Response of Brinjal (Solanum melongena L.) to different doses of humic acid and zinc fertilization on the growth characters and dry matter production

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Abstract

The objective of the study was to determine the effect of soil application of humic acid and zinc fertilization on growth characters and DMP of eggplant, an experiment was conducted in 2018 based on the randomized block design with three replication and twelve treatments. Brinjal plants were treated with the soil application of humic acid and zinc sulphate at various concentrations. The growth characters and DMP has been improved with the soil application of humic acid and zinc sulphate when compared with the untreated plots. In the study, humic acid was applied at 20, 30, 40 kg ha^{-1} (T_2, T_3, T_4) and only RDF in control plot (T_1) and zinc sulphate at 25 and 50 kg ha^{-1} (T_5 and T_6). Combined application of humic acid and zinc sulphate were also given. Application of HA@ 20 kg ha^{-1} + $ZnsO_4$@ 25 kg ha^{-1} (T_7), HA@ 20 kg ha^{-1} + $ZnsO_4$@ 50 kg ha^{-1} (T_8), HA@ 30 kg ha^{-1} + $ZnsO_4$@ 25 kg ha (T_9), HA@ 30 kg ha^{-1} + $ZnsO_4$ + 50 kg ha^{-1} (T_{10}), HA@ 40 kg ha^{-1} + $ZnsO_4$@ 25 kg ha^{-1} (T_{11}), HA@ 40 kg ha^{-1} + $ZnsO_4$@ 50 kg ha^{-1} (T_{12}). Both the treatments positively affected the growth parameters and the dry matter production. The study shows that the combined application of humic acid at 30 kg ha-1 and zinc sulphate at 50 kg ha-1 concentration could be successfully used to obtain better growth in brinjal. The plant height (118.1 cm), Number of branches $plant^{-1}$ (11.32), Leaf area index (1.32), Number of flowers $plant^{-1}$ (32.1), and DMP (13.08 t/ha) recorded the excellent result when compared to control plots.

Keywords: Eggplant, humic acid, zinc, growth, DMP.

INTRODUCTION

Brinjal (Solanum melongena L.) is a perennial tropical vegetable plant native to South and East Asia (China & India). The brinjal is one of the most popular and principal vegetable crops grown in India and other parts of the world. It is quite rich in terms of nutritional value due to its composition, which includes minerals like potassium, calcium, sodium and iron (Raigon *et al.*, 2008) as well as dietary fiber (USDA, 2014). The leading brinjal producing countries in the order of importance are China, India, Japan, Italy and Spain. China is the largest producer of brinjal and contributes about 68.7 per cent of the world's brinjal production while India occupies second position in production with a share of 23.3 per cent. Brinjal is highly productive and usually find its place as poor man’s crop.

Humic acid, which has a hormone-like activity enhances plant growth and nutrient uptake of the brinjal crop. Humic acid (HA) is the result of organic matter decomposition and is beneficial to plant growth and development. Humic acid influences plant growth by modifying the physiology of plants by improving the physical, chemical and biological properties of the soil. Humic acid, an elixir to plants have been long recognized by the scientists for its influence on the growth and development of crops. The beneficial effects of HS on plant growth may be related to their indirect (increase of fertilizer efficiency or reducing soil compaction) or direct effects (improvement of the overall plant biomass). The application of humic acid has been reported to have a positive effect on plant growth (Nardi *et al.*, 2009 and Arancon *et al.*, 2003). Humic acid helps soil loosen and crumble and thus increases the aeration of soil as well as soil workability. It darkens the color of the soil and thus helps the absorption of the sun’s energy. It promotes the conversion of nutrient elements (N, P, K and Trace elements) into available form to plants.

Zinc (Zn) is really a miracle micronutrient for plant life. Zinc is one of the most important and essential micro element for plants. It is an active element in metabolic activities and biochemical processes, such as carbohydrate metabolism (Marschner and Cakmak, 1989), protein production (Pandey et al., 2006), nitrogen metabolism, photosynthesis, chlorophyll synthesis, resistance to biotic and abiotic stress factors, protection against oxidative damage (Ali et al., 2008; Cakmak, 2008, Mousavi, 2011) and enzyme activities. It plays an important role in a wide range of processes, such as growth hormone production and internode elongation the main function of zinc is to help the pant produce chlorophyll. In addition zinc is an active element in chemical and biological interaction with some other elements (Khorgamy and Farnia, 2009).

Zinc deficiency symptoms appear on the younger leaves of plants first. The deficiency of zinc indicates leaf discoloration, stunting reduced height, brown spots on upper leaves, distorted leaves, Interveinal chlorosis which spread later to younger leaves. Delayed flowering and the flowers fails to set fruits and withered (IKISAN). Zinc deficiency can also limit the yield of corn, beans, wheat, cotton, sorghum, fruits and vegetables like okra, brinjal, tomato. Micronutrients like zinc always play a positive role for increasing fruit as well as seed yield in brinjal.

MATERIALS AND METHODS:

The study was carried out as a field experiment at Kavarapattu village, near Chidambaram, Cuddalore district, Tamilnadu. The experimental site is geographically located at 11° 24' N latitude, 79° 44' E longitude and altitude of 8 m above mean sea level (MSL). The experimental soil was sandy clay loam in texture and taxonomically classified as *Typic ustifluvent.*

Some of the soil physical and chemical properties of the experimental area was given in Table. 1. Brinjal variety Palur.2 was used as a test crop for the experiment. Seedlings were planted at 23rd January 2018 at a spacing of 60×60 cm. Trials was carried out in randomized block design with three replication. The experiment was carried out with the objective to evaluate the response of Brinjal (Solanum melongena L.) to different doses of humic acid and zinc fertilization on the growth characters and dry matter production of palur 2 variety.

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In the study, humic acid was applied at 20, 30, 40 kg ha^{-1} (T_2, T_3, T_4) and only RDF in control plot (T_1) and zinc sulphate at 25 and 50 kg ha^{-1} (T_5 and T_6). Combined application of humic acid and zinc sulphate were also given.

Application of HA@ 20 kg ha^{-1} + $ZnsO_4$@ 25 kg ha^{-1} (T_7), HA@ 20 kg ha^{-1} + $ZnsO_4$@ 50 kg ha^{-1} (T_8), HA@ 30 kg ha^{-1} + $ZnsO_4$@ 25 kg ha (T_9), HA@ 30 kg ha^{-1} + $ZnsO_4$ + 50 kg ha^{-1} (T_{10}), HA@ 40 kg ha^{-1} + $ZnsO_4$@ 25 kg ha^{-1} (T_{11}), HA@ 40 kg ha^{-1} + $ZnsO_4$@ 50 kg ha^{-1} (T_{12}). The vegetables are harvested thrice at 60th, 90th, and 120th days after planting. The growth characters (plant height, number of branches, leaf area index and number of flowers and DMP) were observed.

Table 1. Physico-chemical properties of the experimental soil

S.No	Properties	Content
I.	**Physical properties**	
1.	Mechanical composition	
	Sand (%)	
	Silt (%)	66.58
	Clay (%)	25.17
	Texture	7.15

	Taxonomical class	Sandy clay loam
2.	Bulk density(Mgm-3)	*Typic ustifluvent*
3.	Particle density (Mgm-3)	1.25
4.	Pore space (%)	2.38
		48.96
II.	**Physico-chemical properties**	
5.	Soil reaction (pH) 1:2.5 ratio	7.8
6.	Electrical conductivity (dsm-1)	1.48
7.	Cation exchange capacity (C mol (p+) kg-1)	14.10
III.	**Chemical properties**	
8.	Organic carbon (%)	6.4
9.	Alkaline $KMnO_4$-N (kg ha^{-1})	210
10.	Oleson-P (kg ha^{-1})	16
11.	NH_4OAc-K (kg ha^{-1})	286
IV.	**Exchangeable cations**	
12.	Calcium $(Cmol(p^{+})kg^{-1})$	5.5
13.	Magnesium $(Cmol(p^{+})kg^{-1})$	2.9
14.	Sodium (mg kg^{-1})	2.7
15.	Sulphur (mg kg^{-1})	56.1
16.	DTPA-Zn (mg kg^{-1})	0.67

RESULTS AND DISCUSSION:

In order to the soil application of humic acid and zinc sulphate on the growth characters of brinjal. Representative plants in each plots were labelled and the observations were taken at appropriate stages.

Table 2: Effect of humic acid and zinc sulphate on plant height (cm) of brinjal at different crop stages

Treatments	Plant Height (cm)			
	30 days	60 days	90 days	120 days
T_1 – Control	43.7	56.3	68.3	83.2
T_2 - Humic acid @ 20 kg ha^{-1}	46.5	63.2	76.5	87.2
T_3 - Humic acid @ 30 kg ha^{-1}	49.2	65.4	82.7	90.4
T_4 - Humic acid @ 40 kg ha^{-1}	48.1	64.7	79.2	89.1
T_5 - Zinc sulphate @25 kg ha^{-1}	45.4	60.5	75.4	85.9
T_6 - Zinc sulphate @ 50 kg ha^{-1}	44.2	58.4	73.1	84.2
T_7 - Humic acid @ 20 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	49.8	67.1	83.2	92.1
T_8 - Humic acid @ 20 kg ha^{-1}+ Zinc sulphate @	50.6	68.2	86.4	96.4

50 kg ha^{-1}				
T_9 - Humic acid @ 30 kg ha^{-1}+ Zinc sulphate @ 25 kg ha^{-1}	53.4	73.4	91.8	114.2
T_{10}-Humic acid @ 30 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	54.1	74.9	92.4	118.1
T_{11} -Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 25 kgha^{-1}	51.2	69.3	88.3	98.2
T_{12} - Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	52.1	72.1	89.5	111.3
S. Ed	**0.938**	**1.267**	**1.596**	**1.800**
CD (p=0.05)	**0.63**	**1.22**	**0.35**	**3.73**

Among the various humic acid treatments, the application of humic acid at 30 kg/ha recorded the best with 49.2, 65.4, 82.7, 90.4 at 30, 60, 90, 120 days respectively. Among the zinc levels, the application of zinc sulphate at 25 kg ha-1 recorded the best with 45.4, 60.5, 75.4, and 85.9 at respective days. Among the combined application, the treatment T_{10} humic acid at 30 kg ha^{-1} and zinc sulphate at 50 kg ha^{-1} was recorded the plant height of 54.2 cm at 30 days, 75.0 cm at 60 days, 92.6 cm at 90 days, 118.4 cm at 120 days respectively. It clearly shows that the plant height (Fig. 2) was increased due to the increasing concentration of micronutrients by the application of humic acid and zinc sulphate. The increase in plant height under zinc sulphate might be due to the fact that zinc in addition to its role in chlorophyll synthesis it also influenced the cell division, meristematic activity of tissue, expansion of cell and formation of cell wall. Soil application of zinc sulphate increased the plant tissue activity, which ultimately resulted in improving the plant height (table. 2) in accordance with Pandav (2016). There was a variation between the results on number of branches plant-1, ranged from 7.54 (T_{10}) to 5.23 (T_1), and 8.94 (T_{10}) to 6.52 (T_1) on 60 and 90 DAP respectively. At 120 DAP, application of humic acid @ 30 kg ha-1 and zinc sulphate @ 50 kg ha-1 recorded the highest number of branches (11.32) when compared to control (8.52). This increase of number of branches (table. 3) in the plant might be due to improving the soil physical and chemical characters by the humic substances. This was in accordance with Yildrim (2007) that the humic acid application increased the number of branches compared to control.

The soil application of humic acid at 30 kg ha^{-1} and $ZnsO_4$ at 50 kg ha^{-1} (T_{10}) recorded the highest leaf area index of 1.12, 1.22, 1.32 at 30, 60, 90 days duly. Leaf area index (table. 4) were significantly increased by varying zinc levels indicated by Saleha Tawab (2015). He reported that the zinc levels applied on the plots have a positive effect on leaf growth. Among the various combined levels of humic acid and zinc sulphate experimented, the maximum number of flowers plant^{-1} of 12.4 at 60 days and 24.3 at 90 days was observed with humic acid at 30 kg ha^{-1} and zinc sulphate at 50 kg ha^{-1} (T_{10}).The significant increase in the morphological characters such as leaf area index, number of flowers (table.5) with the application of the treatment with humic acid and zinc which might be due to the rapid meristematic activities in plants. Among the combined treatments, the highest dry matter produced in the application of humic acid at 30 kg ha^{-1} and zinc sulphate at 50 kg ha^{-1} was noticed.

The DMP varies from 4.99 t ha^{-1} to 13.08 t ha^{-1}. The highest DMP in the above noticed treatments (T_{10}) was recorded 13.08 t ha^{-1}. This was on par with the treatment T_9 noted as 13.07 t ha^{-1}. The higher due to the favorable nutritional environment and higher uptake of nutrients from humic acids and zinc applied plants might have increased the rate of photosynthesis, better translocation of photosythates from stems and leaves to the plant, which favorably influenced the yield parameters. These findings are in agreement with the report of Pinaka Paneswara Reddy et al., (2004).

Table 3: Effect of Humic acid and Zinc sulphate on the number of branches plant^{-1} of brinjal at different crop stages:

Treatments	Number of Branches			
	30 days	**60 days**	**90 days**	**120 days**
T_1 – Control	3.14	5.23	6.52	8.52
T_2 - Humic acid @ 20 kg ha^{-1}	5.32	6.69	7.72	9.18
T_3 - Humic acid @ 30 kg ha^{-1}	5.50	7.19	8.07	9.74
T_4 - Humic acid @ 40 kg ha^{-1}	5.45	7.08	7.89	9.42
T_5 - Zinc sulphate @25 kg ha^{-1}	5.29	6.54	7.64	8.92
T_6 - Zinc sulphate @ 50 kg ha^{-1}	4.45	6.21	7.52	8.64
T_7 - Humic acid @ 20 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	5.52	7.24	8.19	9.89
T_8 - Humic acid @ 20 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	5.56	7.39	8.20	10.02
T_9 - Humic acid @ 30 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	5.69	7.53	8.93	11.31
T_{10} - Humic acid @ 30 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	5.70	7.54	8.94	11.32
T_{11} - Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	5.58	7.42	8.54	10.24
T_{12} - Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	5.62	7.48	8.72	10.63
S. Ed	**0.104**	**0.137**	**0.155**	**0.188**
CD (p=0.05)	**0.12**	**0.28**	**0.32**	**0.39**

Table 4: Effect of humic acid and zinc sulphate on leaf area index of brinjal at different crop stages

Treatments	Leaf Area Index (LAI)		
	30th Days	60th Days	90th Days
T_1 - Control	0.83	1.01	1.10
T_2 - Humic acid @ 20 kg ha^{-1}	0.95	1.05	1.17
T_3 - Humic acid @ 30 kg ha^{-1}	1.00	1.09	1.22
T_4 - Humic acid @ 40 kg ha^{-1}	0.97	1.08	1.20
T_5 - Zinc sulphate @25 kg ha^{-1}	0.92	1.04	1.14
T_6 -Zinc sulphate @ 50 kg ha^{-1}	0.87	1.02	1.12
T_7 - Humic acid @ 20 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	1.10	1.09	1.23
T_8 - Humic acid @ 20 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	1.50	1.11	1.25
T_9 - Humic acid @ 30 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	1.11	1.21	1.31
T_{10} - Humic acid @ 30 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	1.12	1.22	1.32
T_{11} -Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	1.70	1.16	1.27
T_{12} - Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	1.80	1.17	1.29
S. Ed	**0.024**	**0.020**	**0.023**
CD (p=0.05)	**0.05**	**0.04**	**0.04**

Table 5: Effect of humic acid and zinc sulphate on number of flowers plant^{-1} of brinjal @ different crop stages

Treatments	Number of Flowers Plant^{-1}		
	60 days	90 days	120 days
T_1 - Control	6.2	17.2	20.1
T_2 - Humic acid @ 20 kg ha^{-1}	8.3	18.5	25.7
T_3 - Humic acid @ 30 kg ha^{-1}	9.2	20.1	27.1
T_4 - Humic acid @ 40 kg ha^{-1}	8.9	19.8	26.8
T_5 - Zinc sulphate @25 kg ha^{-1}	7.4	18.4	27.8
T_6 - Zinc sulphate @ 50 kg ha^{-1}	6.9	17.8	24.5
T_7 - Humic acid @ 20 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	9.4	20.7	27.6
T_8 - Humic acid @ 20 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	10.3	21.9	28.8
T_9 - Humic acid @ 30 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	12.3	24.2	31.8
T_{10} - Humic acid @ 30 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	12.4	24.3	32.1
T_{11} -Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	10.7	22.2	29.8
T_{12} - Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	11.2	22.8	31.2
S. Ed	**0.194**	**0.401**	**0.534**
CD (p=0.05)	**0.40**	**0.83**	**1.11**

Table 6: Effect of humic acid and zinc sulphate on DMP (t/ha) of brinjal fruit at 90 DAP

Treatments	Dry matter production (t/ha) at 90 DAP
T_1 - Control	4.99
T_2 - Humic acid @ 20 kg ha^{-1}	7.12
T_3 - Humic acid @ 30 kg ha^{-1}	7.93
T_4 - Humic acid @ 40 kg ha^{-1}	7.46
T_5 - Zinc sulphate @25 kg ha^{-1}	7.02
T_6 - Zinc sulphate @ 50 kg ha^{-1}	6.72
T_7 - Humic acid @ 20 kg ha^{-1} + Zinc sulphate @ 25 kg ha^{-1}	8.13
T_8 - Humic acid @ 20 kg ha^{-1}+ Zinc sulphate @ 50 kg ha^{-1}	8.25
T_9 - Humic acid @ 30 kg ha^{-1}+ Zinc sulphate @ 25 kg ha^{-1}	13.07
T_{10}-Humic acid @ 30 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	13.08
T_{11} -Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 25 $kgha^{-1}$	8.98
T_{12} - Humic acid @ 40 kg ha^{-1} + Zinc sulphate @ 50 kg ha^{-1}	10.16
S. Ed	**0.178**
CD (p=0.05)	**0.36**

CONCLUSION:

The present investigation clearly brought out the beneficial effects of soil application of humic acid and zinc sulphate on the growth of brinjal. Application of humic acid at 30 kg ha-1 and zinc sulphate at 50 kg ha-1 was identified as the best treatment combination for the farmer's recommendation to realize the maximum profit in brinjal. However the results should be test verified under field conditions for recommendation to the farmers.

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