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EFFECT OF HUMIC ACID ON GROWTH AND YIELD OF OKRA

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Abstract–A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal with an aim to study the effect of HA on okra plants along with different doses of FYM and recommended fertilizers. The experiment was laid out in randomized block design with three replications. There were sixteen treatments comprising of organic sources with various levels of humic acid. The results revealed that the treatment T_{15} (FYM plus 100% RDF (Recommended dose of fertilizer) along with 0.2% HA) showed superiority in most of the parameters plant height at first flowering and final harvest, number of branches plant^{-1} at first flowering and final harvest, fruit length, fruit girth, number of fruits plant^{-1}and yield plant^{-1}. It is apparent that the lower dose of HA is favorable in inducing the growth and development in okra.

INTRODUCTION

Vegetables are rich sources of nutrients. Adding vegetables to our daily routine makes a healthy diet. They supply protective substances like vitamins and minerals as well as the energy sources such as carbohydrates, protein and fats. Okra [*Abelmoschus esculentus* (L.) Moench] is a very remunerative, widely grown and indispensable vegetable crop cultivated almost in all states of India. Researchers all over the world have devoted considerable attention to the nutrient management and nutrient supply to plants.

Use of organics like farmyard manure (FYM) and humic acid (HA) not only increases the moisture holding capacity of the soil but also play an important role in soil and water conservation by their binding and aggregating properties. Moreover, they also help in balancing the availability of all essential plant nutrients to the growing plants to maintain high yield and quality of produce (Dutta, 1991). Stimulation in the production of necessary plant growth substances internally by the external application as foliar spray has given good, encouraging and fruitful results in increasing the physiological activities such as growth and development, yield and quality (Arun, 1999).

Humic acids have the ability to hold the water seven times their volume, with a greater water holding capacity. Water stored within the topsoil enables plant roots to quickly access the available nutrients required for growth and yield (Hartwigsen *et al.*, 2000). The humic substances can be very effective in removing excess pesticides from soils which are very low in organic matter thereby avoiding the soil toxicity hazards. The molecular components of humic acid tend to act as plant growth hormones. Applications can be timed to activate vegetative growth, flowering, fruit set and ripening of fruits. Humic acid is recognized by most of the soil scientists and agronomists as a highly important component for a healthy and fertile soil (Ravichandran, 2011).

Foliar applications of relatively smaller molecular units of humic substances containing trace minerals can be timed to meet the needs of specific plant growth requirements. Root growth is primarily stimulated by the smaller molecular components of humic acids. Uptake of smaller molecular components of humic substances is both passive and metabolically active. Lower molecules of HA are reported to be easily assailable by the plants (Pettit, 2012). With this background, the present study was set to study the influence of HA on okra plants growth and yield attributes and yield.

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MATERIALS AND METHODS

The present investigation on the effect of humic acid on okra was carried out during 2015-16 in the college orchard of Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal (U.T. of Puducherry). The physical and chemical properties of the soil of field under study are given in Table 1. The okra variety 'Arka Anamika' released from the Indian Institute of Horticultural Research (IIHR), Bangalore was used in the present study. The humic acid was procured from NLC, Neyveli (Neyveli lignite corporation), Tamil Nadu. The pH and EC of Humic acid was 6.60 and 6.52 dSm^{-1}, respectively. The experiment was laid out in Randomized Block Design (RBD) with three replications and sixteen treatments (Table 2). The humic acid was used at four different concentrations for foliar application *viz.*, 0.1%, 0.2% and 0.4%, along with control. Foliar spraying of humic acid solutions and water (control) were taken up at 30 and 45DAS. FYM @ 25 t ha^{-1} and fertilizers (20:50:30 NPK kg ha^{-1}) was applied as per the recommendation (Crop production techniques of horticultural crops, 2013). The fertilizers were applied at four different levels viz., 0 %. 50%, 75% and 100% recommended doses as per the treatment schedule. The treatment details are furnished in Table 2.

Five plants in each plot were selected at random and tagged. The biometric observations were recorded in the tagged plants and mean values were worked out. The plant height at first flowering and final harvest were recorded by measuring the height from plant base to the growing tip. The number of branches $plant^{-1}$ was recorded at first flowering and final harvest. The fruit length was measured from base to apex of the fruits harvested at 5th harvest (Venkadeshwaran, 2013). The fruit diameter was measured at the broadest point of the fruits harvested at 5th harvest (Thalirkodi, 2007).

Table 1. The physical and chemical properties of the soil

S. No.	Properties	Range
1.	Physical properties	
	Clay (per cent)	12.40
	Silt (per cent)	4.75
	Fine sand (per cent)	17.46
	Coarse sand (per cent)	64.61
	Textural class	Sandy clay loam
	Bulk density (g cm^{-3})	1.333
	Taxonomical group	*Vertic Ustropept*
	Soil series	Surakudy soil series
2.	Physico-chemical properties	
	Soil reaction (pH)	8.01
	Electrical conductivity (dSm^{-1})	0.092
3.	Chemical properties	
	Organic carbon (g g^{-1})	0.240 (Low)
	Available nitrogen (kg ha^{-1})	98.00 (Low)
	Available phosphorous (kg ha^{-1})	9.337 (Low)
	Available potassium (kg ha^{-1})	85.00 (Low)

Table 2. Treatment details

S.No.	Treatments
T_0	Absolute control
T_1	FYM + RDF - 0% + Humic acid - 0%
T_2	FYM + RDF - 0% + Humic acid - 0.1%
T_3	FYM + RDF - 0% + Humic acid - 0.2%
T_4	FYM + RDF - 0% + Humic acid - 0.4%
T_5	FYM + RDF - 50% + Humic acid - 0%
T_6	FYM + RDF - 50% +Humic acid - 0.1%
T_7	FYM + RDF - 50% + Humic acid - 0.2%
T_8	FYM + RDF - 50% + Humic acid - 0.4%
T_9	FYM + RDF - 75% + Humic acid - 0%
T_{10}	FYM + RDF - 75% + Humic acid - 0.1%
T_{11}	FYM + RDF - 75% + Humic acid - 0.2%
T_{12}	FYM + RDF - 75% + Humic acid - 0.4%
T_{13}	FYM + RDF - 100% + Humic acid - 0%
T_{14}	FYM + RDF - 100% + Humic acid - 0.1%
T_{15}	FYM + RDF - 100% + Humic acid - 0.2%
T_{16}	FYM + RDF - 100% + Humic acid - 0.4%

RESULTS AND DISCUSSION

Effect of foliar application of humic acid on growth parameters

Plant height

The treatment T_{15} (FYM plus 100% RDF along with 0.2% HA) recorded the highest plant height at first flowering (62.33 cm) (Table 3). The lowest plant height at flowering of 30.80 cm was recorded in the treatment T_0 (Absolute control). Treatment T_{15} which received FYM plus 100% RDF along with 0.2% HA has recorded the maximum plant height at final harvest (179.13 cm). Plant height at final harvest was minimum in treatment T_0 (Absolute control) with 57.47 cm followed by T_1 (FYM alone).

Number of primary branches $plant^{-1}$

The number of primary branches $plant^{-1}$at first flowering was maximum (2.67 branches) in treatments T_{15} and T_{16} (FYM plus 100% RDF along with 0.2 and 0.4% HA). The minimum number of primary branches $plant^{-1}$ at first flowering was observed in the treatment T_0 (Absolute control) with

0.93 branches. Treatment T_{15} (FYM plus 100% RDF along with 0.2% HA) recorded maximum number of primary branches plant^{-1} at final harvest (3.00 branches). The minimum number of primary branches plant^{-1} at final harvest was found in T_0 (Absolute control) with 1.27. The treatment T_0 (Absolute control) recorded the lowest node for first flowering (3.13) (Table 3).

More number of primary branches produced may be due to the application of FYM which possesses optimum C:N ratio along with humic acid, which on decomposition readily releases nitrogen in the easily available form of nutrient ions such as ammonium and nitrate. The increase in the nitrogen levels of soil might have resulted in the production of more number of branches and leaves, since nitrogen is the chief constituent of amino acid and coenzyme of biological importance. This is in accordance with the findings of Maheswarappa *et al.* (2001) in galangal. This work was in line with the findings of Kazemi (2014), who reported increase in plant height and number of branches in tomato with the foliar application of humic acid.

Effect of foliar application of humic acid on yield parameters

The ultimate goal to be achieved in production of any crop is maximization of yield. The characters such as fruit length and fruit girth play a vital role in increasing the productivity.

Fruit length

The treatment T_{15} which received the application of FYM plus 100% RDF along with 0.2% HA recorded the maximum fruit length (14.49 cm) (Table 4). The fruit length was minimum (9.95 cm) in treatment T_0 (Absolute control).

Fruit girth

Fruit girth was found maximum in the treatment T_{16} (FYM plus 100% RDF along with 0.4% HA) with 5.99 cm (Table 4). The lowest fruit girth was recorded in the treatment T_0 (Absolute control) with 4.47 cm.

Effect of foliar application of Humic acid on Yield

The maximum yield was recorded in T_{15} which received the application of FYM plus 100% RDF along with 0.2% HA (218.53 g plant^{-1} and 16.19 t ha^{-1}). Yield was minimum in treatment T_0 (Absolute control) with 47.67 g plant^{-1} and 3.53 t ha^{-1}(Table 4).

The increase in yield might be attributed to the accumulation of more assimilates leading to increased fruit size and weight owing to proper and continuous supply of nutrients, which is associated with photosynthetic rate (Kloepper, 2003). Similar results have been reported by Kirn *et al.* (2010) application of lignite humic acid along with

Table 3. Effect of Humic Acid on growth parameters of okra

Treatments	Plant height (cm)		Number of branches	
	First flowering	Final harvest	First flowering	Final harvest
T_0	30.80	057.47	0.93	1.27
T_1	43.00	070.47	1.40	1.67
T_2	37.80	071.27	1.73	1.93
T_3	40.67	073.47	1.93	2.27
T_4	38.40	072.53	1.67	2.00
T_5	44.67	086.27	1.40	1.60
T_6	47.47	088.80	1.73	1.93
T_7	43.87	086.40	2.40	2.67
T_8	43.67	090.93	1.80	2.07
T_9	48.73	107.93	2.00	2.13
T_{10}	51.80	132.27	2.33	2.47
T_{11}	54.67	162.67	2.53	2.73
T_{12}	53.87	154.87	2.53	2.67
T_{13}	53.60	151.00	2.33	2.47
T_{14}	60.87	165.20	2.60	2.67
T_{15}	62.33	179.13	2.67	3.00
T_{16}	57.27	173.20	2.67	2.87
Mean	47.85	113.17	2.04	2.26
S.Ed.	03.12	004.29	0.21	0.17
C.D. (0.05)	06.35	008.74	0.43	0.36

Table 4. Effect of HumicAcid on yield parameters and yield of okra

Treatments	Fruit length (cm)	Fruit girth (cm)	Yield plant^{-1} (g)	Estimated yield (t ha^{-1})
T_0	09.95	4.47	047.67	03.53
T_1	10.21	4.85	074.67	05.53
T_2	11.07	4.85	085.73	06.35
T_3	10.71	4.99	091.27	06.76
T_4	13.00	5.30	091.67	06.79
T_5	13.13	4.97	094.07	06.97
T_6	12.43	5.05	117.60	08.71
T_7	10.68	5.15	119.80	08.87
T_8	12.89	5.36	132.93	09.85
T_9	11.94	5.41	136.47	10.11
T_{10}	12.44	5.11	156.00	11.56
T_{11}	13.90	5.45	215.07	15.93
T_{12}	13.74	5.64	163.47	12.11
T_{13}	12.77	5.60	159.60	11.82
T_{14}	13.67	5.51	171.80	12.73
T_{15}	14.49	5.94	218.53	16.19
T_{16}	14.01	5.99	191.33	14.17
Mean	12.41	5.27	133.39	09.88
S.Ed.	00.41	0.21	014.74	01.09
C.D. (0.05)	00.84	0.42	030.03	02.22

recommended dose of fertilizers increased the number of fruits plant^{-1}, highest flower to fruit conversion and green pod yield compared to control in okra. The yield was greatly influenced by the application of FYM plus HA at 0.2 per cent and along with 75% and 100% RDF. Higher yield might be due to improved aeration and water-holding capacity of FYM applied soil and the efficient utilization of nutrients in the FYM applied plants.

CONCLUSION

The investigation revealed that the HA has a pronounced influence on growth, yield and quality traits of okra. Among the different treatments imposed, Treatment T_{15} (FYM plus 100% RDF along with 0.2% HA) showed superiority in most of the parameters under study namely plant height at first flowering and final harvest, number of branches plant^{-1} at first flowering and final harvest, fruit length, fruit girth and yield plant^{-1}. It is apparent that the lower dose of HA is favorable in inducing the growth and development in okra. We conclude that the soil application of FYM and100% RDF along with foliar spray of 0.2% HA is ideal to increase yield.

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