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Effect of NPK and Humic Acid Formulations on Growth, Yield and Quality Characters of Bhendi (*Abelmoschus esculentus (L.) Moench*)

D Elayaraja, R Vetriselvan and K Dhanasekaran
Dept. of Soil Science and Agrl.Chemistry, Faculty of Agriculture, Annamalai University, Annamalainagar- 608 002.

ABSTRACT

To find out the effect of NPK and humic acid formulations on the growth, yield and quality characters of bhendi, a field experiment was conducted at Perampattu village, near chidambaram during January- April 2010. The texture of the soil was sandy loam with pH-7.54 and EC-0.96 dSm^{-1}. The available nitrogen was low whereas available P and K were medium, respectively. The treatments consisted of different levels of NPK *viz.,* control, 50%, 100% and 150% as factor-A and different sources of humic acid formulations *viz.,* Control (water spray), Foliar spray of lignite humic acid @ 0.2%, Foliar spray of formula 15+ @ 0.2% and Foliar spray of humic plus @ 0.2% as factor-B. The experiment was laid out in a factorial randomized block design (FRBD) with three replications using bhendi var. SPBH-7 as test crop. The results revealed that the combined application of 100% NPK along with foliar spray of humic plus @ 0.2% significantly increased the growth, yield and quality characters of bhendi. The increased fruit and stover yield recorded was 17.58 and 11.72 t ha^{-1} as compared to 7.39 and 6.51 t ha^{-1} of fruit and stover yield in control.

Key words : Humic acid formulations, Bhendi, Growth, NPK, Quality, Yield.

Humic acid, a decomposition product of organic matter, influences plant growth by modifying the physiology of plants and by improving the physical, chemical and biological properties of soil. Humic acid, an elixir to plants have long been recognized by the scientists for its influence on the growth and development of crops. It is now well established that low molecular weight humic acids are taken up by crop plants, when it is applied either in soil or foliage. The auxin like activity of these humic substances in plants influences the cell division and cell elongation (Mato *et al*., 1971; Schnitzer and Weightman, 1974). In addition, it mobilizes the plant nutrients by complexing with nutrient cations.

The uptake of humic acids through the roots and their transformation in plants and possibility of their influence on metabolism was reported by Stevenson, (1994). Now a day's foliar nutrition is becoming an established technique in crop production to increase the yield and quality of crops. Since, it was comparable with soil application and it has the benefit of preventing the applied humic acid formulations entering in harmful soil reactions. Foliar fertilization is a simple and effective method of providing nutrients to crops. This is considered as an efficient and economic method of supplementing nutrient requirement to plants (Alexander and Schroeder, 1987). Hence, in the present investigation, an attempt has been made to study the effect of foliar application of different formulations of humic acid with NPK on the growth, yield and quality characters of bhendi.

METERIAL AND METHODS

A field experiment was conducted in a farmer's field at Perampattu village, cuddalore district, Tamilnadu to find out the effect of NPK and Humic acid formulations on the growth, yield and quality characters of bhendi. The experimental soil was sandy loam in texture with pH 7.54 and EC (0.96 d Sm^{-1}). The status of alkaline $KMnO_4$-N, Olsen-P and NH_4OAC-K were 185.32, 11.23 and 194.74 kg ha^{-1}, respectively. The treatments consisted of different levels of NPK like A_0-control, A_1- 50% NPK, A_2 – 100% NPK and A_3 – 150% NPK as factor-A and different sources of humic acid formulations *viz.,* B_0-control (Water spray), B_1- Foliar spray of lignite humic acid (LHA) @ 0.2%, B_2-Foliar spray of formula 15+ (F15+) @ 0.2% and B_3- Foliar spray of humic plus (HP) @ 0.2% as factor-B.

The experiment was conducted in a factorial randomized block design (FRBD) with three replications, using bhendi var. SPBH –7 as test crop. Humic acid extracted from lignite was used for this experiment. Humic acid was applied through foliage.

Foliar application of different humic acid formulations like Lignite Humic Acid, Formula 15+ and Humic plus @ 0.2 per cent on 20 and 45 DAS was applied as per the treatment. Calculated amount of fertilizer doses of 40:50:30 kg N: P_2O_5: K_2O ha^{-1} was applied according to the treatment. At harvest fruit and stover yield were recorded. The growth characters (plant height and DMP) and yield characters (No. of fruits $plant^{-1}$, fruit length and fruit weight) were also recorded at harvest stage. The fruit samples were collected at harvest stage and analysed for various quality characters viz., Ascorbic acid (A.O.A.C, 1975), crude protein (Piper, 1966), fibre (Sadasivam and Manickam 2004), phosphorous, potassium and calcium (Jackson, 973) content.

RESULTS AND DISCUSSION

Growth characters

Foliar feeding of humic acid either in the presence or absence of NPK increased the growth characters of bhendi *viz.,* plant height and dry matter production. Among the different levels of NPK evaluated, application of 150 per cent NPK recorded the maximum plant height (118.81 cm) and dry matter production (12.29 t ha^{-1}) of bhendi. However, it was found to be on par with 100 per cent NPK application, which recorded 109.11 cm plant height and 12.04 t ha^{-1} of dry matter production, respectively. Among the three humic acid formulations tried, foliar application of humic acid through humic plus @ 0.2 per cent was found to be superior in increasing the growth characters *viz.,* plant height and dry matter production, respectively.

Interaction effect due to HA formulation and NPK was significant. Application of 150 per cent NPK along with 0.2 per cent humic plus foliar spray registered the maximum plant height (128.50 cm) and dry matter production (13.89 t ha^{-1}). This was closely followed by the treatment which received 100 per cent NPK + 0.2 per cent humic plus foliar spray. The lowest plant height and dry matter production was noticed in control. The combined application of 100 per cent NPK along with foliar spray of HA through humic plus @ 0.2 per cent excelled all other treatments in improving all the growth characters of bhendi. The increased growth characters with different humic acid formulations through humic acids and NPK fertilizers might be due to the promoted cell division and cell elongation as reported by Donnel (1973) and Dhanasekaran *et al.* (2009).

Yield characters

Among the different levels of NPK evaluated, the application of 150 per cent NPK recorded the highest mean number of fruits $plant^{-1}$, fruit length and single fruit weight of bhendi. However, it was found to be equally efficacious with application of 100 per cent NPK. Among the different humic acid formulations, humic plus excelled the other two in improving the yield components of bhendi.

The interaction effect due to the application of NPK and HA formulation on yield characters of bhendi was significant. The treatment which received 150 per cent NPK + humic plus foliar spray recorded a higher number of fruits $plant^{-1}$ (23.75), fruit length (25.13 cm) and fruit weight (29.37 g). However, it was found to be on par with 100 per cent NPK + humic plus (HP) foliar spray. The betterment in yield parameters of bhendi may be due to abundant supply of nutrients with the application of NPK along with humic acid foliar spray. An adequate supply of plant nutrients applied through NPK fertilizers enhanced various metabolic activities in plant. Moreover, addition of NPK improved the supply of major and minor nutrients in soil. Addition of humic acid formulations through foliar spray which resulted in increased in rhythm with the pattern of crop growth which in turn influenced the plant growth and yield attributing characters of bhendi. These results are in conformity with Yadav *et al.* (2007) and Sangeetha and Singaram (2007).

Yield of bhendi crop

Among the various levels of NPK, application of NPK @ 150 per cent excelled the other three levels. Foliar application of all the humic acid formulations exerted a favourable effect in increasing the yield of bhendi. Though, all the humic acid formulations were efficient, the effect due to the foliar application of humic plus @ 0.2 per cent excelled other two formulations by registering a fruit and stover yield of 15.94 and 11.09t ha^{-1}, respectively.

Combined application of NPK and humic acid formulations on yield of bhendi was significant. The treatment (A_3B_3), 150 per cent NPK + humic plus (HP) foliar spray recorded a fruit and stover yield of 17.85 and 12.17 t ha^{-1} which was 49.12 and 40.53 per cent increase over100 per cent NPK. This treatment was closely followed by the treatment which received 100 per cent NPK +humic plus foliar spray (A_3B_2).The treatment 100 per cent NPK + humic plus foliar spray registered a fruit and stover yield of 17.58 and 11.72 t ha^{-1} which was 46.86 and 35.53 per cent increase over 100 per cent NPK alone.

The higher fruit yield might be due to increased nutrients uptake from soil, effective

Table 1. Effect of NPK and humic acid formulations on the growth characters of bhendi

A / B	Plant height (cm)					Dry matter production (t ha^{-1})				
	A_0	A_1	A_2	A_3	Mean	A_0	A_1	A_2	A_3	Mean
B_0 – Water Spray	68.06	81.64	89.77	92.35	82.96	8.30	9.31	10.30	10.60	9.62
B_1 – Lignite Humic Acid Spray @ 0.2%	88.15	98.02	105.14	107.35	99.67	8.77	10.31	11.41	11.81	10.57
B_2 – Formula 15+ Spray @ 0.2%	100.17	109.29	116.16	119.05	111.16	10.13	11.70	12.75	12.89	11.91
B_3 Humic Plus Spray @ 0.2%	109.72	119.10	125.38	128.50	120.67	11.30	12.75	13.72	13.89	12.91
Mean	91.53	102.01	109.11	118.81		9.62	11.01	12.04	12.29	
	SE_D			CD (p=0.05)		SE_D			CD (p=0.05)	
A	2.08			4.25		0.28			0.59	
B	2.85			5.83		0.31			0.65	
A × B	3.01			6.15		0.35			0.72	

Table 2. Effect of NPK and humic acid formulations on the yield (t ha^{-1}) of bhendi .

A / B	Fruit yield					Stover yield				
	A_0	A_1	A_2	A_3	Mean	A_0	A_1	A_2	A_3	Mean
B_0 – Water Spray	7.39	9.19	11.97	12.31	10.21	6.51	7.72	8.66	9.10	8.00
B_1 – Lignite Humic Acid Spray @ 0.2%	10.71	12.48	14.36	14.79	13.08	7.93	8.99	9.77	10.11	9.20
B_2 – Formula 15+ Spray @ 0.2%	12.20	14.23	16.17	16.68	14.82	8.70	9.79	10.60	11.10	10.05
B_3 Humic Plus Spray @ 0.2%	13.45	14.90	17.58	17.85	15.94	9.61	10.84	11.72	12.17	11.09
Mean	10.93	12.70	15.02	15.40		8.19	9.33	10.19	10.62	
	SE_D			CD (p=0.05)		SE_D			CD (p=0.05)	
A	0.34			0.70		0.28			0.58	
B	0.40			0.82		0.29			0.61	
A × B	0.47			0.97		0.36			0.74	

Table 3. Effect of NPK and humic acid formulations on the quality characters of bhendi.

A / B	Ascorbic acid content (mg100 g^{-1}fruit)					Crude protein content (%)					Fibre content (g 100g^{-1} fruit)				
	A_0	A_1	A_2	A_3	Mean	A_0	A_1	A_2	A_3	Mean	A_0	A_1	A_2	A_3	Mean
B_0 – Water Spray	9.96	11.94	13.05	13.09	12.01	1.33	1.50	1.57	1.58	1.50	8.39	11.04	12.82	13.08	11.33
B_1 – Lignite Humic Acid Spray @ 0.2%	12.00	12.96	13.75	13.89	13.15	1.48	1.56	1.63	1.64	1.58	12.50	13.97	13.25	16.04	13.94
B_2 – Formula 15+ Spray @ 0.2%	12.87	13.69	14.68	14.70	13.98	1.54	1.66	1.73	1.75	1.67	15.27	16.82	18.18	18.93	17.30
B_3 Humic Plus Spray @ 0.2%	13.92	14.89	15.70	15.71	15.05	1.66	1.73	1.82	1.83	1.76	17.31	19.29	20.52	21.25	19.59
Mean	12.18	13.37	14.30	14.35		1.50	1.61	1.69	1.70		13.36	15.28	16.69	17.32	
	SE_D		CD (p=0.05)			SE_D		CD (p=0.05)			SE_D		CD (p=0.05)		
A	0.29		0.61			0.010		0.021			0.43		0.89		
B	0.35		0.72			0.026		0.055			0.50		1.02		
A × B	0.36		0.75			0.029		0.060			0.51		1.05		

Table 4. Effect of NPK and humic acid formulations on the nutritional quality characters of bhendi.

A / B	Ascorbic acid content (mg100 g^{-1}fruit)					Crude protein content (%)					Fibre content (g 100g^{-1} fruit)				
	A_0	A_1	A_2	A_3	Mean	A_0	A_1	A_2	A_3	Mean	A_0	A_1	A_2	A_3	Mean
B_0 – Water Spray	0.52	0.61	0.67	0.68	0.62	1.45	1.73	1.90	1.98	1.77	4.11	4.45	4.72	4.81	4.52
B_1 – Lignite Humic Acid Spray @ 0.2%	0.59	0.67	0.71	0.72	0.67	1.89	2.12	2.30	2.32	2.16	4.81	5.17	5.44	5.56	5.24
B_2 – Formula 15+ Spray @ 0.2%	0.65	0.72	0.75	0.76	0.72	2.21	2.40	2.57	2.61	2.45	5.17	5.51	5.82	5.90	5.60
B_3 Humic Plus Spray @ 0.2%	0.69	0.74	0.78	0.79	0.75	2.44	2.68	2.86	2.87	2.71	5.50	5.89	6.17	6.28	5.96
Mean	0.61	0.69	0.73	0.74		2.00	2.23	2.41	2.45		4.90	5.26	5.54	5.64	
	SE_D		CD (p=0.05)			SE_D		CD (p=0.05)			SE_D		CD (p=0.05)		
A	0.009		0.018			0.07		0.15			0.09		0.18		
B	0.011		0.023			0.08		0.17			0.11		0.23		
A × B	0.012		0.026			0.09		0.20			0.15		0.31		

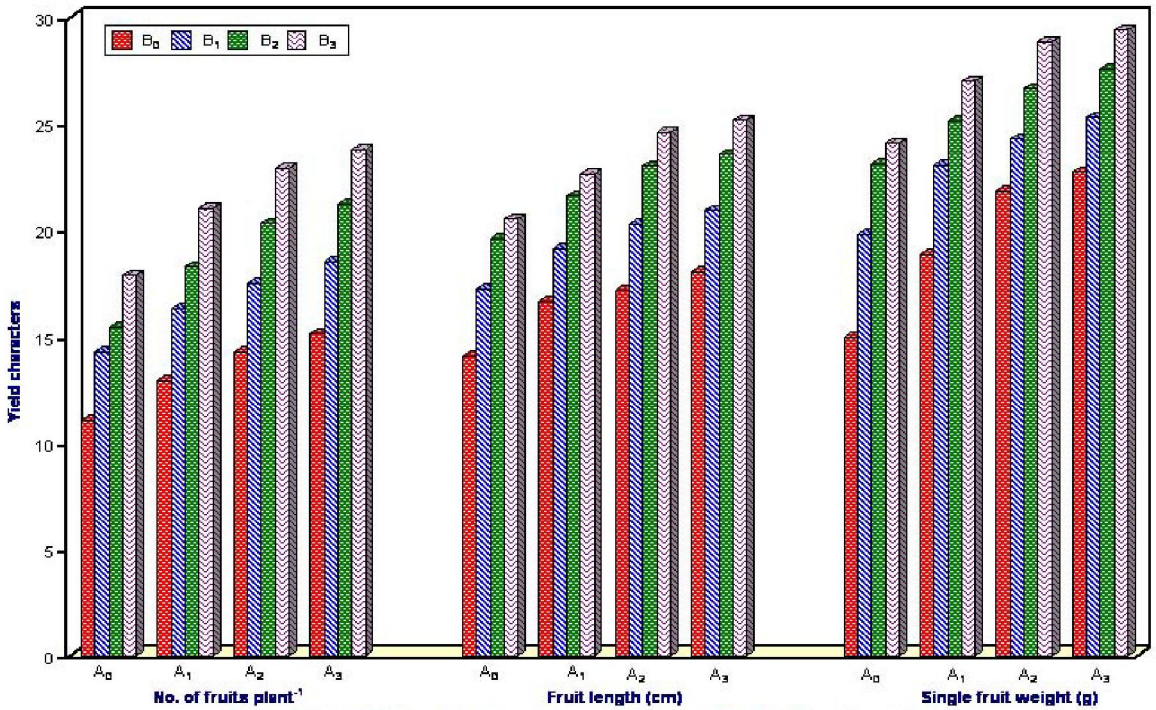

Fig. 1. Effect of NPK and humic acid formulations on the yield characters of bhendi

A_0 – Control; A-$_1$ – 50% NPK; A_2 – 100% NPK and A_3 – 150% NPK B_0 – Water Spray;
B_1 – Lignite Humic Acid Spray @ 0.2 %; B_2 – Formula 15+ Spray @ 0.2 %;
B_3 – Humic Plus Spray @ 0.2 %

utilization of foliar applied nutrients from humic acids, which resulted in better vegetative growth coupled with better partitioning and promotion of photosynthesis and respiration contributed by the proteins and quinone groups, respectively of due to humic substances. The reports of Butani *et al.* (2007) and Dhanasekaran *et al.* (2008) confirmed the present findings.

Quality characters

Among the different levels of NPK studied, the highest mean ascorbic acid (14.35 mg 100 g^{-1} fruit), crude protein (1.70 per cent), fibre (17.32g100g^{-1} fruit), phosphorus (0.74%), potassium (2.45%) and calcium content (5.64%) of bhendi fruit were recorded with 150 per cent NPK application which was at par with 100 per cent NPK. Among the different humic acid formulations, foliar spray of humic plus recorded the highest ascorbic acid, protein, fibre, phosphorus, potassium and calcium content of bhendi fruit. This was followed by the foliar spray of formula 15+ and lignite humic acid @ 0.2 per cent.

Interaction effect between humic acid formulation and NPK on quality characters of bhendi was significant. The treatments 150% NPK + HP @ 0.2% foliar spray and 100% NPK + HP @ 0.2% foliar spray equally efficient in increasing the ascorbic acid (15.71 and 15.70 mg 100 g^{-1} fruit), protein (1.83 and 1.82%), fibre (21.25 and 20.52 mg 100 g^{-1} fruit), phosphorus (0.79 and 0.78%), potassium(2.87 and 2.86%) and calcium content (6.28 and 6.17%) of bhendi, respectively. Increased ascorbic acid, fibre, protein, phosphorus, potassium and calcium content could mainly be due to better availability of both macro and micro nutrients in these treatments. Further, higher nutrient availability resulted in greater accumulation of N in the fruits and hence crude protein content of the fruit. Ascorbic acid and fibre content was also increased due to increased NPK fertilizer level and humic acid application. This was in accordance with the earlier findings of Balamurugan (2006) and Olaniyi *et al.* (2010).

LITERATURE CITED

A O A C 1975 Official and tentative methods of analysis, Association of Official Agricultural Chemists, Washington, D.C., USA.

Alexander A and Schroeder M 1987 Modern tends in foliar fertilization. *Journal of Plant Nutrition,* 10(9-16): 1391-1399.

Balamurugan N 2006 Effect of humic acid, NPK and organic on the performance of tomato (*Lycopersicon esculentum* Mill.). *M.Sc. (Ag.) Thesis,* Annamalai Univ., Annamalainagar.

Butani B M, Akbari K N and Polara J V 2007 Response of Okra (*Abelmoschus esculentus* (L.) Monech). *Adv. Plant Science,* 20: 215-216.

Dhanasekaran K, Sivakumar K, Bhuvaneswari R, Sathiyamurthi S 2008 Effect of lignite humic acid on the growth and yield of bhendi. *Proc. of Natl. Sem. on Recent Advances in Soil Health and Crop Management for Sustainable Agric.* 122-128.

Dhanasekaran K, Sivakumar K, Bhuvaneswari R and Sathiyamurthi S 2009 Effect of soil application of lignite humic acid on the growth and yield of tomato. *International Journal of Trop. Agricultural,* 27: 1-2.

Donnel R W 1973 The auxin like effects of humic preparations from leonardite. *Soil Science,* 113-116.

Jackson M L 1973 Soil chemical analysis, Prentice Hall of India Pvt. Ltd., New Delhi.

Mato M C, Fabregas R and Mendez J 1971 Inhibitory effect of soil humic acids on indole acetic acid oxidase. *Soil Biology Biochemestry,* 3: 285-288.

Olaniyi J O, Akanbi W B, Olaniran O A and Ilvpejv O T 2010 The effect of organo-mineral and inorganic fertilizers on the growth, fruit yield and chemical composition of Okra. *Journal of Animal Plant Sciences,* 9: 1135-1140.

Piper C S 1966 Soil and plant analysis. *Hans. Publishers,* Bombay.

Sadasivam S and Manickam A 2004 Biochemical methods, Sec. Ed. New Age International (P) Ltd., Publications, New Delhi, pp. 112-118.

Sangeetha M and Singaram P 2007 The effects of lignite humic acid and inorganic fertilizer additions on the productivity of typic haplustalf, Tamil Nadu, India. *Asian Journal of Soil Science,* 2: 134-137.

Schnitzer E A and Wightman F 1974 Metabolism of auxin in higher plants. *Ann. Rev. Plant Physiology,* 25: 487-513.

Stevenson F J 1994 Humus chemistry: Genesis composition, reaction, 2nd Ed. A Wiley Inter Science Publication, John Wiley and Sons, New York.

Yadav S K, Rana J C, Pradeep K, Yadav Shiv K, Zakir Hussainand, Mishra S K 2007 Effect of NPK, FYM and climatic zones on seed yield and quality in tomato (*Lycopersicon esculentum* Mill.). *Internation Journal of Trop. Agricultural,* 25(4): 867-869.

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