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International Journal of Current Research in Life Sciences
Vol. 07, No. 08, pp.2567-2569, August, 2018

ISSN: 2319-9490

RESEARCH ARTICLE

INFLUENCE OF BIO -FORTIFICATION TECHNIC WITH MICRONUTRIENTS ON TOMATO CROP (PKM-1) IN SALT AFFECTED SOIL

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Received 28th June, 2018; Accepted 20th July, 2018; Published 25th August, 2018

ABSTRACT

In India 11.7 million ha^{-1} is likely to be affected by salinity and alkalinity problem by 2025. 25 % of ground water used for irrigation is either saline or brackish. 10 million ha-^{1} of land are lost because of salinity caused by irrigation each year. Most salt-affected soils are deficient in N and Zn and are medium to high in K. In order to provide micronutrient to plant in a sustained manner, It is advocated to apply micronutrients in enriched form with organic manures .In this contest, a field experiment was conducted on salt affected soil (sandy loam) to evaluate study of biofortification technic with micronutrientson tomato crop in salt affected soil. The treatments consisted of application of organic manures enriched with micronutrients. The experiment was laid out in Randomized Block Design and replicated three times. The treatments were T_1- 20 kg of $ZnSO_4$ + 5.0 kg of borax as soil application. T_2-T_1+pressmud @ 12.5 t ha^{-1}. T_3- 10 kg of $ZnSO_4$+ 2.5 kg of borax as a soil application+ pressmud @ 12.5 t ha^{-1} + 0.50 % $ZnSO_4$ + 0.40% borax of F.S on 45 and 60 DAT. T_4- 10 kg of $ZnSO_4$ + 2.5 kg of borax as a soil application enriched with pressmud @ 12.5 t ha^{-1} + 0.50% $ZnSO_4$+0.40% borax as F.S on 45 and 60 DAT. T_5-T_1+vermicompost @ 4 t ha^{-1}. T_6 - 10 kg of $ZnSO_4$ + 2.5 kg of borax as a soil application + vermicompost @ 4 t ha^{-1} + 0.50 % $ZnSO_4$ + 0.40% borax as F.S on 45 and 60 DAT. T_7- 10 kg of $ZnSO_4$ + 2.5 kg of borax as a soil application enriched with vermicompost @ 4 t ha^{-1} + 0.50 % $ZnSO_4$ + 0.40% borax as F.S on 45 and 60 DAT. The results of the experiment clearly revealed that the application of 10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with vermicompost @ 4 tha^{-1} + 0.50% $ZnSO_4$+0.40% borax as F.S on 45and 60 DAT significantly influenced the growth, yield, quality and nutrient uptake. The treatment next in order were T_4 -10 kg of $ZnSO_4$ + 2.5 kg of borax as a soil application enriched with pressmud @ 12.5 t ha^{-1} + 0.50 % $ZnSO_4$ + 0.40% borax of F.S on 45 and60 DAT respectively.

Key words: Vermicompost, pressmud, Yield, Tomato, Salt affected soil.

Citation: Senthilkumar, 2018. "Influence of bio -for tification technic with micronutrients on tomato crop (PKM-1) in salt affected soil" *International Journal of Current Research in Life Sciences*, 7, (08), 2567-2569.

INTRODUCTION

Tomato (*Lycopersicom esculentum* L.) is one of the important crop in the world. It occupies an important place in view of its nutritive value, multivarious use and tops the list of processed vegetables. Tomato is an important mineral, protein and vitamin rich vegetable crop which plays a vital role in Indian economy by virtue of its various modes of consumption in human diet. India is the world second largest producer of vegetables next to china. The present production of vegetable has to be raised to 250 million tonnes by 2025. Although production is almost doubled during the last three decades, the technology used and practices adopted are predominantly traditional. This results in low productivity and poor quality of vegetables are considered as productive supplementary of food as they contain large quantities of minerals, vitamins and essential amino acids, which are required for normal functioning of the human metabolic process. Though we have attained food security through enhancement of cereal production the much needed nutrition security can be achieved only through fruits and vegetables and hence, there is an imperative need to double the production from its present levels so as to meet the per capita supply of 210 g per day. In India, it is grown in an area of 6.1 lakh hectares with an annual production of about 8.0 million tonnes (FAO, 2013) and in Tamilnadu, it is grown in an area of 0.46 lakh hectare with an annual production of 0.36 million tonnes (Namasivayam, 2014). The average productivity of tomato in India is only 17.5 t ha^{-1} which is very low as compared to the world average production of tomato (25 t ha^{-1}). For increasing the high quality and quantity it needs to apply high amount of fertilizers, it leads to affect the soil parameters and affect the soil health. In recent years, adoption of high yielding varieties and use of high analysis NPK fertilizers led to decline in the micronutrient status in soil to below normal at which productivity of crops cannot be sustained (Kumar and Babel, 2011). Velu *et al*.

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(2008) reported that 67 per cent of the soils of Cuddalore district were deficient in available Zinc (Zn) which needed attention towards Zn management in crops. Copper (Cu) and Iron (Fe) were deficient to the extent of 4 and 26 per cent respectively. Hence, it is an imperative need to develop a technology which improves the yield of crop without affecting the quality of produces as well as soil health. In Tamil Nadu about 57 and 44 per cent of total area is deficient in Zn and B respectively. Growing of tomato in such nutrient deficient soil is also one of the reasons for low productivity. Micronutrient management especially the Zn and B assumes greater significance for tomato production by their specific role in growth and metabolic activities. In India Salt affected soils are found in 2.95 million hectare. In Tamil Nadu it is 13,231 ha. Saline soil defined as soil having a conductivity of the saturation extract greater than 4 dS m^{-1} and exchangeable sodium percentage less than 15. pH is usually less than 8.5, Formerly these soils were called white alkali soil because of surface crust of white salts. Osmotic pressure is high enough to prevent absorption of moisture and plant nutrients from such soils. (Mioli Mandal *et al.,* 2009). The results are quite encouraging, present investigation was carried out to achieve the yield and quality of tomato in saline soil.

MATERIALS AND METHODS

A field experiment was conducted during 2014 at Theerthampalayam village, Cuddalore District, Tamil Nadu with tomato cv., PKM-1. The experimental soil was sandy loam with a pH of 8.41, EC of 4.02 dS m^{-1} and CEC of 15.20 cmol (p^{+}) kg^{-1}. The available nitrogen, phosphorus and potassium content were 216, 9 and 150.7 kg ha^{-1} respectively. The available zinc and boron contents were 0.67 and 0.29 mg kg^{-1}. The exchangeable calcium, magnesium, potassium and sodium contents were 5.3, 2.9, 3.2 and 3.8 cmol (p^{+}) kg^{-1} respectively. The treatments consisted of application of bio fortification technic with micronutrients. The treatments were T_1- 20 kg of $ZnSO_4$ + 5.0 kg of borax as soil application. T_2- T_1+pressmud @ 12.5 t ha^{-1}. T_3- 10 kg of $ZnSO_4$+ 2.5 kg of borax as soil application+ pressmud @ 12.5 t ha^{-1} + 0.50 % $ZnSO_4$ + 0.40% borax of F.S on 45 and 60 DAT. T_4- 10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with pressmud @ 12.5 t ha^{-1} + 0.50% $ZnSO_4$+0.40% borax as F.S on 45 and 60 DAT. T_5-T_1+vermicompost @ 4 t ha^{-1}. T_6 - 10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application + vermicompost @ 4 t ha^{-1} + 0.50 % $ZnSO_4$ + 0.40% borax as F.S on 45 and 60 DAT. T_7- 10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with vermicompost @ 4 t ha^{-1} + 0.50 % $ZnSO_4$ + 0.40% borax as F.S on 45 and 60 DAT. The experiment was laid out in Randomized Block Design (RBD) and replicated three times. The recommended dose of fertilizers *viz.,* 150:100:50 kg N: P_2O_5: K_2O ha^{-1} wasapplied uniformly to all plots.The growth attributes *viz.,* plant height was recorded on 25, 50 and 75 days after transplanting. The number of branches was recorded 40 days after transplanting, number of flowers was recorded 60 days after transplanting and number of fruits was recorded 80 days after transplanting. The stover and fruit yield were recorded at harvest. The titrable acidity, ascorbic acid and total soluble solid content were also estimated in the fruits at harvest stage. The nutrient uptake *viz.,* N, P, K, Ca, Mg, S, Zn and B by plant, stover and fruit at harvest were computed from the dry matter production recorded and the stover and fruit yield and their nutrient contents (N, P, K, Ca, Mg, Zn and B). The available nutrient status of the post harvest soil was also analyzed. The above soil and plant sample was collected periodically and analysis for standard procedures and experimental data were processed statistical analysis followed.

RESULTS AND DISCUSSION

The present investigation was undertaken to find out the effect of micronutrients and organic manures (pressmud and vermicompost) on growth components, nutrient content and uptake, yield attributes and yield by tomato PKM-1 in a saline soil (Table-2).

Physico – chemical properties of initial soil: The initial soil collected from the exprerimental field was analysedfor the physico – chemical properties and the results are furnished in Table 1. The soil of Theerthampalayam Village was found to contain 48.9, 22.4 and 27.9 per cent sand, silt and clay respectively and come under the textural class sandy loam. The bulk density, Particle density, pore space, pH, electrical conductivity and contain exchange capacity of the soil were 1.20, 2.03 Mg m^{-3}, 45.0 per cent and 8.41, 4.02 dS m^{-1} and 15.20 cmol (p^{+}) kg^{-1} respectively. The organic carbon content of soil was 6.8 g kg^{-1}. The available N, P and K content of soil was 216.0, 9.0 and 150.7 kg ha^{-1} respectively. The available sulphur content was 12.5 mg kg^{-1}. The exchangeable Calcium, Magnesium, Potassium and Sodium content were 5.3, 2.9, 3.2 and 3.8 cmol (p^{+}) kg^{-1} respectively. The available Micronutrients Zn, Fe, Mn, Cu and B content of Soil was 0.67, 1.45, 1.67, 0.24 and 0.29 mg kg^{-1} respectively.

Growth Characters: Among the different treatments tried, application of 10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with vermicompost @ 4 t ha^{-1} + 0.50% $ZnSO_4$ + 0.40% borax as F.S on 45 and 60 DAT (T_7) significantly increased the growth components *viz.*, Plant height (25, 50 and 75 DAT), number of branches (40 DAT) and number of flowers $plant^{-1}$ (60 DAT) respectively.

Table 1. Physico – Chemical Properties of initial soil

I	Physical Properties	Contents
	Mechanical analysis	
a)	Sand (%)	48.90
	Silt (%)	22.40
	Clay (%)	27.90
	Textural Class	Sandy Loam
	Bulk density(Mg m^{-3})	1.20
	Particle density(Mg m^{-3})	2.03
	Pore Space (%)	45.0
II	Physico-Chemical properties	
1)	pH	8.41
2)	EC (dS m^{-1})	4.02
3)	Organic Carbon(g kg^{-1})	6.80
4)	CEC cmol (p^{+}) kg^{-1}	15.20
5)	Available Macronutrients	
I	Alkaline $KMnO_4$ (kg ha^{-1})	216.0
Ii	Olsen's-p (kg ha^{-1})	9.00
Iii	NH_40AC- K (kg ha^{-1})	150.70
Iv	Available Sulphur (mg kg^{-1})	12.50
6)	Available micro nutrients	
A	DTPA – Zn (mg kg^{-1})	0.67
B	DTPA – Fe (mg kg^{-1})	1.45
C	DTPA – Mn (mg kg^{-1})	1.67
D	DTPA – Cu (mg kg^{-1})	0.24
E	Hot Water – B (mg kg^{-1})	0.29
7)	Exchangeable Cations	
A	Cacmol (p^{+}) kg^{-1}	5.30
B	Mg cmol (p^{+}) kg^{-1}	2.90
C	Na cmol (p^{+}) kg^{-1}	3.80
D	K cmol (p^{+}) kg^{-1}	3.20

Table 2. Effect of micronutrients and organic manures (pressmud and vermicompost) on growth and yield in tomato

Treatment details	Plant Height(cm)			Number of branches plant $^{-1}$	Number of flowers plant^{-1}	Number of fruit plant $^{-1}$	Single fruit weight (gm)	Stover yield (kg ha^{-1})	Fruit yield (q ha^{-1})
	25 DAT	50 DAT	75 DAT						
T_1 –	14.16	29.10	34.4	6.99	23.00	15.00	70.94	1241.33	295.73
T_2 –	20.56	37.50	42.10	10.62	27.33	18.27	78.00	1548.33	395.06
T_3 –	27.40	47.90	52.80	13.78	31.22	19.48	85.54	1969.66	461.65
T_4 –	34.10	54.20	63.13	16.3	36.00	20.19	92.84	2453.33	520.23
T_5 –	27.96	48.0	52.86	13.63	30.33	19.70	84.95	1996.33	463.4
T_6 –	40.46	60.16	72.86	18.09	39.00	22.34	94.52	2733.66	585.81
T_7 –	47.38	65.00	82.20	22.53	46.50	25.22	98.00	3142.33	684.25
S.Ed.	1.79	3.40	4.80	1.13	1.77	0.82	6.50	119.50	24.04
CD (p = 0.05)	3.91	5.06	8.11	1.99	3.05	2.51	7.09	260.38	52.39

Regarding the growth attributes, the best treatment was T_7 (10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with vermicompost @ 4 t ha^{-1} + 0.50% of $ZnSO_4$ + 0.40% of borax as F.S on 45 and 60 DAT). The highest plant height 47.38, 65.0 and 82.20 cm on 25, 50 and 75 DAT, Number of branches plant^{-1} of 22.53 was recorded at 40 DAT and number of flowers plant^{-1} of 46.50 was recorded at 60 DAT respectively in the same treatment.

Yield Attributes and Yield: Among the different treatments tried, application of 10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with vermicompost @ 4 t ha^{-1} + 0.50% of $ZnSO_4$ + 0.40% of borax as F.S on 45 and 60 DAT significantly increased the yield attributes *viz*., number of fruits plant^{-1}, single fruit weight, fruit volume, fruit density, fruit yield and Stover yield. Application of (10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with vermicompost @ 4 t ha^{-1} + 0.50% of $ZnSO_4$ + 0.40% of borax as F.S on 45 and 60 DAT) T_7 registered maximum number of fruits plant^{-1} 25.22, single fruit weight of 98.0 gm on 80 DAT, fruit volume 62.27 (cc) and fruit density 1.57 (g cc^{-1}) respectively.The maximum fruit yield of 684.25 q ha^{-1} and Stover yield of 3142.33 kg ha^{-1} was recorded in the treatment T_7 (10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with vermicompost @ 4 t ha^{-1} + 0.50% of $ZnSO_4$ + 0.40% of borax as F.S on 45 and 60 DAT). This was followed by T_6 (10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application + vermicompost @ 4 t ha^{-1} + 0.50% of $ZnSO_4$ + 0.40% of borax as F.S on 45 and 60 DAT). The yield of tomato significantly increased besides, reducing the fruit cracking. The improvement in plant growth might be due to enhancement in photosynthetic and other metabolic activities, which lead to an increase in plant metabolism. It was observed that soil application of boron enhanced the number of fruits plant^{-1} and single fruit weight Sathya *et al*. (2010). The increased fruit yield due to organic manures might be attributed to supply of micronutrients, N, P, K are slow release nutrients all over the growth season, moreover, organic manure is rich in its nitrogen. These favourable conditions create better nutrients absorption. Consequently higher total yield would be obtained by enriched organic manures Glala *et al*. (2013). The highest fruit and stover yield might be due to optimum Boron application, boron plays important role in maintaining cell integrity, improving respiration, enhancing metabolic activities and uptake of nutrients Raja Mohib Mazzam Naz *et al*. (2012).Tomato fruit yield was affected significantly by applying of enriched organic manures with micronutrients leading to increase fruit and stover yield. The highest fruit and stover yield was recorded by the application of enriched organic manures Prativa and Bhattari (2011).

Conclusion

It is clear from the present investigation for the saline soil, the best combination is 10 kg of $ZnSO_4$ + 2.5 kg of borax as soil application enriched with vermicompost @ 4 t ha^{-1} + 0.50% of $ZnSO_4$ + 0.40% of borax as F.S on 45 and 60 DAT (T_7). Therefore for successful and profitable crop production there would be needed to supply Zn and B from fertilizers, especially for the saline soil in tomato crop. As organic manures (vermicompost) is quite important for supply of micronutrients, farmers of the district should be encouraged to apply bio fortification with micronutrients along with balanced use of fertilizers boosting the production of fruit yield and quality of tomato crop in saline soils.

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