The Pharma Innovation Journal 2023; 12(5): 3373-3776

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 3373-3376

www.thepharmajournal.com
Received: 18-02-2023
Accepted: 30-04-2023

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Effect of integrated nutrient management and foliar spray of humic acid on growth, yield and quality of Brinjal (*Solanum melongena* L.)

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Abstract
The present investigations entitled "Effect of integrated nutrient management and foliar spray of humic acid on growth, yield and quality of brinjal" was undertaken at Instructional Farm, Department of Vegetable Science, Dr. PDKV, Akola during *Rabi* season of 2021-2022. The experiment was laid out in Randomized Block Design with 10 treatments and 3 replications. The Treatments includes: T_1- 100% RDF, T_2- 100% RDF+ FYM @ 5 t ha^{-1}, T_3- 100% RDF+ NPS compost @ 2.5 t ha^{-1}, T_4, T_5 and T_6- 100% RDF+ FYM @ 5 t ha^{-1}+ 4 sprays of humic acid @ 0.5, 1 and 1.5% respectively, T_7, T_8 and T_9- 100% RDF+ NPS compost @ 2.5 t ha^{-1}+ 4 sprays of humic acid @0.5,1 and 1.5% respectively, T_{10}- Absolute control. Among all treatments T_8 (100% RDF+ NPS compost @ 2.5 t ha^{-1}+ 4 sprays of humic acid @1%) treatment was recorded significantly maximum plant height (80.03 cm), Number of branches (11.2), plant spread (57.06 cm), leaf area (186.8 cm^2), stem girth (3.07 cm) at 90 DAT, chlorophyll index (37.90) at 60 DAT and yield parameters *viz.* fruits plant^{-1} (52.82), fruit girth (3.18 cm), fruit length (11.46 cm), average fruit weight (31.30 g), fruit yield per plant (1.65 kg), fruit yield per plot (33.07 kg) and fruit yield (408.38 q ha^{-1}).

Keywords: Brinjal, integrated nutrient management, humic acid, NPS compost

Introduction
Brinjal (*Solanum melongena* L.) is likewise known as eggplant, a famous vegetable fruit crop and is local to India. Brinjal is grown on a variety of soils, however deep, fertile and well drained soils are recommended for its cultivation. The fruit of brinjal is packed with important nutrients including protein, carbohydrates, fat and calcium. It also contains folate, niacin, thiamine, ascorbic acid. Leaves and roots contain alkaloid called as solanin. Eggplant is used in treatment of various diseases. Specially, white brinjal is used for treatment of diabetes patient.

In sustainable horticulture, humic substances are widely used. Extracted from leonardite shale, humic acid is one of the most concentrated organic materials in existence. The primary and secondary metabolism of plants is altered by humic and fulvic acids. Humic substances boost root growth, nutrient uptake, and crop resistance to environmental stresses. Humic acid absorbs minor and major elements, activates or inhibits enzymes, changes membrane permeability, resulting in protein synthesis and activating biomass production, all of which promote plant growth (El-Ghamry *et al.*, 2009) [4]. The beneficial effects of combined application of chemical fertilizers with organic manures *viz.*, farmyard manure, NPS compost and many more of such materials are universally known.

Material and Methods
The current investigation was undertaken at Instructional Farm, Department of Vegetable Science, Dr. PDKV, Akola during *Rabi* season of 2021-2022. The experiment was laid out in Randomized Block Design with 10 treatments and 3 replications. The experiment was framed with ten treatments *viz.* T_1- 100% RDF, T_2- 100% RDF+ FYM @ 5 t ha^{-1}, T_3- 100% RDF+ NPS compost @ 2.5 t ha^{-1}, T_4, T_5 and T_6- 100% RDF+ FYM @ 5 t ha^{-1}+ 4 sprays of humic acid @0.5,1 and 1.5% respectively, T_7, T_8 and T_9- 100% RDF+ NPS compost @ 2.5 t ha^{-1}+ 4 sprays of humic acid @0.5,1 and 1.5% respectively, T_{10}- Absolute control. The soil of experimental field was slightly alkaline (pH-7.97) with organic carbon (4.34 g kg^{-1}) and available N (174 kg ha^{-1}), available P (13.5 kg ha^{-1}), available K (307 kg ha^{-1}).

The experiment was laid out in 6.6 X 2.25 m plot size with 75X 60 cm spacing. Healthy seedlings of F_1 hybrid were transplanted on raised beds. The optimum plant population was maintained. Recommended fertilizer dose of 200:150:100 N, P and K kg ha^{-1}, full dose of P and K as basal dose and half dose of N and remaining N 30 days after transplanting were applied. Humic acid and NPS compost were brought from Dr. PDKV soil science and agricultural chemistry laboratory. NPS compost (1.78%N, 1.12%P, and 0.79% K) was derived from composting process enriched with rock phosphate and applied as basal dose to crop. FYM (0.53%N, 0.28%P, and 0.41% K) was also applied as basal dose. Schedule for spraying of humic acid includes first spray at flowering, second spray at first fruit setting, third spray at 10-15 days after first picking and fourth spray at 10-15 days after second picking. The observation recorded for growth, yield and quality parameters. For growth and yield parameters, five plants from each plot were selected randomly and tagged. Growth observations for different parameters were recorded at 90 days after transplanting. Chlorophyll index was recorded using SPAD meter at 60 DAT. Data recorded for growth parameters *viz.* plant height (cm), Number of branches, plant spread (cm), leaf area (cm^2), stem girth (cm). Data on yield parameters were recorded after each harvesting from tagged plants and cumulative of all data is presented in table. Data recorded for yield parameters *viz.* fruits $plant^{-1}$, fruit girth (cm), fruit length (cm), average fruit weight (g), fruit yield per plant (kg), fruit yield per plot (kg) and fruit yield (q ha^{-1}). The data obtained on various observations were analyzed as per the method advocated for Randomized Block Design (RBD) by Panse and Sukhatme (1985) [9]. Treatment means were compared by using critical difference at 5% level of significance.

Result and Discussion

Growth parameters

Data pertaining to plant height is presented in table no. 1. Maximum plant height was recorded in treatment T_8 (100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%) i.e., 80.03 cm at 90 DAT, which remained at par with treatment T_9 and T_4. The increase in plant height in treatment T_8 might be due to the application of NPS compost and foliar spray of humic acid which enhances the organic carbon of soil by increasing microbial activity in the soil. The results of present investigation are in confirmatory with El-Nemret *et al.* (2013) [5] in brinjal. Data for number of branches per plant is presented in table no.1. The maximum number of branches were observed in T_8 i.e. 11.2 at 90 DAT respectively, followed by T_9. These findings are in agreement with Kazemi *et al.* (2014) [6] in tomato crop. The data pertaining to plant spread at 90 DAT is presented in table no.1. Treatment T_8 recorded maximum plant spread 57.06 cm at 90 DAT respectively, followed by T_9 (54.23cm) at 90 DAT. The combined application of RDF and NPS compost along with foliar application of humic acid led to good growth of secondary roots, which increased the uptake of nutrients and increased photosynthetic activity of plants. Higher absorption of nutrients increased vegetative growth of plants. Maximum leaf area (table no. 1) was recorded in treatment T_8 (100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%) i.e. 186.8 cm^2 at 90 DAT which was at par with treatments T_9 and T_7. Foliar application of humic acid increases the plant metabolism and increases photosynthetic activity. Increased nutrient uptake helped improve the vegetative growth of the plant. Mohan *et al.* (2020) [7] reached a congruent conclusion with the use of organic coated fertilizer to improve brinjal growth. Treatment T_8 recorded highest stem girth 3.07 cm at 90 DAT respectively followed by T_9 and T_7. The increase in stem girth might (table no. 1) be due to an increase in the uptake of nutrients and the increased availability of nutrients in soil.

Quality parameters

Data pertaining to chlorophyll index is presented in table no.2. Chlorophyll index was recorded at 60 DAT. Treatment T_8 (100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%) recorded 37.90 maximum chlorophyll index which was followed by treatment T_9, T_3 and T_7 (37.41, 36.06 and 36 respectively). The increased leaf chlorophyll might be due to foliar application of humic acid enhancing the acceleration of N uptake and enhancing N metabolism which ultimately increased chlorophyll content. The results are in accordance with Thouti *et al*. (2022) [13].

Yield parameters

The data recorded on fruits per plant as influenced by different treatments is presented in table no.2. Among different treatment T_8 (100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%) produced significantly maximum fruits $plant^{-1}$(52.82) which was at par with treatment T_9 (51.99). The increase in fruits per plant might be due to the positive effects of nutrients. NPS compost and humic acid sprays, which could have induced higher vegetative growth, ultimately helped in the synthesis of food material, which increased the number of fruits per plant. Similar results have also been recorded by Suchitra *et al.* (2012) and Azarpourl *et al.* (2012) [12, 2] in brinjal. Maximum fruit length (table no.2) was observed in T_8 (100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%) 11.46 cm which was at par with treatment T_9 (11.18 cm). Fruits were harvested according to consumer's preference. These findings are confirmatory with Nantha Kumar *et al*. (2021) [8] in spiny brinjal. Maximum fruit girth (table no.2) recorded in treatment T_8 (3.18cm) followed by T_7 (3.13 cm) and T_9 (3.12 cm). Minimum fruit girth obtained in T_{10} (2.70 cm). The basic reason for the increase in fruit girth might be due to the application of NPS compost and humic acid, which provide better mobilization of plant nutrients, particularly N and P, during stages of growth, which might thus have improved fruit girth. These results are confirmatory with Roig *et al.* (2016) [10] in brinjal. The data related to average fruit weight is presented in table no.2. Among all treatments, maximum fruit weight recorded in treatment T_8 (31.30 g) followed by T_9 (31.10 g). The increase in average fruit weight might be due to accelerated photosynthetic activity which increases the food production in plants, ultimately improving the average fruit weight. Similar results were obtained by Bhuvaneshwari *et al.* (2020) [3] in brinjal.

Four sprays of humic acid showed significant impact on fruit yield per plant (table no.4). Highest yield of fruit per plant (1.65 kg) was recorded in treatment T_8 (100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%) which was at par with treatment T_9 (1.61 kg). The lowest fruit yield per plant was recorded in control (0.78 kg). From the table no. 2, it is observed that highest yield per plot (33.07 kg) was recorded in treatment T_8 which was at par with treatment T_9

(32.34 kg). Humic acid sprays along with NPS compost and RDF improved other yield parameters which simultaneously increased fruit yield per hectare. Significantly, maximum fruit yield per hectare (408.38 q ha^{-1}) was recorded in treatment T_8 (100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%) which remained at par with treatment T_9 (399.33 q ha^{-1}). The lowest yield (194.32 q ha^{-1}) was obtained in treatment T_{10} (control). The increase in fruit yield might be due to the stimulating effect of the humic acid on the growth and yield of the crop. Application of NPS compost and humic acid improved soil properties which increased nutrient uptake, thus improving fruit yield per plant. Increase in growth characters such as plant height, plant spread, number of branches, which ultimately increased the number of fruits per plant and fruit yield per hectare. Results of the present investigation are in conformity with findings of Azarpourl *et al.* (2012) [2] in Brinjal crop, Avinash *et al.* (2017) in capsicum and Ruban *et al.* (2019) in brinjal [1, 11].

Table 1: Effect of integrated nutrient management and foliar spray of humic acid on plant height (cm), number of branches, plant spread (cm), leaf area (cm^2), and Stem girth (cm) and chlorophyll index

Sr. No.	Treatment details	Plant height (cm)	No. of branches	Plant spread (cm)	Leaf area (cm^2)	Stem girth (cm)	Chlorophyll index
		90 DAT	90 DAT	90 DAT	90 DAT	90 DAT	60 DAT
T1	100% RDF	75.87	8.76	51.23	173.9	2.31	34.33
T2	100% RDF+FYM @ 5 t ha^{-1}	74.33	8.63	49.93	177.5	2.54	35.27
T3	100% RDF + NPS compost @ 2.5 t ha^{-1}	75.71	9.10	54.00	179.3	2.57	36.06
T4	100% RDF+ FYM @ 5 t ha^{-1} + 4 spray of HA @ 0.5%	76.70	9.40	53.50	181.6	2.68	34.11
T5	100% RDF + FYM @ 5 t ha^{-1} + 4 spray of HA @ 1%	73.67	8.83	51.06	179.6	2.59	36.11
T6	100% RDF + FYM @ 5 t ha^{-1} + 4 spray of HA @ 1.5%	75.73	9.00	51.96	182.1	2.55	34.90
T7	100% RDF + NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 0.5%	75.70	9.50	51.77	181.0	2.69	36.00
T8	100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%	80.03	11.2	57.06	186.8	3.07	37.90
T9	100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1.5%	77.03	10.2	54.23	184.2	2.8	37.41
T10	Absolute control	57.13	7.90	34.70	103.3	1.33	28.53
S.E.(m) ±		1.67	0.21	1.24	1.21	0.06	0.69
C.D at 5%		4.97	0.62	3.70	3.61	0.20	2.06

Table 2: Effect of integrated nutrient management and foliar spray of humic acid on yield parameters

Sr. No.	Treatment details	Yield parameters						
		Fruits plant $^{-1}$	Fruit girth (cm)	Fruit Length (cm)	Avg. Fruit Weight (g)	Fruit Yield/ Plant (kg)	Fruit Yield/ plot (kg)	Fruit Yield (q ha^{-1})
T1	100% RDF	41.16	2.97	10.57	29.70	1.22	24.44	301.81
T2	100% RDF+FYM @ 5 t ha^{-1}	42.20	3.02	10.46	29.97	1.26	25.29	312.30
T3	100%RDF + NPS compost @ 2.5 t ha^{-1}	46.72	3.07	11.11	30.39	1.42	28.39	350.54
T4	100% RDF+ FYM @ 5 t ha^{-1} + 4 spray of HA @ 0.5%	45.17	3.06	10.73	30.61	1.38	27.65	341.41
T5	100% RDF + FYM @ 5 t ha^{-1} + 4 spray of HA @ 1%	46.62	3.05	10.91	30.12	1.40	28.09	346.86
T6	100% RDF + FYM @ 5 t ha^{-1} + 4 spray of HA @ 1.5%	46.49	3.11	10.72	30.01	1.39	27.91	344.65
T7	100% RDF + NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 0.5%	50.45	3.13	10.74	30.26	1.53	30.54	377.04
T8	100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1%	52.82	3.18	11.46	31.30	1.65	33.07	408.38
T9	100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1.5%	51.99	3.12	11.18	31.10	1.61	32.34	399.33
T10	Absolute control	26.23	2.70	9.22	29.99	0.78	15.74	194.32
S.E. (m) ±		0.62	0.03	0.16	0.23	0.02	0.47	5.80
C.D at 5%		1.84	0.09	0.49	0.68	0.06	1.39	17.26

*NPS- Nitro phospho sulphur compost,*RDF- Recommended dose of fertilizer, HA- Humic acid

Conclusion

In present investigation, it was found that treatment with 100% RDF+ NPS compost @ 2.5 t ha^{-1} + 4 spray of HA @ 1% recorded significant effect on growth, yield and quality parameters of brinjal crop.

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