RESEARCH ARTICLE

ECONOMICS OF VARIOUS TREATMENT OF BIO STIMULANT ON THE YIELD OF SWEET POTATO

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Abstract: Bio stimulants are important biological or microorganism origin substances which is intended to use for increase plant nutrient use efficiency and growth process. It is used as organic fertilizer and substitute for synthetic fertilizers. Therefore, to analyse the effect of different bio stimulants on yield and quality of sweet potato, an experiment entitled "Effect of biostimulants on growth, yield and quality of sweet potato (*Ipomoea batatas* L.) cv. CO-34" was conducted at the vegetable farm, Department of Vegetable Science, College of Horticulture and Forestry, Jhalawar during *rabi* season 2020-21. The experiment consisted of twelve treatment combinations having four levels each of humic acid (0, 10, 20 and 30 ml/l) and seaweed (0, 1 and 2 ml/l) in Factorial Randomized Block Designwith three replications. There was significant effect of biostimulants (humic acid and seaweed) on growth, yield and quality of sweet potato alone and combination over control. Significant increase in net return (Rs. 225039.30 / ha) and B:C (4.22) ratio was obtained with treatment T_{11} (Humic acid 30 ml/l and seaweed 2 ml/ l).

Keywords: Bio stimulants, Economics attributes, Humic acid, Sea weed, Sweet potato

INTRODUCTION

The Sweet potato (*Ipomoea batatas* L.) is a dicotyledonous plant that belongs to the family *Convolvulaceae*. It is grown as a starchy food crop throughout the tropical, sub-tropical and frost-free temperate climatic zones in the world. It is believed to have originated in Central America and the North Western part of South America. Sweet potato is an important root vegetable in developing countries. After its domestication in Neotropical America, human migration led to the distribution of the sweet potato plant throughout the world. Globally sweet potato is cultivated in 117 countries in an area of 8.62 million ha producing 105.19 million tons with a yield of 12.20 t ha-1 (FAO, 2016). Africa is the world largest sweet potato growing region and majority of the sweet potato production about 95 per cent comes from developing countries, of which China having the maximum share of 67.09 per cent (FAO, 2016). In India, sweet potato occupies an area over 118 thousand hectares with production of 1209 thousand tonnes (NHB, 2021). In India, it is cultivated in almost all the states but major contribution comes from four states namely Odisha, Kerala, West Bengal and Uttar Pradesh. Odisha is the largest producer of sweet potato in India. Sweet potato is a very nutritive vegetable, producing substantially high edible energy per day per hectare as compared to rice, wheat, maize and cassava. It contains starch (12.7g), sugar (4.2 g), vitamin A (709 µg) and protein (1.6 g) per 100 g of edible part (USDA 2009). Sweet potato is the main source of starch and alcohol and contains 10 per cent starch and 3-6 percent sugar. Tubers are good source of vitamin A, B, C and minerals like phosphorus, iron and calcium. The orange fleshed varieties are most common in the USA and Europe; the white fleshed are more popular in the Asian and Arabic kitchen. (Choudhary, 2014). It is widely used in India as a popular human food, however; green foliage and unmarketable roots are used as a raw material in many industries such as starch and alcohol extraction. Looking upon the utility and importance of sweet potato in India and Rajasthan, there is further need to increase the yield and productivity of the root as it very lows as compared to the world.

There are various ways to improve the yield and quality for food crops,but now a days as we are avoiding the synthetic hormones and other chemicals which not only deteriorates the quality of the produce but also soil sustainability is reduced. On account of this, the use of Humic acid and Seaweed extract is becoming popular as organic fertilizer and as substitute of synthetic fertilizers. The term biostimulants refers to substances of biological origin or microorganisms which, when applied to plants either via root drench, foliar spray, or a combination of both, is intended to stimulate natural processes in the plant that is responsible for efficient plant nutrient use efficiency and growth processes and/or an increase in the tolerance to abiotic and biotic stress, irrespective of the plant-beneficial nutrient content of the substances.

Humic acid (HA) is considered non-essential fertilizers but it is soil health enhancer and soil improver. It physically modifies the soil, biologically stimulates plant growth and chemically changes the fixation properties of soil. Humic acid is the final products of the decomposition of organic residuals and take part in important reactions that occur in soils, influencing fertility by improving physical and biological conditions and by producing

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physiologically active substances (Canellas *et al*., 2008).

Seaweeds are the macroscopic marine algae. They are used as food for human, fodder for cattle, as a substitute of chemical fertilizer and source of various fine chemicals. Besides this, it is used for obtaining many industrial products such as agar and alginate (Khan *etal*. 2009). In recent years, natural seaweeds are being used as substitute of synthetic fertilizers. Seaweed extracts are marketed as liquid fertilizers and bio-stimulants because they contain multiple growth regulators such as cytokinins (Durand *et al*. 2003), auxins (Sahoo, 2000), gibberellins (Strik and Staden, 1997) and various macro and micronutrients necessary for plant growth and development.

MATERIALS AND METHODS

The present investigation entitled "Effect of biostimulants on growth, yield and quality of sweet potato (*Ipomoea batatas* L.) Cv. Co-34" was conducted during the year 2020-2021. The details of the experiment in respect to materials used and techniques employed for studies have been described in this chapter.

Experiment was laid out in factorial randomized block design with three replications. The experiment consisted of 12 treatment combinations involving 2 biostimulants (Humic acid and seaweed) with four levels of Humic acid @ 0, 10, 20 and 30 ml/ soil drenched and three levels of Seaweed @ 0, 1, and 2ml/litter as foliar spray. The details of treatment combinations are given below:

S. No.	Treatment Notation	Treatments combination	Treatment Details
1.	T_0	$H_0 + S_0$	0 ml H + 0 ml S (Control)
2.	T_1	$H_0 + S_1$	0 ml H + 1 ml S
3.	T_2	$H_0 + S_2$	0 ml H + 2 ml S
4.	T_3	$H_1 + S_0$	10 ml H + 0 ml S
5.	T_4	$H_1 + S_1$	10 ml H + 1 ml S
6.	T_5	$H_1 + S_2$	10 ml H + 2 ml S
7.	T_6	$H_2 + S_0$	20 ml H + 0 ml S
8.	T_7	$H_2 + S_1$	20 ml H + 1 ml S
9.	T_8	$H_2 + S_2$	20 ml H + 2 ml S
10.	T_9	$H_3 + S_0$	30 ml H + 0 ml S
11.	T_{10}	$H_3 + S_1$	30 ml H + 1 ml S
12.	T_{11}	$H_3 + S_2$	30 ml H + 2 ml S

Nursery and transplanting

Sweet potato vine measuring 20-30 cm lengths were brought from primary nursery and then it was maintained in the secondary nursery for further growth. After 45 days of transplanting, they were transplanted in the main field. The cuttings measuring 20-30 cm in length were made and planted in the field with a spacing of 60 cm x 30 cm. Before planting of vine in the field they were treated with Blitox @ 2.5 g/kg of vine. The recommended dose of N, P_20_5 and K_2O were 50, 60 and 50 kg/ha. The whole quantity of organic manure (Vermicompost @ 10t/ha), K_2O, P_2O_5 and half quantity of nitrogen was incorporated in the soil at the last ploughing. Remaining quantity of nitrogen was top dressed in furrows about 15-20 cm away from vines at the time of earthing up. To observe the cost effect of humic acid and seaweed, various economics parameters were studied. The economic components viz., Total cost of cultivation, gross return, net return and B:C ratio was calculatedas per standard method (Saran et al., 2018).

RESULTS AND DISCUSSION

The result of present investigation showed that application of humic acid and seaweed when applied individually and combined they had significant effect on the total cost of cultivation, gross income, net profit and B:C ratio in sweet potato for different treatments. Highest total cost of cultivation, gross return, net profit and B:C ratio were found with treatment H_3 (humic acid 30 ml/l) i.e., 118875 ₹ ha^{-1}, 293840 ₹ ha^{-1}, 174944 ₹ ha^{-1} and 1.46 respectively, whereas minimum total cost of cultivation, gross return, net profit was found in treatment H_0 (control) and minimum B:C ratio was found in treatment H_2 (humic acid 20 ml/l).

Application of seaweed treatment S_2 (seaweed 2 ml/l) also increased total cost of cultivation (90014 ₹ ha^{-1}), gross return (217474₹ ha^{-1}), net profit (127453 ₹ ha^{-1}) and B:C ratio (1.39) over control.

Combined application of humic acid and seaweed also significantly increased the economics attributes in the arid region like Rajasthan. Treatment H_3S_2 (humic acid 30 ml and seaweed 2 ml/l) increased total cost cultivation 123334 (₹ ha^{-1}), gross return 322710 ₹ ha^{-1}, net profit (199359 ₹ ha^{-1}) and B:C

ratio was 1.61 compared to control. Important root crop like *Asparagus racemosus* also grown at farmers field in which farmers fetched Rs. 4.87 l ha/ year net returns and B:C ratio was 3.66 over net return from the sale of dry roots (Saran et al., 2020) which is suitable for gravelly soil and arid region. Other crops *viz.*, Aloe vera for its faster multiplication of Suckers (Saran et al., 2019), Papaya for its medicinal properties (Saran et al., 2015) and Vegetables like tomato (Damor *et al*., 2021) for its food nutrition values can be grown on suitable region.

Table 1. Effect of humic acid and seaweed on total cost of cultivation of treatments.

Seaweed / Humic acid	S_0	S_1	S_2	Mean
H_0	47,827.00	52,223.67	56,679.67	52,243.45
H_1	70,055.34	74,422.00	78,909.34	74,462.22
H_2	92,251.66	96,646.66	101,133.00	96,677.11
H_3	114,446.00	118,846.30	123,334.00	118,875.40
Mean	81,145.00	85,534.66	90,014.00	

	S.Em±	C.D. at 5%
H	6.62	19.55
S	5.76	16.93
H ×S	11.47	NS

Table 2. Effect of humic acid and seaweed on gross return of treatments.

Seaweed / Humic acid	S_0	S_1	S_2	Mean
H_0	112,331.00	125,870.00	138,392.30	125,531.10
H_1	150,992.30	163,105.00	178,276.70	164,124.70
H_2	190,340.00	201,360.00	230,520.00	207,406.70
H_3	265,080.00	293,730.00	322,710.00	293,840.00
Mean	179,685.80	196,016.30	217,474.80	

	S.Em±	C.D. at 5%
H	3.99	11.78
S	3.45	10.26
H ×S	6.91	20.41

Table 3. Effect of humic acid and seaweed on gross return of treatments.

Seaweed / Humic acid	S_0	S_1	S_2	Mean
H_0	64,546.00	73,683.00	81,737.00	73,322.00
H_1	80,939.66	88,643.00	99,353.66	89,645.45

H_2	98,077.66	104,751.70	129,365.70	110,731.70
H_3	150,631.70	174,841.70	199,359.00	174,944.10
Mean	98,548.75	110,479.80	127,453.80	

	S.Em±	**C.D. at 5%**
H	10.79	31.87
S	9.35	27.60
H ×S	18.70	55.20

Table 4. Effect of humic acid and seaweed on B:C ratio of treatments.

Seaweed / Humic acid	**S_0**	**S_1**	**S_2**	**Mean**
H_0	1.34	1.40	1.44	1.39
H_1	1.15	1.18	1.25	1.19
H_2	1.07	1.08	1.27	1.14
H_3	1.31	1.46	1.61	1.46
Mean	1.21	1.28	1.39	

	S.Em±	**C.D. at 5%**
H	0.003	0.010
S	0.003	0.009
H ×S	0.006	0.017

CONCLUSION

The combined application of humic acid and seaweed increased the gross return, net returns as well as B:C ration. Therefore, we can conclude that the cultivation of sweet potato with the replacement of use of synthetic fertilizer with bio stimulant *viz.*, Humic acid and Sea weed is beneficial for the improvement of yield and quality of crop as well as sustainable use and improvement in fertility of soil combined with higher economic return.

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