



**EFFECT OF NPK LEVELS AND DIFFERENT HUMIC ACID  
FORMULATIONS ON THE GROWTH, YIELD AND NUTRIENTS  
UPTAKE BY BHENDI**

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**ABSTRACT:**

A field experiment was conducted in a farmer's field at Perampattu village, near Chidambaram during January – April 2010, to find out the influence of humic acid formulations and different levels of NPK on the yield and nutrient uptake by bhendi. Texturally, the experimental soil was sandy loam with initial soil characteristics (0-15 cm layer) of the experimental site were, pH-7.54 and EC-0.96 dS m<sup>-1</sup>. The soil registered low organic carbon status of 3.1 g kg<sup>-1</sup>, 185.32 kg ha<sup>-1</sup> of alkaline KMnO<sub>4</sub> -N; 11.23 kg ha<sup>-1</sup> of Olsen-P and 194.74 kg ha<sup>-1</sup> of NH<sub>4</sub>OAc-K, respectively. The treatments consisted of different levels of NPK viz., A<sub>0</sub>-Control; A<sub>1</sub>-50% NPK; A<sub>2</sub>-100% NPK and A<sub>3</sub>-150% NPK as factor A and foliar application of different humic acid formulations viz., B<sub>0</sub>-Control (Water spray), B<sub>1</sub>-Foliar spray of lignite humic acid @ 0.2% , B<sub>2</sub>- Foliar spray of formula 15+ @ 0.2% and B<sub>3</sub> - Foliar spray of humic plus @ 0.2% as factor B. The above treatments were arranged in a Factorial Randomized Block Design (FRBD) with three replications and tested with bhendi var. SPBH 7 as test crop. The results of the study indicated that the combined application of 100% NPK along with foliar spray of humic plus @ 0.2% was significantly superior in increasing the yield and nutrients uptake by bhendi.

**KEY WORD:** *Humic acid formulations, NPK levels, yield, nutrient uptake, bhendi.*

**INTRODUCTION:**

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 Weight man, 1974). In addition, it mobilizes the plant nutrients by complexing with nutrient cations.

Foliar application of different formulations of humic acids may solve the problem of assimilation of nutrients in the leaves, which resulted in an increased photosynthetic rate, better nutrient uptake from the soil and translocation of these nutrients from the leaves to fruits, thereby enhancing higher fruit yield. Further, foliar fertilization of nutrients to the plants helps to absorb and transport the nutrients without spending any energy as well as without any loss in transit (Srivastava, 1995). Hence, the present investigation was carried out to study the influence of foliar application of different formulations of humic acid with NPK levels on the nutrient uptake and yield of bhendi.

### ***MATERIALS AND METHOD:***

A field experiment was conducted in a farmer's field at Perampattu village, Cuddalore district, Tamilnadu during January –April 2010. The initial soil of the experimental site had a pH-7.54 and EC-0.96 d Sm<sup>-1</sup>. The soil was low in organic carbon (3.1 g kg<sup>-1</sup>), low in available N (185.32 kg ha<sup>-1</sup>), medium in available P (11.23 kg ha<sup>-1</sup>) and available K (194.74 kg ha<sup>-1</sup>). Four levels of NPK viz., A<sub>0</sub>-Control, A<sub>1</sub>- 50% NPK, A<sub>2</sub>- 100% NPK and A<sub>3</sub>- 150% NPK were applied basally and three different sources of humic acid formulations viz., B<sub>0</sub>- Control, B<sub>1</sub>- Foliar spray of lignite humic acid (LHA) @ 0.2%, B<sub>2</sub>- Foliar spray of formula 15+ (F15+) @ 0.2% and B<sub>3</sub> - Foliar spray of humic plus (HP) @ 0.2% were applied through foliage. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications, using bhendi var. SPBH 7 as test crop. An uniform fertilizer dose of 40 kg of N + 50 kg of P<sub>2</sub>O<sub>5</sub> + 30 kg of K<sub>2</sub>O per hectare for bhendi was applied as urea, single super phosphate and muriate of potash, respectively. The entire dose of N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O were applied as basal. 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. The fruit and stover samples were collected at harvest stage and analysed for the content of N, P and K using the standard procedure as outlined by Jackson (1973) and uptake were calculated. At harvest fruit and stover yield were recorded.

### ***RESULTS AND DISCUSSIONS:***

#### *Growth characters:*

Foliar feeding of humic acid either in the presence or absence of NPK increased in the growth characters of bhendi viz., plant height, number of branches plant<sup>-1</sup> 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), number of branches plant<sup>-1</sup> (5.47) and dry matter production (12.29 t ha<sup>-1</sup>) of bhendi.

However, it was found on par with 100 per cent NPK application, which recorded 109.11 cm plant height, 5.40 number of branches plant<sup>-1</sup> and 12.04 t ha<sup>-1</sup> 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 (120.67 cm), number of branches plant<sup>-1</sup> (5.74) and dry matter production (12.91 t ha<sup>-1</sup>), respectively. This was followed by the foliar application of humic acid through formula 15+ @ 0.2 per cent and lignite humic acid @ 0.2 per cent.

In the 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 highest plant height (128.50 cm), number of branches plant<sup>-1</sup> (6.08) and dry matter production (13.89 t ha<sup>-1</sup>). 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, number of branches plant<sup>-1</sup> and dry matter production was noticed in control.

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

A	Plant height (cm)					No. of branches plant <sup>-1</sup>					Dry matter production (t ha <sup>-1</sup> )				
	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean
B <sub>0</sub>	68.06	81.64	89.77	92.35	82.96	3.76	4.33	4.65	4.72	4.36	8.30	9.31	10.30	10.60	9.62
B <sub>1</sub>	88.15	98.02	105.14	107.35	99.67	4.18	4.79	5.30	5.36	4.90	8.77	10.31	11.41	11.81	10.57
B <sub>2</sub>	100.17	109.29	116.16	119.05	111.16	4.75	5.28	5.67	5.75	5.36	10.13	11.70	12.75	12.89	11.91
B <sub>3</sub>	109.72	119.10	125.38	128.50	120.67	5.17	5.71	6.00	6.08	5.74	11.30	12.75	13.72	13.89	12.91
Mean	91.53	102.01	109.11	118.81		4.46	5.02	5.40	5.47		9.62	11.01	12.04	12.29	
	SE <sub>D</sub>		CD (p=0.05)			SE <sub>D</sub>		CD (p=0.05)			SE <sub>D</sub>		CD (p=0.05)		
A	2.08		4.25			0.05		0.12			0.28		0.59		
B	2.85		5.83			0.08		0.17			0.31		0.65		

A × B	3.01	6.15	0.09	0.20	0.35	0.72
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**Yield:**

A profound influence of humic acid formulations and NPK levels in increasing the fruit and stover yield of bhendi was well evidenced in the present study. Among the various levels of NPK, application of NPK @ 150 per cent excelled the other three levels. Application of 150 per cent NPK registered a fruit and stover yield of 15.40 and 10.62 t ha<sup>-1</sup> respectively which was at par with 100 per cent NPK which registered 15.02 and 10.19 t ha<sup>-1</sup> of fruit and stover, respectively. Among the different humic acid formulations, the effect due to the foliar application of humic plus was superior followed by the foliar spray of formula 15+ and lignite humic acid @ 0.2 per cent.

The interaction effect due to the combined application of NPK and humic acid formulations on yield of bhendi was significant. The treatment which received 150 per cent NPK + humic plus (HP) foliar spray recorded a fruit and stover yield of 17.85 and 12.17 t ha<sup>-1</sup> which was 49.12 and 40.53 per cent increase over 100 per cent NPK. This treatment was closely followed by the treatment which received 100 per cent NPK + humic plus foliar spray. Application of 100 per cent NPK + humic plus foliar spray registered a fruit and stover yield of 17.58 and 11.72 t ha<sup>-1</sup> which was 46.86 and 35.53 per cent increase over 100 per cent NPK alone.

The improvement in higher fruit and stover yield with foliar spray of humic acid and NPK fertilizer could be ascribed to the promoted cell division and cell elongation (Donnel, 1973 and Vaughan, 1974). Further, the humic acids are known to form chelates with micronutrients and thus it improves translocation of the nutrient cations within the plant system. The increased bhendi yield due to the application of humic acids and NPK fertilizer have already been well documented by Sangeetha and Singaram (2005) and Munazza Rafique *et al.* (2010).

Table 2. Effect of NPK and humic acid formulations on the yield (t ha<sup>-1</sup>) of bhendi

A B	Fruit yield					Stover yield				
	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean
B <sub>0</sub>	7.39	9.19	11.97	12.31	10.21	6.51	7.72	8.66	9.10	8.00
B <sub>1</sub>	10.71	12.48	14.36	14.79	13.08	7.93	8.99	9.77	10.11	9.20

B <sub>2</sub>	12.20	14.23	16.17	16.68	14.82	8.70	9.79	10.60	11.10	10.05
B <sub>3</sub>	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 <sub>D</sub>		CD (p=0.05)		SE <sub>D</sub>		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			

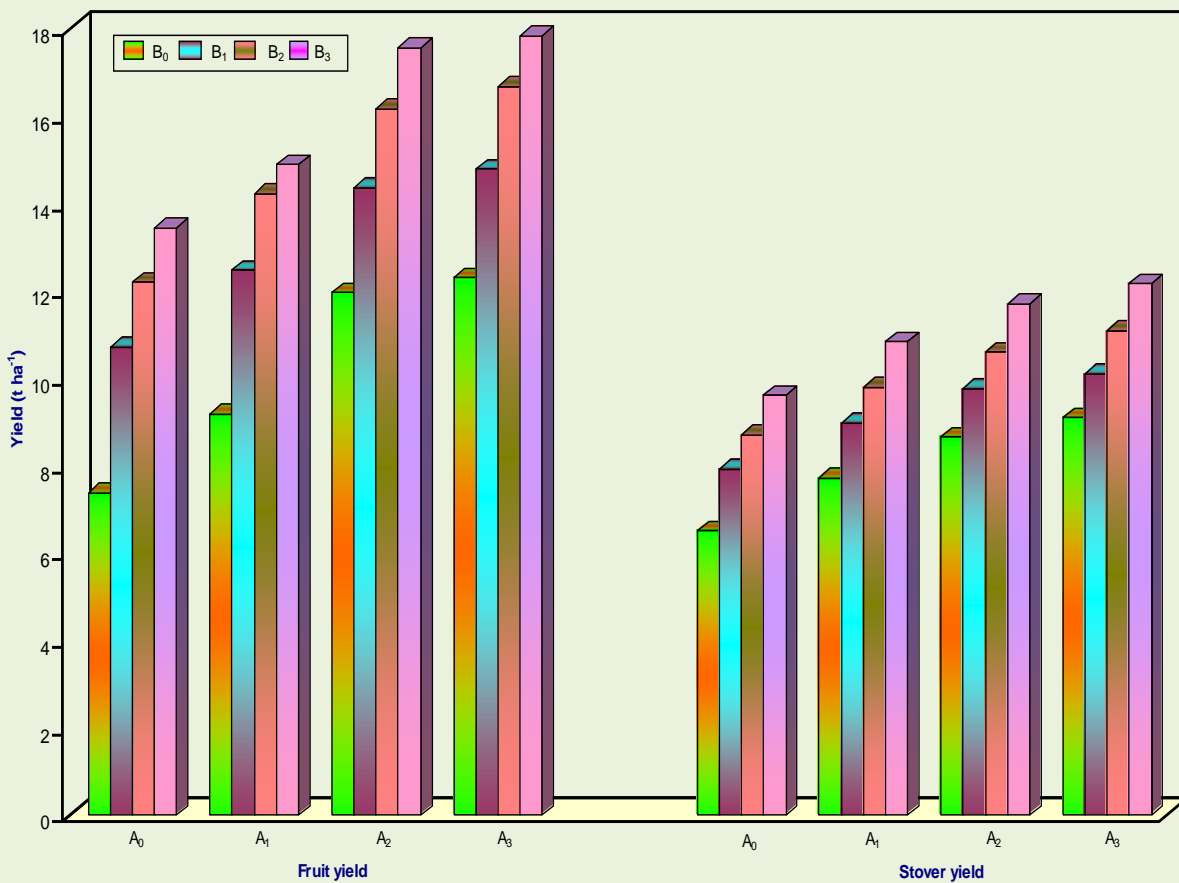


Fig. 4. Effect of NPK and humic acid formulations on the yield (t ha<sup>-1</sup>) of bhendi

*Nitrogen uptake:*

The uptake of N was significantly influenced by the application of NPK fertilizers and foliar application of humic acid formulations by both fruit and stover. Among the various NPK levels, the application of 150 per cent NPK ( $A_3$ ) recorded the highest N uptake by bhendi fruit and stover. However, it was found to be equally efficacious with the treatment  $A_2$  (supplied with 100 per cent NPK). Among the various humic acid formulations evaluated, humic plus foliar spray @ 0.2 per cent ( $B_3$ ) significantly improved the nitrogen uptake by bhendi fruit and stover. This was followed by the treatment  $B_2$  (foliar application of formula 15+ @ 0.2 %).

Regarding the interaction effect due to humic acid formulations and NPK levels on N uptake was significant. The foliar application of humic plus @ 0.2 per cent along with 150 per cent NPK ( $A_3B_3$ ) registered the highest N uptake of 58.68 and 36.35 kg ha<sup>-1</sup> in fruit and stover, respectively. However, it was found to be on par with the treatment ( $A_2B_3$ ) which received 100 per cent NPK + humic plus @ 0.2 per cent foliar spray by recording the N uptake of 57.56 and 35.49 kg ha<sup>-1</sup> in fruit and stover, respectively. The highest N uptake was registered with the application of NPK fertilizers along with humic acid through humic plus foliar spray treatments, which ensured greater N uptake perhaps due to the steady and increased availability of N throughout the period of crop growth. Similar observations were made by Sunitha (2003).

Table 3. Effect of NPK and humic acid formulations on the nitrogen uptake (kg ha<sup>-1</sup>) by bhendi

A \ B	Fruit					Stover				
	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean
B <sub>0</sub>	38.24	45.11	48.32	48.89	45.14	23.18	26.87	28.88	29.89	27.21
B <sub>1</sub>	45.96	48.83	51.48	52.69	49.74	26.51	29.85	31.36	32.43	30.04
B <sub>2</sub>	47.65	51.52	54.60	55.58	52.34	30.12	32.91	34.45	34.31	32.95
B <sub>3</sub>	51.24	54.58	57.56	58.68	55.58	31.78	33.81	35.49	36.35	34.36
Mean	45.77	50.01	52.99	53.96		27.90	30.86	32.54	33.24	

	SE <sub>D</sub>	CD (p=0.05)	SE <sub>D</sub>	CD (p=0.05)
A	1.08	2.21	0.69	1.41
B	1.25	2.57	0.82	1.69
A × B	1.37	2.81	0.88	1.80

*Phosphorus uptake:*

The uptake of phosphorus by bhendi was also significantly and positively influenced by the foliar application of humic acid formulations along with NPK fertilizers. Among the various NPK levels, the application of 150 per cent NPK (A<sub>3</sub>) recorded the highest amount of P uptake by both fruit and stover. However, it was found to be on par with the application of 100% NPK (A<sub>2</sub>). Among the various humic acid formulations evaluated, foliar spray of humic plus @ 0.2% (B<sub>3</sub>) significantly improved the P uptake by bhendi fruit and stover.

The interaction effect due to foliar spray of HA formulations and NPK on P uptake by bhendi was significant. The treatments 150 per cent NPK + humic plus 0.2 per cent (A<sub>3</sub>B<sub>3</sub>) and 100 per cent NPK + humic plus @ 0.2 per cent (A<sub>2</sub>B<sub>3</sub>) were equally efficient in increasing the phosphorus uptake of 16.32 and 16.08 kg ha<sup>-1</sup> by fruit and 11.19 and 10.98 kg ha<sup>-1</sup> by stover, respectively. Higher P uptake recorded in bhendi due to humic acid application. Combined application of humic acid and NPK improved the uptake of P and also enhanced the growth, yield and quality of bhendi. This was in accordance with the findings of Dhanasekaran *et al.* (2007).

A \ B	Fruit					Stover				
	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean
B <sub>0</sub>	10.39	11.50	12.31	12.52	11.68	6.30	7.54	8.42	8.61	7.72
B <sub>1</sub>	11.73	12.74	13.58	13.89	12.99	7.79	8.70	9.25	9.62	8.84

B <sub>2</sub>	13.30	14.21	15.09	15.25	14.46	8.76	9.62	10.20	10.38	9.74
B <sub>3</sub>	14.14	15.21	16.08	16.32	15.44	9.53	10.34	10.98	11.19	10.51
Mean	12.39	13.42	14.27	14.50		8.10	9.05	9.71	9.95	
	SE <sub>D</sub>		CD (p=0.05)			SE <sub>D</sub>		CD (p=0.05)		
A	0.28		0.58			0.20		0.40		
B	0.32		0.65			0.22		0.46		
A × B	0.37		0.76			0.25		0.51		

Table 4. Effect of NPK and humic acid formulations on the phosphorus uptake (kg ha<sup>-1</sup>) by bhendi*Potassium uptake:*

The uptake of K by bhendi was significantly influenced by the foliar application of humic acid formulations and NPK fertilizers.

Table 5. Effect of NPK and humic acid formulations on the potassium uptake (kg ha<sup>-1</sup>) by bhendi

A B	Fruit					Stover				
	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean	A <sub>0</sub>	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	Mean
B <sub>0</sub>	32.81	37.39	39.78	41.56	37.89	18.89	22.21	24.13	25.19	22.61
B <sub>1</sub>	38.24	41.49	44.17	45.15	42.26	21.80	24.96	26.82	27.77	25.34
B <sub>2</sub>	40.64	44.61	47.21	48.29	45.19	24.11	25.89	27.78	29.85	26.91



B <sub>3</sub>	44.47	47.36	49.93	51.18	48.24	27.49	29.46	30.94	31.83	29.93
Mean	39.04	42.71	45.27	46.54		23.07	25.63	27.42	28.66	
	SE <sub>D</sub>		CD (p=0.05)		SE <sub>D</sub>		CD (p=0.05)			
A	1.03		2.11		0.68		1.39			
B	1.16		2.38		0.71		1.45			
A × B	1.22		2.51		0.77		1.58			

A<sub>0</sub> – Control; A<sub>1</sub> – 50% NPK; A<sub>2</sub> – 100% NPK and A<sub>3</sub> – 150% NPK; B<sub>0</sub> – Water Spray; B<sub>1</sub> – Lignite Humic Acid Spray @ 0.2%; B<sub>2</sub> – Formula 15+ Spray @ 0.2%; B<sub>3</sub> – Humic Plus Spray @ 0.2%

A significant interaction effect was noticed between humic acid formulations and NPK level. The combined application of 150 per cent NPK + HP @ 0.2 per cent (A<sub>3</sub>B<sub>3</sub>) and 100 per cent NPK + HP @ 0.2 per cent (A<sub>2</sub>B<sub>3</sub>) registered the highest comparable potassium uptake (51.18 and 49.93 kg ha<sup>-1</sup>) by fruit and (31.83 and 30.94 kg ha<sup>-1</sup>) stover, respectively. The foliar spray of humic acid through humic plus along with NPK fertilizers accounted for the highest K uptake. The humic substances besides increasing availability of K might be due to slow release nature of K-humate complex would have enhanced the uptake of K by plants. The results are in conformity with Ibodov *et al.* (1983) and Pinaka Paneswara Reddy *et al.* (2004).

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