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Effect of Foliar Application of IAA, GA_3, TIBA and Boron on Growth, Sex Expression and Yield of Bottle Gourd (*Lagenaria siceraria* (Mol.) Standl.)

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ABSTRACT. *Indole acetic acid (IAA) at 100, 200 and 250 ppm, Gibberellic acid (GA_3) at 10, 50 and 75 ppm, Tri–iodobenzoic acid (TIBA) at 10, 50 and 75 ppm and Boron (B) at 2.5, 4, 20 and 40 ppm were used as foliar spray to study their effect on growth, sex expression and yield of bottle gourd. The highest length of main vine and total vine were observed at 2.5 ppm B and the highest number of branches at 200 ppm IAA. At all concentrations IAA, preferentially increased the number of female flowers and reduced male to female sex ratio which ultimately increased the number of fruits and yield per plant significantly. Both GA and TIBA at 75 ppm increased the total vine length, number of nodes and leaves, number of branches and fresh and dry weights of plants significantly. The male to female sex ratio was found higher in all concentrations of GA_3. TIBA at 10 and 50 ppm produced a significantly higher number of female flowers which resulted in a significantly lower male to female sex ratio.*

INTRODUCTION

The modification of growth, sex expression and yield of monoecious cucurbits has been the subjects of many investigations. In monoecious cucurbits the male flower appears at the early stage of growth and the female flower appears weeks later (Sumpoundlek and Abella, 1974). The male to female sex ratio in cucurbits is usually found very high (Erwin and Haber, 1929) which may be responsible for low yield. Although sex expression of cucurbits is controlled by the genetic make up of the plant (Roy and Roy, 1971), in some cases it can be modified by the foliar application of IAA (Gaur and Joshi, 1965 and Choudhury and Babel, 1969 and Bandari and Sen 1973), GA_3 (Randhawa and Singh, 1970 and Fuch *et al.*, 1977), TIBA (Suryana and Raju, 1983 and Verma *et al.*, 1985 b) and B (Verma *et al.*, 1985 a; Mary and Blevins

et al., 1987). Information available in this regard on bottle gourd, however, is scanty. Moreover, the optimum doses of IAA, GA_3, TIBA and B having significant effect on bottle gourd was not so far known. Hence different levels of these chemicals were selected to find out the appropriate concentration. Besides, the effect of internal concentration of N, P and K of the treated plants the sex expression of bottle gourd has so far not been investigated. Hence, studies were conducted to examine the effect of foliar spray of IAA, GA_3, TIBA and B at different concentrations on growth, sex expression, N, P, and K concentrations and yield of bottle gourd.

MATERIALS AND METHODS

Seeds from long green bottle gourd grown locally were collected and were sown in the prepared pit (60 cm x 60 cm) in a plot (4 m x 4 m) in *Rabi* season. Each pit contained 20 kg of decomposed cowdung, 57 g N, 57 g P_2O_5 and 37 g K_2O as basal dose. Eight seeds were sown per pit and at two true leaf stage seedlings were thinned out and four seedlings with uniform growth were kept per pit. Watering, weeding, mulching and other cultural practices were done when needed. The experiment was set in a tri – replicated randomised complete block design. Distilled water solution of IAA, GA_3, TIBA and B were used as foliar spray. IAA 100, 200 and 250 ppm; GA_3 10, 50 and 75 ppm; TIBA 10, 50 and 75 ppm and B 2.5, 4. 20 and 40 ppm solutions were sprayed once and singly at two leaf stages in the early part of sunny day. Length of mainvine and branches; number of nodes and leaves and appearance of first male and female flowers were recorded. The numbers of male and female flowers were counted at the time of opening of the first flower and continued till the final harvest. The fruits were harvested from time to time at the marketable stage. Number of fruits, fresh weight, length, circumference, diameter per fruit and yield per plants were noted. The plants were finally harvested after four months of sowing. Fresh weight of plants (exclusive) were taken immediately after harvest, then chopped and dried in an oven at 65° C until a constant dry weight was attained. NPK were determined in the digest of powdered sieved (60 mesh) plant materials following established procedures (Jackson, 1958).

RESULTS AND DISCUSSION

Vegetative growth and nutrient concentrations

It is evident from Table 1 that the length of the main vine, although increased in all the treatments except GA_3, a significant increase was found at IAA 100 and 200 ppm, B 2.5 and 20 ppm only. Total length of plant increased significantly in all the treatments and the highest total length was at 2.5 ppm B, mainly due to the high length of the main vine. The number of branches increased significantly in all the treatments except GA 10 and TIBA 10 ppm and the highest number of branches was at IAA 200 ppm. The number of nodes and leaves also increased significantly in all the treatments except TIBA 10 and 50 ppm and the highest number of nodes and leaves was observed at B 2.5 ppm. Excepting IAA, the fresh and dry weights of plants increased significantly in all cases. The highest values were at GA 10 ppm. Nitrogen concentration of the plant increased significantly only at GA 10, 75; TIBA 10, 50 and 4 ppm B and the highest N concentration was at TIBA 50 ppm. N concentration decreased significantly at all concentrations of IAA and 4 and 40 ppm B treatments. P concentration of plant increased significantly in all the treatments except IAA 100, GA 50 and 2.5 ppm B. The highest P concentration was observed at 4 ppm B. K concentration of plants increased significantly only at GA 10 and 50; TIBA 10 and 20 ppm B and the highest K concentration was at 20 ppm B.

In most casaes of this investigation, Indole acetic acid stimulated the vegetative growth in bottle gourd, which agrees with Choudhury and Babel (1969). The effect of auxin on vegetative growth may be mediated through short term physiological processes (Botrill and Hanson, 1968). The increase of P and K concentration in some concentrations of IAA corroborates with the findings of Singh and Choudhury (1977) on cucumber. The increase in total length, number of branches, nodes and leaves, fresh and dry weight of plant due to GA_3 treatment agrees with Randhawa and Singh (1978) on bottle gourd. According to Brain and Hemming (1958) the increase in length due to GA_3 treatment was caused mainly due to cell elongation. The increase in length of plant due to TIBA treatment found in the present investigation agrees with Rahman *et al.*, (1983) in white gourd and that of vegetative growth due to B treatment was consistent with the findings of Patra and Das (1978).

Table 1. Effect of foliar application of IAA, GA_3, TIBA and B on vegetative growth and nutrient concentrations of bottle gourd.

Treatments	Length of m.v. cm/pl.	Total length (m.v. branches cm/plant	No. of bran./ plant	No. of nodes & leaves/ plant*	Fresh weight g/plant	Dry weight g/plant	Nutrient concentration (g%) N	P	K
Control	427.16	837.33	1.88	92.61	885.00	112.26	2.35	0.24	1.97
IAA 100 ppm	524.77	1390.89	11.67	148.89	850.00	120.32	2.06	0.24	2.04
IAA 200 ppm	511.22	1157.83	18.97	118.55	875.00	109.30	2.06	0.35	1.66
IAA 250 ppm	531.50	1485.33	12.08	158.33	825.00	112.09	2.06	0.33	2.12
GA_3 10 ppm	381.50	1160.67	8.42	199.00	2270.00	192.43	2.80	0.31	2.15
GA_3 50 ppm	336.25	1197.92	9.50	189.75	1250.00	163.00	2.40	0.21	2.18
GA_3 75 ppm	340.25	1204.58	11.38	183.58	1200.00	153.89	2.80	0.34	1.69
TIBA 10 ppm	489.44	969.22	8.05	97.11	1040.00	145.50	2.63	0.35	2.56
TIBA 50 ppm	443.50	1000.94	10.30	98.86	980.00	142.95	3.03	0.33	1.56
TIBA 75 ppm	494.33	1263.88	11.72	127.86	1260.00	165.12	2.33	0.35	1.96
B 2.5 ppm	606.33	1633.25	14.00	233.67	1205.00	135.99	1.81	0.25	2.05
B 4.0 ppm	485.00	1414.00	13.33	190.75	1175.00	142.96	2.59	0.36	1.63
B 20.0 ppm	517.00	1589.13	11.54	141.50	1910.00	177.92	2.53	0.31	2.76
B 40.0 ppm	419.58	1320.25	13.00	152.54	960.00	166.50	2.10	0.32	1.73
LSD 0.05	89.35	85.34	1.30	20.59	45.00	19.70	0.23	0.03	0.17
LSD 0.01	123.55	177.99	1.79	28.48	60.40	26.70	0.35	0.05	0.26

+ Due to alternate phyllotaxy the number of nodes equals the number of leaves.
m.v. Mainvine

Number of male and female flowers and their ratios

It is observed from Table 2 that first a male flower appeared at a significantly lower number of nodes at IAA 100, GA 10 and 50 ppm and in all the concentrations of B. It appeared at lowest number of nodes at IAA 100 ppm. The first female flower although it appeared at lower number of branches in some cases, but the difference from control was insignificant. It appeared at significantly higher number of nodes at GA 50 and 40 ppm B. The findings of the appearance of first male flower at lower number of nodes at IAA 100 ppm agrees with Gaur and Joshi (1965). The number of male and total flowers increased significantly in all the treatments except TIBA 10 and 50 ppm and the highest number being observed at 4 ppm B. The number of female flowers increased significantly in all the concentrations of IAA, TIBA, and 4 ppm B and the highest number was at IAA 250 ppm. The percentage of female flowers increased significantly at all concentrations of IAA and TIBA where the percentage of male flowers decreased significantly. This caused a significantly lower male to female sex ratio in the treatments by IAA and TIBA. The highest percentage of female flowers of IAA 200 ppm produced the lowest male to female sex ratio. The significantly lower percentage of female flowers was found at GA_3 and B where male and female sex ratio was significantly higher. The increase of number of female flowers due to TIBA application of this observation agrees with that of Choudhury and Babel (1969). Application of auxin or auxin-like substances induces female sex expression in cucurbits (Lang, 1961) while gibberellin induces male sex expression (Heslop-Harrison, 1972). According to Shannon and Guarding (1969) the effect of auxin on sex expression is through an ethylene formation process during growth and development. Ethylene enhanced female sex expression in cucumber (Iwahori *et al.*, 1970).

Fruit characters and yield

It is observed from Table 3 that the number of fruits increased in all the concentrations of IAA, GA_3 75 ppm, 4 and 40 ppm B and the highest number was at IAA 250 ppm. The fresh weight of fruits increased in almost all the treatments, but significant increases were at IAA 200, TIBA 10, 75 and 4 ppm B only the highest fresh weight was at TIBA 10 ppm. The length of fruits though increased in some cases of this observation but significant increases were at GA3 10, TIBA 10,

Table 2. Effect of foliar application of IAA, GA_3, TIBA and B on the appearance of first male and female flowers, number and % of flowers and male to female sex ratio of bottle gourd.

Treatments	Nodes of m.v. at which 1st M. flower appeared	Branch at which 1st F. flower appeared	No. of flowers/ plant		Flowers in % of total		Male to female sex ratio
			male	female	male	female	
Control	15.94	4.50	70.18	5.72	92.74	7.54	12.27
IAA 100 ppm.	11.83	4.50	111.44	13.27	89.36	10.64	8.40
IAA 200 ppm.	15.83	3.88	85.89	12.42	87.37	12.63	6.91
IAA 250 ppm.	16.61	4.33	104.39	13.39	86.63	11.37	1.79
GA_3 10 ppm.	12.96	3.50	125.65	5.50	95.81	4.19	22.85
GA_3 50 ppm.	13.50	6.75	147.67	6.25	95.94	4.06	23.63
GA_3 75 ppm.	15.92	5.50	144.42	6.50	95.69	4.31	22.21
TIBA 10 ppm.	15.39	4.22	71.67	8.89	88.96	11.04	8.06
TIBA 50 ppm.	15.58	4.22	80.17	9.55	89.36	10.64	8.39
TIBA 75 ppm.	16.55	5.50	92.83	8.82	91.33	8.67	10.52
B 2.5 ppm	14.00	4.20	128.25	5.75	95.71	4.29	22.30
B 4.0 ppm	13.25	5.75	156.25	8.83	94.65	5.35	17.69
B 20.0 ppm	13.38	5.67	118.25	5.66	95.43	4.57	20.89
B 40.0 ppm	13.50	8.16	106.54	6.58	94.18	5.82	16.19
LSD 0.05	1.48	1.26	13.06	1.00	1.06	1.06	2.55
LSD 0.05	2.34	1.74	18.89	1.50	2.32	2.32	3.53

M = Male
F = Female

75 and 4 ppm B only, the highest length was at 75 ppm TIBA. The circumference of fruit increased in all the treatments except IAA 250 and TIBA 50 ppm and the highest circumference of fruit was found at 20 ppm B. The diameter per fruit was found to be higher than the control except at IAA 250 and TIBA 50 ppm but the difference from control was not significant in any of the treatments. The yield per plant was higher than the control in all the treatments and the differences from control were significant in all the concentrations of IAA, TIBA 75, 4 and 40 ppm B. The highest yield was found to be at IAA 200 ppm. The increase in yield due to IAA treatment was found consistent with the findings of Choudhury and Babel (1969) on bottle gourd. The increase in yield in TIBA treatment agrees with Khan *et al.*, (1982) in water melon. Increase in yield due to foliar application of B corroborates with the findings of Verma and Choudhury (1980) in cucumber.

Low N and high P concentrations in IAA treated plants had a higher number and percentage of female flowers and low male to female sex ratio, higher number and fresh weight of fruit. But GA_3 treated plants at higher N, P and K in most of the concentrations which had stimulatory effect only on the number of fruits. Higher P concentrations in all the treatments of TIBA increased the number of female flowers and decreased the male to female sex ratio. Higher P concentration at 4 ppm B increased the number of female flowers, number of fruits and yield per plant.

In the present experimentation IAA in all the concentrations was found effective in increasing the number of female flowers and reducing the male to female sex ratio which ultimately produced higher yield. Among the three concentraions of IAA, 200 ppm was observed best in producing the highest number of fruits per plant and maximum yield.

CONCLUSIONS

It can be concluded that foliar application of IAA, GA_3, TIBA and B influenced vegetative growth, N, P, and K concentrations, sex expression and yield of bottle gourd. The degree and nature of effect on the processes, however, are dependent on the nature of chemicals and concentrations used. So, with proper use of these chemicals, it may be possible to manipulate vegetative growth and reproductive processes

Table 3. Effect of foliar application of IAA, GA_3, TIBA, and B on fruit characters and yield of bottle gourd.

Treatments	No. of fruits plant	Fresh weight kg/fruit.	Length cm/fruit	Circumference cm/fruit	Diameter cm/fruit	Yield kg/plant
Control	5.00	1.85	34.92	36.85	11.76	9.25
IAA 100 ppm	1.00	2.11	34.44	40.44	11.41	14.71
IAA 200 ppm	1.80	2.22	29.84	42.92	13.69	17.32
IAA 250 ppm	8.00	2.15	35.33	34.16	11.25	17.20
GA_3 10 ppm	4.90	2.16	40.40	42.60	12.40	10.58
GA_3 50 ppm	5.80	1.80	28.70	40.70	12.30	10.44
GA_3 75 ppm	6.10	1.86	30.45	41.75	13.20	11.35
TIBA 10 ppm	4.00	2.71	42.33	41.55	13.17	10.84
TIBA 50 ppm	5.00	2.15	34.00	35.42	11.64	10.75
TIBA 75 ppm	5.25	2.53	43.22	38.66	12.37	13.28
B 2.5 ppm	5.00	2.10	29.94	41.75	13.40	10.50
B 4.0 ppm	6.50	2.27	40.49	43.34	12.28	14.76
B 20.0 ppm	5.10	1.98	35.55	43.72	12.90	10.10
B 40.0 ppm	6.10	2.06	35.65	39.00	12.71	12.57
LSD 0.05	1.00	0.34	5.38	5.20	NS	3.30
LSD 0.01	1.30	0.48	7.75	8.50	–	4.95

NS = Non significant

and thereby good economic benefit may be achieved, through increased yield and early harvest of bottle gourd.

REFERENCES

Bandari, M.C. and Sen, D.M. (1973). Effect of certain growth regulators in the sex expression of *Citrullus lanatus* (Thump) Monof. Biochemical Und. Physiologic der pllanzen. 164: 450 – 453.

Botrill, D.E. and Hanson, J.B. (1968). Short term growth response to growth regulators in roots of *Zea mays*. Australian J. Biol. Sci. 21: 2101 – 208.

Brian, P.W. and Hemming, H.G. (1958). Complementary action of gibberellic acid and auxins in pea internodes extension. Ann. Bot. 22: 1 – 17.

Choudhury, B. and Babel, Y.S. (1969). Studies on sex expression, sex ratio and fruit set as affected by different plant regulator sprays in *Lagenaria siceraria* (Molina) Standl. Hort. Sci. 1(1): 61 – 71.

Erwin, A.T. and Haber, E.S. (1929). Species and varietal crosses in *Cucurbita*. Iwa Agri. Exp. Sta. Bull. pp. 263.

Fuch, E.D., Atmon, D. and Halevy, A.H. (1977). Adventitious staminate flower formation in gibberellin treated gynoecious cucumber plants. Plant and cell physiol. 18: 1193 – 1201.

Gaur, S.K.S. and Joshi, D.P. (1965). Effect of 3 – indole acetic acid on the growth and development of *Lagenaria siceraria* standl. (Vern. Lauki). The Allahabad Farm. 39: 92 – 98.

Heslop – Herrison, J. (1972). Sexuality of Angiosperms. Plant physiology – A treatise. *In*: Stewart, F.C. (Ed.). Academic Press, New York and England. 6(C): 133 – 189.

Iwahori, S.T., Lyons, J.M. and Smith O.E. (1970). Sex expression in cucumber plants as affected by 2 – chloroethyl phosphoric acid, ethylene and growth regulators. Plant physiol. 46: 412 – 415.

Jackson, M.L. (1958). Soil chemical analysis. 1st edn. Prantice Hall of India, Pvt. Ltd., New Delhi, India.

Khan, M.A.A., Rahman, M.A.; Nasiruddin, M. and Tarek, M. (1982). Sex expression and yield responses to GA_3 and TIBA application in four varieties of watermelon. C.U. Studies. 6(2): 35 – 39.

Lang, A. (1961). Auxin in flowering. Encycl. Plant physiol. 14: 909 – 950.

Mary, K.S. and Blevins, D.G. (1987). Boron Stem infusion stimulate yield by increasing pods on lateral branches. Plant physiol. 84: 969 – 971.

Patra, S. and Das, C.R. (1978). Effect of molybdenum and boron on growth and fruit set of pointed gourd (*Trichosanthes dioica* Roxb.). Orissa J. Hort. 4(1 and 2): 54 – 56.

Rahman, M.A., Nasiruddin, M. and Alam, M.S. (1983). Sex expression and metabolic responses of white gourd (*Benincase hispida*) to TIBA application. Bangladesh Hort. 1(2): 21 – 25.

Randhawa, K.S. and Singh, K. (1970). Influence of foliar application of certain chemicals on sex behaviour, fruitset and quality of muskmelon. Plant. Sci. 2: 118 – 122.

Randhawa, K.S. and Singh, K. (1978). The effect of certain growth influencing substances and sowing techniques on the vegetative growth, sex ratio, early and total yield of bottle gourd. J. Res. Punjab. Agri. Univ. 13(4): 367 – 371.

Roy, R.P. and Roy, P.M. (1971). Mechanism of sex determination in *Coccinia indica* J. Indian Bot. Soc. 50: 391 – 400.

Shannon, S. and Guarding, M.D. (1969). Sex expression and production of ethylene induced by auxin in the cucumber (*Cucumus sativus* L.). Nature. 223: 186 – 187.

Sing, A.K. and Choudhury, B. (1977). Further studies on nutrient uptake as affected by growth regulator sprays in relation to sex modification in cucumber. Indian J. Hort. 34: 50 – 59.

Sumpoundlek, W. and Abella, P.A. (1974). Effect of ethrel on sex expression and yield of cucumber. The CLSU Sci. J. 10(2): 22 – 27.

Suryana, V. and Raju, B.N. (1983). Effect of growth regulators on growth, sex expression and yield of bottle gourd and cucumber. The Andra Agri. J. 30(2): 101 – 104.

Verma, V.K. and Choudhury, B. (1980). Chemical sex modification in cucumber (Cucumis sativus) through growth regulators and chemicals and their effect on yield. Indian J. Agri. Sci. 50(3): 231 – 235.

Verma, V.K., Singh, N. and Choudhury, B. (1985a). Chemical alteration of sex expression in *Cucurbita moschata* (Duch). Poir. Indian J. Agri. Sci. 55(4): 296 – 297.

Verma, V.K., Sing, N. and Choudhury, B. (1985b). Effect of growth regulators and ethephon on sex expression and growth in *Cucurbita moschata* (Duch) poir. Indian J. Agri. Sci. 55(5): 374 – 379.