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REGULAR ARTICLE

EFFECT OF MICRONUTRIENTS AND ORGANIC MANURES ON SESAME

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ABSTRACT

A field experiment was carried out in a coastal farmer's field, to study the effect of NPK level, micronutrients and organics on the soil nutrient availability, microbial population, enzyme activity and yield of sesame. The various treatments included were, T_1-100% NPK (Farmer's Practice), T_2-125% NPK, T_3-150% NPK, T_4-125% NPK+CCP @ 12.5 t ha^{-1}, T_5-125% NPK+FYM @ 12.5 t ha^{-1}, T_6-150% NPK+CCP @ 12.5 t ha^{-1}, T_7-150% NPK+FYM @ 12.5 t ha^{-1}, T_8-125% NPK+CCP @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}, T_9-125% NPK+FYM @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}, T_{10}-150% NPK+CCP @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}, T_{11}-150% NPK+FYM@ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}. The results of the study clearly showed that the yield benefit of the treatment T_8, the application of 125% NPK along with composted coirpith @12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg $ha^{-1}$and $MnSO_4$ @ 5 kg ha^{-1}superior in increasing the soil nutrient availability and yield of sesame.

Keywords: Coastal saline soil, NPK level, Organics, Zinc, Manganese, Soil nutrient availability, Microbial population, Enzyme activity, Sesame, Yield

INTRODUCTION

The coastal saline soils have specific soil constraints *viz.,* light texture, poor exchange property, nutrient and water retention capacity, low status of organic carbon and deficiency of nutrients etc [1]. These problems severely affect the productivity of crops in this region. Even the applied nutrients, due to poor physical and exchange characteristics are leached. This necessitates the increased rate of nutrients application especially NPK in such soil [2].

Coarse textured soils have several soil problems *viz.,* light texture, poor exchange property, nutrient and water retention capacity, low status of soil organic carbon and deficiency of both macro and micronutrients [3]. These problems severely affect the productivity of sesame in this region. Even the applied nutrients are leached to the sub surface soil. Coastal salt affected soils are most commonly suffered due to zinc deficiency. Boron, iron, manganese and copper are also deficient in some locations. Zinc and manganese plays an important role in various enzymatic activities in the growth and development of sesame production [4]. It is now established that micronutrient deficiency is the prime factor responsible for that low productivity of crops in coastal areas [5]. Hence, inclusion of increasing dose of NPK, organic manure along with micronutrient fertilizer in the fertilization programme becomes an imperative need to improve the yield of sesame. It is more vivid that application of organic manure along with micronutrients fertilization sustain soil health and crop productivity in coastal saline soil. Therefore, the present investigation was carried out to study the effect of micronutrients and organics on the soil nutrient availability, microbial population, enzyme activity and yield of sesame in coastal saline soil.

MATERIALS AND METHODS

A field experiment was conducted in a farmer's field at Ponnanthittu coastal village, near Chidambaram in Cuddalore district, Tamilnadu during January–April, 2014, to find out the influence of NPK level, micronutrients and organics on the soil nutrient availability, microbial population, enzyme activity and yield of sesame in coastal saline soil. The treatments consisted of T1-100% NPK (Farmer's Practice), T2-125% NPK, T3-150% NPK, T4-125% NPK+CCP @ 12.5 t ha-1, T5-125% NPK+FYM @ 12.5 t ha-1, T6-150% NPK+CCP @ 12.5 t ha-1, T7-150% NPK+FYM @ 12.5 t ha-1, T8-125% NPK+CCP @ 12.5 t ha-1+ZnSO4 @ 25 kg ha-1+MnSO4 @ 5 kg ha-1, T9-125% NPK+FYM @ 12.5 t ha-1+ZnSO4 @ 25 kg ha-1+MnSO4 @ 5 kg ha-1, T10-150% NPK+CCP @ 12.5 t ha-1+ZnSO4 @ 25 kg ha-1+MnSO4 @ 5 kg ha-1, T11-150% NPK+FYM @ 12.5 t ha-1+ZnSO4 @ 25 kg ha-1+MnSO4 @ 5 kg ha-1. The experiment was studied in a Randomized Block Design (RBD), with three replications, using sesame variety TMV 7 as test crop. The initial experimental soil was sandy texture with pH 8.41; EC 1.65 d Sm-1; organic carbon-2.30 g kg-1; zinc 0.71 mg kg-1and manganese status of 0.96 mg kg-1. The alkaline KMnO4–N; Olsen-P and NH4OAc-K, were low, low and medium status, respectively. A fertilizer dose of 35:23:23 kg N: P2O5: K2O ha-1 was followed and applied through urea, super

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phosphate and muriate of potash, respectively as per the treatment. Required quantities of zinc sulphate and manganese sulphate as per the treatment schedule were incorporated just before sowing. The soil samples were collected at different critical stages of sesame *viz.,* flowering, capsule formation and at harvest stage and analyzed for available N, P, K, Zn and Mn and microbial population (bacteria, fungi and actinomycetes) enzyme activities (urease, phosphatase and dehydrogenase) using standard procedure of Jackson [14]. At harvest seed and stalk yield were recorded.

RESULTS AND DISCUSSION

Major nutrients availability

The available NPK status increased with addition of organics along with micronutrients. The application of 150 per cent NPK+CCP @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1} (T_{10}) registered the highest alkaline $KMnO_4$, Olsen-P and NH_4OAc-K content of 156.36, 12.56 and 162.96 kg ha^{-1} at the harvest stages, respectively. However, it was found to be on par with the treatment T_8, the application of 125 per cent NPK+CCP @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}. This treatment was followed by T_{11}, application of 150 per cent NPK+FYM @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1} recorded the significant amount of NH_4OAc-K content at all the stages of sesame growth. This was found to be comparable with the treatment T_9, the application of 125 per cent NPK+FYM @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}. These two treatments registered a comparable NPK availability of soil. A similar trend was also observed with the treatments T_6 (150% NPK+CCP @ 12.5 t ha^{-1}) and T_4 (125 % NPK+CCP @ 12.5 t ha^{-1}). This was followed by the treatments T_7 (150 % NPK+FYM @ 12.5 t ha^{-1}) and T_5 (125 % NPK+FYM @ 12.5 t ha^{-1}) which recorded a comparable NPK availability of soilat all stages, respectively. The control treatment (100% NPK) recorded the lowest soil NPK availability at all the critical stages of sesame.

Table 1: Effect of organics and micronutrients on the major and micronutrients availability (kg ha^{-1}) in soil

Treatments	Alkaline $KMnO_4$-N			Olsen-P			NH_4OAc-K			DTPA-Zn (mg kg^{-1})			DTPA-Mn (mg kg^{-1})		
	FS	CFS	HS	FS	CFS	HS	FS	CFS	HS	FS	CFS	HS	FS	CFS	HS
T_1	132.42	125.29	112.98	11.20	9.41	7.25	137.61	122.77	113.13	1.72	1.36	0.66	1.86	1.52	0.86
T_2	141.33	134.57	120.78	12.46	10.42	8.28	146.8	132.24	122.78	1.72	1.36	0.65	1.86	1.53	0.87
T_3	153.28	136.52	122.99	12.68	10.72	8.48	148.72	134.35	124.03	1.73	1.37	0.66	1.85	1.54	0.87
T_4	159.73	153.50	138.76	14.78	12.87	10.50	167.59	152.9	141.78	1.99	1.60	0.86	2.14	1.85	1.14
T_5	150.80	144.31	132.07	13.52	11.64	9.46	157.17	142.67	131.94	1.87	1.45	0.76	2.01	1.72	1.02
T_6	161.62	155.51	140.5	14.99	13.18	10.67	169.73	155.26	144.09	2.04	1.63	0.87	2.17	1.88	1.17
T_7	152.95	146.62	133.21	13.77	11.86	9.69	159.53	144.75	133.98	1.90	1.49	0.78	2.03	1.74	1.04
T_8	177.33	170.10	153.40	16.93	15.35	12.42	188.8	172.75	160.86	2.27	1.86	1.05	2.45	2.11	1.40
T_9	168.63	161.95	146.51	15.90	14.14	11.49	178.51	163.14	151.59	2.14	1.72	0.94	2.31	1.98	1.29
T_{10}	179.45	172.94	156.36	17.15	15.53	12.56	191.13	174.71	162.96	2.33	1.89	1.07	2.47	2.14	1.43
T_{11}	170.47	163.58	148.54	16.05	14.43	11.67	180.57	165.22	153.54	2.18	1.77	0.97	2.35	2.02	1.31
SE_D	3.52	3.37	3.06	0.37	0.36	0.29	3.78	3.53	3.33	0.034	0.031	0.024	0.039	0.036	0.034
CD (p=0.05)	7.34	7.01	6.37	0.78	0.75	0.61	7.88	7.36	6.94	0.071	0.065	0.051	0.082	0.075	0.071

Table 2: Effect of organics and micronutrients on the enzymatic activity of soil

Treatments	Urease (µg NH_4-N/g soil/24 h)			Phosphatase (µg *p*-nitrophenol/g soil/h)			Dehydrogenase (µg TTF/g soil/24 h)			Bacteria (×10^6/g soil)			Fungi (× 10^5/g soil)			Actinomycetes (×10^4/g soil)		
	FS	CFS	HS	FS	CFS	HS	FS	CFS	HS	FS	CFS	HS	FS	CFS	HS	FS	CFS	HS
T_1	10.14	23.14	16.94	7.79	10.01	8.04	51.31	67.62	60.25	12.84	16.82	15.10	6.19	11.22	9.34	3.77	6.09	4.33
T_2	12.10	25.82	18.56	8.37	11.25	9.51	54.20	70.65	63.30	12.60	16.03	15.05	6.21	11.40	9.41	3.86	6.10	4.45
T_3	12.32	26.13	19.05	8.51	11.43	9.62	54.27	71.28	63.93	13.49	16.87	15.12	6.39	11.51	9.40	3.85	6.07	4.43
T_4	15.34	30.13	23.10	9.91	13.69	11.59	60.43	77.34	69.60	18.38	19.87	19.18	10.50	14.67	12.67	6.66	9.37	7.36
T_5	13.73	28.01	20.81	9.06	12.33	10.43	56.98	74.04	66.38	15.46	18.02	17.26	8.95	13.15	11.31	5.97	8.04	6.07
T_6	15.67	30.57	23.52	10.02	13.94	11.82	61.63	78.17	70.52	19.30	20.61	19.44	10.79	14.97	12.88	6.71	9.55	7.54
T_7	13.97	28.62	21.58	9.20	12.59	10.58	57.87	74.59	66.74	16.33	18.58	17.61	9.09	13.30	11.36	6.03	8.32	6.10
T_8	20.54	34.54	28.08	11.46	16.07	13.82	68.42	85.00	75.91	22.47	24.22	22.95	13.52	17.83	15.43	7.81	11.27	9.63
T_9	16.95	32.25	25.48	10.63	14.99	12.66	64.49	81.09	73.00	21.27	21.46	21.28	12.41	16.16	14.20	7.32	10.41	8.60
T_{10}	21.46	35.31	28.57	11.58	16.28	14.02	69.31	85.74	76.20	22.54	25.17	23.40	13.63	18.05	15.74	7.89	11.37	9.70
T_{11}	17.69	32.98	26.39	10.78	15.14	12.84	65.51	82.12	73.56	21.32	22.25	21.43	12.63	16.35	14.38	7.36	10.56	8.75
SE_D	0.50	0.57	0.63	0.21	0.34	0.30	1.13	1.15	1.00	0.49	0.51	0.50	0.29	0.40	0.33	0.10	0.19	0.11
CD (p=0.05)	1.05	1.20	1.32	0.45	0.71	0.63	2.37	2.41	2.08	1.03	1.07	1.04	0.61	0.85	0.70	0.21	0.40	0.24

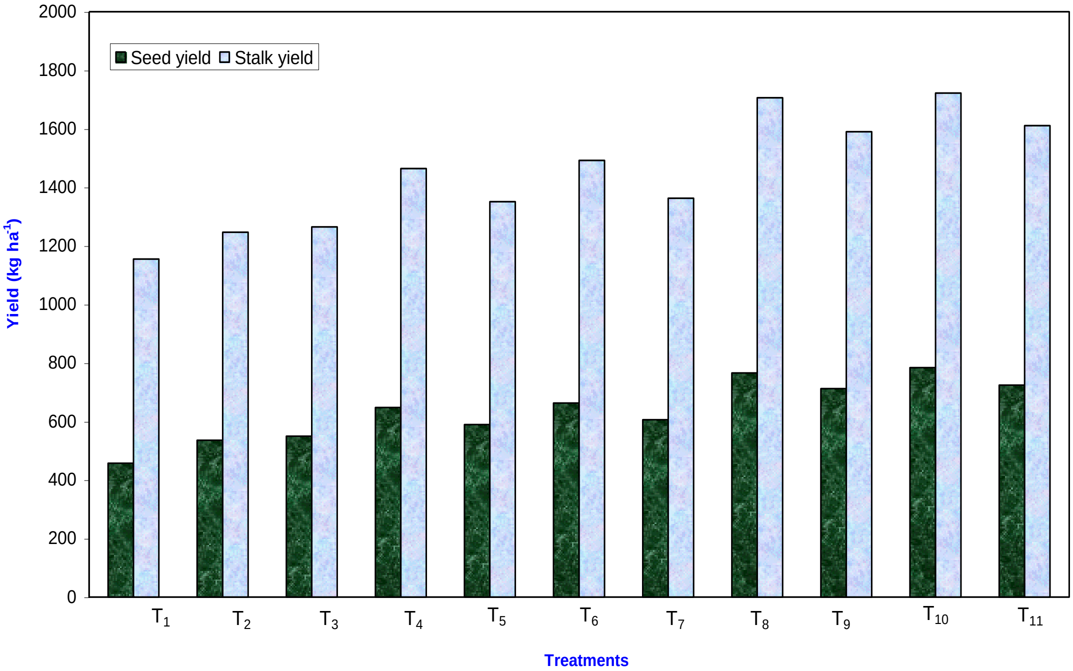

Fig. 1: Effect of organics and micronutrients on the yield of sesame

The availability of NPK increased in the soil due to the application of NPK, zinc, manganese along with organic manures. This may be attributed to the addition of nutrients from both organics and inorganics sources. Inorganic sources sustain the crop demand in initial stage while organic source owing to their slow release contribute at the later stage. Similar results were reported earlier [6]. Further the improved soil physico-chemical properties and microbial activity might have resulted in higher mineralization releasing more available NPK in soil. This corroborates the earlier report [7].

Micronutrients availability

DTPA-zinc

The highest available zinc status at flowering (2.34 mg kg^{-1}), capsule formation (1.89 mg kg^{-1}) and at harvest stage (1.07 mg kg^{-1}) was recorded with the combined application of 125% recommended dose of NPK+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}(SA) through soil and foliar ($ZnSO_4$ and $MnSO_4$ @ 0.5 per cent at twice) spray along with CCP @ 5 t ha^{-1} (T_{11}). However, this was found to be on par with treatment (T_3) which received 125% recommended NPK+CCP along with $ZnSO_4$ @ 25 kg ha^{-1} through soil and recorded a comparable available DTPA-Zinc content of 1.01 and 0.99 mg kg^{-1}at harvest stage, respectively. This was followed by the treatment T_{10}, application of 125% NPK+CCP @ 12.5 t ha^{-1}along with $MnSO_4$ @ 5 kg ha^{-1} through soil as well as foliar application of $MnSO_4$ @ 0.5% and it recorded 0.92 mg kg^{-1}of available DTPA-Zinc content of soil at harvest stage and, this could be comparable with treatment T_4 (the application of 125% NPK+$MnSO_4$ @ 5 kg ha^{-1} (SA) through soil along with composted coirpith application) which recorded 0.89 mg kg^{-1}of available DTPA-Zinc content of soil at harvest stage.

DTPA-manganese

The highest DTPA-Mn was registered with 125% recommended dose of fertilizer (RDF)+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1} SA+$ZnSO_4$ and $MnSO_4$ (FA) @ 0.5% foliar spray along with CCP @ 12.5 t ha^{-1} (T_{11}) which recorded a Mn content of 2.39, 2.05 and 1.24 mg kg^{-1} at FS, CFS and at the harvest stages, respectively. However, it was found to be equally efficacious with the treatment T_5 (125% RDF+CCP @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1} through soil alone). The treatment T_5, registered a DTPA-Mn content of 2.35, 2.03 and 1.22 mg kg^{-1}, respectively at the above said three critical stages of sesame. This was followed by the treatments T_{10}, application of NPK+CCP @ 12.5 t ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}+$MnSO_4$ @ 0.5 per cent through soil as well as foliar spray and T_4, application of 125% recommended dose of NPK+$MnSO_4$ @ 5 kg ha^{-1} through soil along with composted coirpith @ 12.5 t ha^{-1} which recorded a comparable DTPA-Mn content of 1.13 and 1.10 mg kg^{-1} at harvest stage, respectively. This was followed by the treatment T_9, (125% NPK+CCP+$ZnSO_4$ @ 25 kg ha^{-1} through soil and foliar). This was closely onpar with treatment T_3, (125% NPK+CCP+$ZnSO_4$ @ 25 kg ha^{-1} through soil alone). This was followed by the treatments arranged in the descending order as T_2>T_8>T_7 and T_6. Our results match with earlier reports of Javia *et al.* [8].

Microbial population of soil

Combined application of $ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1} through soil application+foliar spray of $ZnSO_4$+$MnSO_4$ @ 0.5% along with 125% recommended dose of NPK and composted coirpith @ 12.5 t ha^{-1} (T_{11}) recorded the highest population of bacteria (25.17 × 10^6), fungi (18.09 × 10^5) and actinomycetes (11.37 × 10^4) at capsule formation stage. However, it was found to be comparable with the treatment T_5 (the application of RDF (125% NPK)+CCP @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1} through soil application) which registered a comparable population of bacteria (24.46 × 10^6), fungi (17.68× 10^5) and actinomycetes (11.23 × 10^4) at capsule formation stage, respectively. This was followed by the treatment T_{10} (125% NPK+CCP+$MnSO_4$ @ 5 kg ha^{-1}+$MnSO_4$ @ 0.5% through soil and foliar application). This was followed by the treatment T_2 which received 125% recommended dose of NPK along with composted coirpith (without micronutrients). Regarding organics along with micronutrients through foliar applied (without soil application of micronutrients) treatments *viz*., T_8, (125% NPK+CCP+$ZnSO_4$+$MnSO_4$ @ 0.5 % FA), T_7 (125% NPK+CCP+$MnSO_4$ @ 0.5 % FA) and T_6 (125% NPK+CCP+$ZnSO_4$ @ 0.5 % FA) through foliar application alone recorded the lowest microbial population count noticed as compared to soil applied treatments. The control treatment T_1, application of recommended dose of fertilizer alone (100% NPK alone) recorded a comparatively lowest microbial population counts. Higher microbial counts in soil microorganisms with application of organics along with micronutrients may be due to better soil biological environment of coastal saline soil [9]. These results are in parity with the results reported by Abdullahi *et al.* [10].

Enzymatic activity

The application of NPK, micronutrients along with incorporation of organic sources had profound influence on the urease, phosphatase and dehydrogenase activity of soil. The maximum enzyme activity was observed at capsule formation stage). The application of 150 per cent NPK+CCP @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1} (T_{10}) registered the highest urease (35.31 □g NH_4-N/g soil/24 hr), phosphatase (□g*p*-nitrophenol/g soil/hr) and dehydrogenase (□g TTF/g soil/24 hr) activity of the soil at CFS, respectively and this was compared with the treatment T_8. This treatment was followed by T_{11}, application of 150 per cent NPK+FYM @ 12.5 t ha^{-1}+$ZnSO_4$ @ 25 kg ha^{-1}+$ZnSO_4$ @ 5 kg ha^{-1} recorded the significant amount of urease, phosphatase and dehydrogenase activity content at all the stages of sesame growth. This was found to be comparable with the treatment T_9, These two treatments registered a comparable enzyme activity of soil at above said critical stages of sesame. A similar trend was also observed with the treatments T_6 (150 % NPK+CCP @ 12.5 t ha^{-1}) and T_4 (125 % NPK+CCP @12.5 t ha^{-1}). This was followed by the treatments T_7 and T_5 which recorded a comparable enzyme activity of soil. The treatments, application of 150 per cent NPK (T_3) and 125 per cent NPK (T_2) alone without organics and micronutrients recorded equally efficacious enzyme activity of soil. The control treatment (100% NPK) recorded the lowest urease activity of the soil at all the three critical stages of sesame.

The increased rate of nitrogen application and various biomaterials added to the soil as well as the root exudates promoted the nitrogenase substances which have induced the urease activity. The results of the present findings are agreeable with the results obtained earlier [11]. The increase in the soil phosphatase activity with the addition of organics may be due to action of fertilizers. The phosphates added through organics and fertilizer improved the phosphatase activity, and may be due to the stabilized extra cellular fraction of enzyme [12]. The increased dehydrogenase activity might be due to the incorporation of organics, owing to increase in microbial activity of the soil. This in accordance with previous report [13].

Yield

The treatments influenced the yield of sesame (fig. 1). Among the various treatments, the highest seed yield (784 kg ha^{-1}) and stalk yield (1722 kg ha^{-1}) was recorded with combined application This was followed by the treatment, 150 per cent NPK+$ZnSO_4$ @ 25 kg ha^{-1}+$MnSO_4$ @ 5 kg ha^{-1}+FYM @ 12.5 t ha^{-1} (T_{11}) it was found to be on par with 125 per cent NPK+$ZnSO_4$+$MnSO_4$ along with FYM (T_9). The treatment (T_6), application of 150% NPK along with CCP alone without micronutrients significantly increased the seed and stalk yield to 663 and 1492 kg ha^{-1} respectively and application of 125% NPK along with CCP (T_4) registered a comparable seed and stalk yield to the tune of 648 and 1464 kg ha^{-1} respectively as compared to NPK applied treatments (T_3 and T_2). These results are in agreement with previous findings [4, 7].

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