrescine) when compared with treatment T_1 (control) and remaining treatments under study. Furthermore, treatment T_7 (50 ppm putrescine) also significantly increased dry matter over treatment T_1 (control). Treatments T_3 (50 ppm IBA), T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control). At 45 DAS significantly maximum dry matter was reported in treatment T_5 (100 ppm IBA) followed by treatment T_9 (100 ppm putrescine) when compared with treatment T_1 (control) and remaining treatments under study. Treatments T_4 (75 ppm IBA) and T_8 (75 ppm putrescine) were also found superior in respect to dry matter over control (T_1). Treatments T_7 (50 ppm putrescine), T_3 (50 ppm IBA), T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control). The increase in dry weight of treated plant is a reflection to the increase in growth rate, (He-Lixiong *et al.,* 2002) cell division and / or cell enlargement and differentiation (Davies, 1995). In support of these results Paschalidis and Roubelakis-Angelakis (2005) reported that, polyamines, their precursors (arginine) and their biosynthetic enzymes correlated with cell division, expansion, differentiation and development in tobacco plant and these might be the reasons for increased dry weight in maize plant. Wagh (2015) also studied the effect of two foliar sprays (30 and 45 DAS) of putrescine and IBA @ 0, 50, 75, 100, 125, 150 ppm on soybean. He reported that two foliar sprays of putrescine and IBA @ 100 ppm significantly increased dry weight.

Flowering in maize indicated by extrusion of anthers from spikelet on tassels and the emergence of silk (stigma) from the husk**.** Days to tasseling and silking in the present investigation were recorded when 50% of plant in plot emerged tassels and silk in maize grown under different treatments. From the recorded data it is pointed out that significantly earliest tassels appeared in treatment T_5 (100 ppm IBA) followed by T_9 (100 ppm putrescine), T_4 (75 ppm IBA), T_8 (75 ppm putrescine), T_7 (50 ppm putrescine) and T_3 (50 ppm IBA) over treatment T_1 (control). Treatments T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control). Data regarding days to 50 % silking was exhibited that significantly earliest silking observed in treatment T_5 (100 ppm IBA) followed by T_9 (100 ppm putrescine), T_4 (75 ppm IBA), T_8 (75 ppm putrescine) and T_7 (50 ppm putrescine) over treatment T_1 (control). Treatments T_6 (25 ppm putrescine), T_3 (50 ppm IBA) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control).

Growth analysis

Relative growth rate (RGR) represents total dry weight gained over existing dry weight in unit time. This was originally termed an "efficiency index" because it expresses growth in terms of a rate of increase in size unit^{-1} of size. In this regard, data revealed that at 30-45, 45-60 and 60-75 DAS significantly maximum RGR was observed in treatment T_5 (100 ppm IBA) followed by treatments T_9 (100 ppm Putrescine), T_4 (75 ppm IBA), T_8 (75 ppm putrescine) and T_7 (50 ppm Putrescine) when compared with treatment T_1 (control) and remaining treatments under study. While, treatments T_3 (50 ppm IBA), T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control). The effect of putrescine and IBA on RGR was in agreement with Wagh (2015), who mention that two foliar sprays (30 and 45 DAS) of putrescine and IBA @ 0, 50, 75, 100, 125, 150 ppm on soybean. Considering the concentrations 100 ppm putrescine and IBA were found more effective and significantly increased plant height, number of branches, leaf area, dry weight, RGR and NAR.

Similarly NAR is the rate of increasing the dry weight of a plant unit^{-1} of active growing material and it depends upon the excess dry matter gained, over the loss in respiration. It is increase in plants dry weight unit^{-1} area of assimilation tissues unit^{-1} time. From the data it is concluded that maximum NAR was registered at 30-45 DAS when IBA applied at 100 ppm (T_5) at vegetative stage followed by treatments T_9 (100 ppm putrescine), T_4 (75 ppm IBA), T_8 (75 ppm putrescine) and T_7 (50 ppm putrescine) when compared with treatment T_1 (control). Treatments T_3 (50 ppm IBA), T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with control (T_1). At 45-60 DAS Significantly maximum NAR was observed in treatment T_5 (100 ppm IBA) over control (T_1) and remaining treatments. Treatments T_9 (100 ppm putrescine), T_4 (75 ppm IBA), T_8 (75 ppm putrescine), T_7 (50 ppm putrescine), T_3 (50 ppm IBA) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control). Data recorded at 60-75 DAS showed that significantly maximum NAR was observed in treatments T_5 (100 ppm IBA), T_4 (75 ppm IBA), T_8 (75 ppm putrescine), T_7 (50 ppm putrescine), T_3 (50 ppm IBA), T_6 (25 ppm putrescine) in a descending manner over control (T_1). But treatment T_2 (50 ppm putrescine) was found at par with treatment T_1 (control). These results were coincided with those reported by Mathur and Vyas (2007) in pearl millet. They conducted a field experiment to estimate the effect of salicylic acid (1, 2 and 3 mM), sitosterol as well as putrescine concentrations (0.05, 0.10 and 0.15 mM) on pearl millet (*Pennisetum typhoides*). Results showed that application of salicylic acid @ 3 mM and sitosterol or putrescine @ 0.15 mM significantly increased net assimilation rate. It was suggested that putrescine improves the photosynthetic rate and stomatal conductance and Putrescine also seems to be helpful in ameliorate the negative effect of K^+ and Cl^- on photosynthesis by reducing uptake of these two and improvement in concentration of K^+ and Ca^{+2} ions. Putrescine (polyamines) application implied that they could act as a growth promoter (Mirza and Bagni, 1991). These might be the reasons for increase in RGR and NAR in the present investigation.

Yield parameters

The application of various concentrations of putrescine and IBA in present work induced significant increase in the yield of maize plants represented as yield ha^{-1} and harvest index (Table 2). The magnitude of increase was pronounced with spraying of 100 ppm IBA followed by 100 ppm putrescine. Also treatments T_4 (75 ppm IBA), T_8 (75 ppm putrescine), T_7 (50 ppm putrescine) and T_3 (50 ppm IBA) gave significantly higher yield when compared with control (T_1) and remaining treatments. While, treatments T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with treatment T_1 (control). The increments in yield components due to Putrescine treatments may be attributed to the increasing growth rate, in this respect, Davies (1995) reported that polyamines play a critical role in different biological processes, including cell division, growth, somatic embryogenesis, floral initiation, development of flowers and fruits. It is worthy to mention that there is a close relationship between the effect of PAs and the stimulated growth, endogenous phytohormones, the photosynthetic output (soluble sugars, polysaccharides and total carbohydrates) and the nitrogen constituents. These results might increase the efficiency of solar energy conversion which maximize the growth ability of maize plant and consequently increased its productivity and yield components. 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

Table 1. Effect of putrescine and IBA on plant height, leaf area, dry matter, RGR

Treatments	Plant height (cm)				Leaf area (dm^2)				Dry weight (g)				Days to 50% tasseling	Days to 50% silking
	30 DAS	45 DAS	60 DAS	75 DAS	30 DAS	45 DAS	60 DAS	75 DAS	30 DAS	45 DAS	60 DAS	75 DAS		
T_1 (control)	99.50	128.73	179.43	183.53	12.12	19.23	24.89	23.91	9.53	41.38	92.53	127.32	61.00	66.00
T_2 (25 ppm IBA)	103.94	136.97	183.25	188.00	12.94	20.16	25.97	25.27	11.20	45.28	98.90	140.62	58.67	63.33
T_3 (50 ppm IBA)	100.72	139.40	186.78	195.89	12.32	21.51	27.41	27.01	10.90	48.05	106.50	153.68	58.33	62.33
T_4 (75 ppm IBA)	98.10	145.25	193.70	201.08	16.81	24.95	31.49	31.22	11.3	55.12	128.57	185.75	57.67	61.67
T_5 (100 ppm IBA)	97.29	151.29	197.93	204.12	18.36	26.68	33.60	33.39	12.87	64.56	151.44	218.23	54.67	59.00
T_6 (25 ppm putrescine)	99.17	136.91	182.39	188.67	13.21	20.36	26.19	25.69	10.80	45.46	100.89	144.27	59.00	63.00
T_7 (50 ppm putrescine)	99.52	140.90	191.17	196.70	15.01	23.23	28.20	27.85	10.76	49.55	114.82	167.30	58.33	62.33
T_8 (75 ppm putrescine)	101.59	143.62	193.03	197.72	15.83	23.15	29.47	29.17	11.10	51.84	120.08	172.56	58.33	62.00
T_9 (100 ppm putrescine)	100.35	146.93	194.86	202.50	17.62	23.28	32.54	32.32	11.67	57.86	135.09	194.97	55.33	59.67
SE (m) ±	3.81	2.999	3.003	3.780	1.580	1.396	1.268	1.553	1.446	3.102	7.194	8.424	1.158	1.169
CD at 5%	-	8.879	8.981	11.333	-	4.177	3.779	4.586	–	21.658	9.340	25.361	3.429	3.496

Table 2. Effect of putrescine and IBA on RGR, NAR, grain yield ha^{-1}, B:C ratio and harvest index

Treatments	RGR ($g\ g^{-1}\ day^{-1}$)			NAR ($g\ dm^{-2}\ day^{-1}$)			Grain yield (q) ha^{-1}	Harvest index (%)	B:C ratio
	30-45 Days	45-60 Days	60-75 Days	30-45 Days	45-60 Days	60-75 Days			
T_1 (control)	0.0978	0.0536	0.0212	0.1377	0.1531	0.0948	47.08	39.75	2.09
T_2 (25 ppm IBA)	0.0931	0.0520	0.0234	0.1392	0.1553	0.1048	57.89	41.51	2.47
T_3 (50 ppm IBA)	0.0989	0.0530	0.0244	0.1399	0.1597	0.1154	59.70	45.28	2.45
T_4 (75 ppm IBA)	0.1056	0.0564	0.0241	0.1417	0.1734	0.1211	61.79	50.98	2.44
T_5 (100 ppm IBA)	0.1075	0.0568	0.0245	0.1548	0.1930	0.1243	63.73	53.28	2.42
T_6 (25ppm putrescine)	0.0958	0.0531	0.0238	0.1395	0.1592	0.1110	58.20	43.06	2.27
T_7 (50 ppm putrescine)	0.1017	0.0560	0.0240	0.1403	0.1729	0.1162	60.29	47.65	2.09
T_8 (75 ppm putrescine)	0.1027	0.0559	0.0241	0.1409	0.1733	0.1189	61.12	48.90	1.91
T_9 (100 ppm putrescine)	0.1067	0.0565	0.0244	0.1432	0.1770	0.1212	62.30	51.13	1.77
SE (m) ±	0.0027	0.00057	0.0017	0.00098	0.00907	0.00501	2.53	2.66	-
CD at 5%	0.0087	0.0017	0.0050	0.00299	0.0273	0.01503	7.60	7.97	-

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). Deotale *et al*. (2016) tested different concentrations 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 in enhancing seed 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). Maximum harvest index was observed in plants which grouped for spraying with 100 ppm IBA. Treatments receiving T_9 (100 ppm Putrescine) followed by the treatments T_4 (75 ppm IBA) and T_8 (75 ppm putrescine) also reflected higher results when compared with control (T_1) and remaining treatments under study. Treatments T_7 (50 ppm putrescine), T_3 (50 ppm IBA), T_6 (25 ppm putrescine) and T_2 (25 ppm IBA) were found at par with T_1 (control). Similar finding was also reported earlier by El-Bassiouny *et al.* (2008) in wheat. They tested arginine and putrescine (0.0, 0.6, 1.25, 2.5 and 5 mM) at three physiological stages (vegetative, 30 DAS; just before emergence of main spike, 60 DAS and during grain filling, 90 DAS) and reported that foliar application of 2.5 mM arginine and putrescine on wheat significantly increased straw yield and harvest index when applied at 30 or 60 DAS over control.

REFERENCES

Amin, A.A., F.A. Gharib, H.F. Abouziena and Mona G. Dawood, 2013. Role of indole-3-butyric acid or/and putrescine in improving productivity of Chickpea (*Cicer arientinum* L.) Plants.Pakistan J. Biol. Sci. **16**: 1894-1903.

Biasi, R., G.Costa and N. Bagni,1991. Polyamine metabolism as related to fruit set and growth.Pl. Physiol. Biochem.**29**:497-506.

Bueno,M. and A.Matilla,1992. Effect of spermine and abscisic acid on mitotic divisions in isolated embryonic axes of chick pea seeds.Cytobiology, **71**:151-155.

Davies, P.J. 1995. Plant hormones: Physiology and Biochemistry and Biology pp. 159 Kluwer Academic Publishers, London.

Deotale, R.D., Y.A. Wagh, S.R. Patil and V. B. Kalamkar, 2016. Influence of putrescine and indole-3-butyric acid on chemical and biochemical parameters and yield of soybean. J. Curr. Res.Sci. **8** (3): 27248-27255.

Donald, C. M. and J. Hamblin, 1976.Growth and development in physiology of crop plants 2nd Ed.Scientific publishers Jodhpur, pp.198-199.

El–Bassiouny, H.M., H.A.Mostafa, S. A. El–Khawas, R. A.Hassanein, S.I. Khalil and A. A. Abd El–Monem, 2008. Physiological responses of wheat plant to foliar treatments with arginine or putrescine, Aust.J. Basic and Appl. Sci. **2**(4): 1390-1403.

Ghodrat, V., M. J.Rousta and M. S. Tadaion, 2012. Effect of priming with indole-butyric acid (IBA) on germination and growth of wheat under saline conditions.IJACS.**4**(6):289-292. 18 ref.

He-Lixiong, K. Nanda and S. Tachibana, 2002. Effects of spermidine pretratment through the roots of chilled cucumber plants *Cucumber sativus* L. J. Japan. Soc. Hort. Sci. **71**: 490-498.

Kao,C.H. 1994. Endogenous polyamine levels and dark- induced senescence of detached corn leaves. Bot. Bull. Acad. Sin. **35**:15-18.

Mulkey, T.J. 1982. Plant Physiol.**70**: 186-188.

Mathur, Nishi and Anil Vyas, 2007. Physiological effect of some bioregulators on vegetative growth, yield and chemical constituents of pearl millet (*Pennisetumtyphoides* (Burm) Stapf. and Hubb). Int. J. Agri.Res. **2** (3): 238-245.

Mirza, J.I. and N.Bagni,1991.Plant Growth Regul.**10**: 163-168.

Nagel, 2001. Annals of Botany, **88**: 27-31.

Paschalidis, K.A., K.A. Roubelakis-Angelakis, 2005. Spatial and temporal distribution of polyamines levels and polyamines anabolism in different organs/tissues of the tobacco plant. Correlations with age, cell division/expansion and differentiation. Plant Physiol. **138**(1) : 142-152.

Shraiy, Amal M. El. and Amira M. Hegazi, 2009. Effect of acetylsalicylic acid, indole-3- bytric acid and gibberellic acid on plant growth and yield of pea (*Pisum Sativum* L.), Aust.J. Basic and Appl. Sci. **3**(4): 3514-3523.

Wagh, Y. A. 2015. Influence of putrescine and indole-3-butyric acid on growth and productivity of soybean. M.Sc. (Agri.) thesis (Unpublished) submitted to Dr. P.D.K.V. Akola.

Rec. on 05.05.2016 & Acc. on 03.06.2016