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Effect of Secondary and Micronutrient Fertilization with Compsted Coirpith on The Yield And Nutrients Uptake By Sunflower in Coastal Saline Soil

D.Elayaraja, P. Kamalakannan and S. Sathiyamurthi
Department of Soil Science and Agricultural Chemistry, Faculty of Agriculture,
Annamalai University, Annamalai Nagar- 608 002.
E.mail: md.elayaraja@yahoo.in

ABSTRACT

A field experiment was conducted in a farmer's field at Mandabam coastal village, near Chidambaram during June September 2016, to find out the effect of secondary and micronutrients fertilization with organics on the yield and nutrient uptake by groundnut in coastal saline soil. The experimental soil was sandy loam in texture and taxonomically classified as Typic Ustifluvent. The initial soil had the following characteristics (0-15 cm layer) of the experimental site were, pH–8.34 and EC–2.41dS m^{-1}. The soil registered low organic carbon status of 2.30 g kg^{-1}, 156.32 kg ha^{-1} of alkaline $KMnO_4$ – N; 9.35 kg ha^{-1} of Olsen–P, 173.74 kg ha^{-1} of NH_4OAc-K, 6.15 mg kg^{-1} of 0.15% $CaCl_2$-S, 0.71mg kg^{-1} of DTPA-zn and 0.08 mg kg^{-1} of hot water boron, respectively. The various treatments included were T_1-Control (RDF alone), T_2 - RDF + Composted coirpith (CCP) @ 12.5 t ha^{-1}, T_3 - RDF + CCP + Sulphur (S) @ 200 kg ha^{-1} through Gypsum, T_4 - RDF + CCP + S + $ZnSO_4$ soil application (SA) @ 25 kg ha^{-1}, T_5- RDF + CCP + S + $ZnSO_4$ foliar application (FA) @ 0.5% , T_6- RDF + CCP + S + Borax (SA) @ 10 kg ha^{-1}, T_7 - RDF + CCP + S + Borax (FA) @ 0.5%, T_8- RDF + CCP + S + $ZnSO_4$ (SA) + Borax (SA), T_9- RDF + CCP + S + $ZnSO_4$ (FA) + Borax (FA) and T_{10} - RDF + CCP + S + $ZnSO_4$ (SA) + Borax (SA) +$ZnSO_4$ (FA) + Borax (FA). The above treatments were arranged in a Randomized Block Design (RBD) with three replications and tested with sunflower var. Sunbred-hybrid. The results of the study indicated that the combined application of recommended dose of NPK fertilizer along with composted coirpith @12.5 t ha^{-1} + S @ 200 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha-1 + Borax @ 10 kg ha-1 through soil along with foliar application @ 0.5% twice was significantly superior in increasing the yield and nutrients uptake by sunflower.

Key words: Coastal saline soil, organics, gypsum, $ZnSO_4$, borax, yield, nutrient uptake, sunflower.

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INTRODUCTION

Soil salinity hampers crop production in the coastal ecosystem to a greater extent. Rectification of coastal soils problems is beyond the capacity of the resource poor farmer's to address. However, exploitation of these stressed ecosystems for arable cropping will help to agricultural production to commensurate with the increasing population. From this perceptive, it is the high time to exploit coastal saline soil for agricultural production with the adoption of some improved techniques [4]. The coastal sandy soils, being a nutrient impoverished soil, nutrient deficiencies are common due to low nutrient retentive capacity. Moreover, application of NPK fertilizer to these soil, aggregate the deficiency of secondary and micronutrients especially sulphur, boron, zinc which are susceptible for leaching. In sunflower production and improving the quality, the zinc and boron plays a vital role. Zinc is recognized as a key element for protein synthesis, biological nitrogen fixation and also plays an important role in various enzymatic activities in the development of plant growth

and increase of oil content in sunflower crop. Boron plays a significant role in promoting growth, quality of seeds and yield of sunflower. It also arrest flower drop/poor seeds formation, and plays a pivotal role in cell division in the process of enlarged size of flower capitulum formation besides its involvement in carbohydrate and fat synthesis. Several earlier works has emphasized the need for application of these nutrients for increasing the growth, yield and quality of sunflower crop (Kalaiyarasan and Vaiyapuri, 2008[3] and Rasool *et al.,* 2013[7]). Whereas sulphur is also increasingly being recognized as the fourth major plant nutrient next to nitrogen, phosphorus and potassium. It helps in the synthesis of cystein, methionine, chlorophyll, vitamins-B like biotin and thiamine, metabolism of carbohydrates increasing oil and protein content as well as associated with growth and metabolism, especially affecting the protolytic enzymes [5]. In addition, Utilization of organic manures in coastal soils have multidimensional effect in improving all the soil related constraints. Hence, in the present investigation, an attempt has been made to study the effect of secondary and micronutrients fertilization along with organics on the nutrient uptake and yield of sunflower in coastal saline soils.

MATERIALS AND METHODS

A field experiment was conducted in a farmer's field in Mandabam coastal village during June–September 2016. The initial soil of the experimental site had a pH–8.34 and EC-2.41dS m^{-1}. The soil was low in organic carbon (2.3 g kg^{-1}), low in available N (156.32 kg ha^{-1}), P (9.35 kg ha^{-1}), medium in available K (173.74 kg ha^{-1}) and low in $Cacl_2$-S (6.15 mg kg^{-1}), respectively. The low status of DTPA-Zn (0.71 mg kg^{-1}) and boron (0.08 mg kg^{-1}). The treatments imposed viz.,., T_1-Control (RDF alone), T_2 - RDF + Composted coirpith (CCP) @ 12.5 t ha^{-1}, T_3 - RDF + CCP + Sulphur (S) @ 200 kg ha^{-1} through Gypsum, T_4 - RDF + CCP + S + $ZnSO_4$ soil application (SA) @ 25 kg ha^{-1}, T_5- RDF + CCP + S + $ZnSO_4$ foliar application (FA) @ 0.5% , T_6- RDF + CCP + S + Borax (SA) @ 10 kg ha^{-1}, T_7 - RDF + CCP + S + Borax (FA) @ 0.5%, T_8- RDF + CCP + S + $ZnSO_4$ (SA) + Borax (SA), T_9- RDF + CCP + S + $ZnSO_4$ (FA) + Borax (FA) and T_{10} - RDF + CCP + S + $ZnSO_4$ (SA) + Borax (SA) +$ZnSO_4$ (FA) + Borax (FA). The experiment was laid out in a Randomized Block Design (RBD) with three replications, using sunflower var. Sunbred-Hybrid. A fertilizer dose of 60 kg of N + 90 kg of P_2O_5 + 60 kg of K_2O per hectare for sunflower was applied as urea, single super phosphate and muriate of potash, respectively. Half of the N and entire P_2O_5 and K_2O were applied as basal and the remaining half dose of N was applied in two splits at flowering and capitulum formation stage. A required quantity of gypsum was also applied as basal as per the treatment schedule. Composted coirpith (CCP) @ 12.5 t ha^{-1} were applied basally and well incorporated into the soil as per the treatment schedule. Required quantities of $ZnSO_4$ and Borax were applied either through soil or foliar spray and or both as per the treatment schedule. Foliar application of $ZnSO_4$ and Borax @ 0.5 per cent in each at Pre Flowering Stage (PFS) and at Flowering Stage (FS) was applied as per the treatment. The biofertilizer namely *Azospirillum* @ 2 kg ha^{-1} was applied to all the experimental plots. The plant samples were collected at critical stages of sunflower viz., flowering, capitulum formation and at harvest stages and analyzed for the concentration of nutrients like N, P, K, S, Zn and B were estimated using the standard procedure as outlined by Jackson [2] and uptake were calculated. At harvest seed and stalk yield were recorded.

RESULTS AND DISCUSSION

Yield characters and yield of sunflower:

The sunflower responded well for the secondary and micronutrients application. The significant influence of secondary (sulphur) and micronutrient fertilization (zinc + boron) along with recommended NPK and organics in increasing the yield characters and seed and stalk yield of sunflower was well evidenced in the present investigation.The yield components and yield realized under the nutrient poverished coastal saline soil, the highest yield characters like, capitulum diameter (17.58 cm), number of seeds capitulum^{-1} (1028) and 100 seed weight (5.62 g), seed yield (1911 kg ha^{-1}) and stalk yield (3218 kg ha^{-1}) was recorded with combined application of recommended dose of NPK fertilizer (RDF) + S @ 200 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + borax @ 10 kg ha^{-1} (SA) through soil as well as foliar spray of $ZnSO_4$ @ 0.5% + borax @ 0.5 per cent twice at pre flowering and flowering stage along with composted coirpith @ 12.5 t ha^{-1} (T_{10}). This was followed by

the treatments T_8, (RDF + S @ 200 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + borax @ 10 kg ha^{-1} (SA) + CCP @ 12.5 t ha^{-1}) and treatment T_9, (RDF + CCP @ 12.5 t ha^{-1} + S @ 200 kg ha^{-1} + ($ZnSO_4$ + borax) FA @ 0.5 per cent (T_9). The treatments T_8 and T_9 were found to be on par with each other. The next best treatments in increasing yield of sunflower are T_6, (RDF + S + borax @ 10 kg ha^{-1} (SA) +CCP @ 12.5 t ha^{-1}), T_7 (RDF + S + borax @ 0.5% (FA) + CCP @ 12.5 t ha^{-1}), T_4 (RDF + S+ $ZnSO_4$ @ 25 kg ha^{-1} (SA) + CCP @ 12.5 t ha^{-1}) and T_5 (RDF + S + $ZnSO_4$ @ 0.5% (FA) through foliar application along with CCP). This was followed by the treatments T_3 (RDF + CCP + sulphur alone/without micronutrients) and T_2 (RDF + CCP alone/without secondary and micronutrients). Of all the treatments, the treatment (T_{10}), recommended dose of NPK + S + composted coirpith along with micronutrients through soil ($ZnSO_4$ @ 25 kg ha^{-1} + borax @ 10 kg ha^{-1}) and foliar ($ZnSO_4$ @ 0.5% + borax @ 0.5 per cent) application recorded a seed and stalk yield of 1911 and 3218 kg ha^{-1} which was 48.71 and 53.20 per cent higher over 100 per cent NPK or RDF alone (without sulphur, micronutrients and organics).

The highest yield components and seed and stalk yields with conjunctive use of zinc + boron through soil as well as foliar spray along with sulphur + organics and recommended dose of NPK. Supply of both macro and micronutrients play a major role in physiological activities of sunflower. Further, the betterment of yield characters might be ascribed to the effect of zinc and boron which enhanced the photosynthetic activity resulting in the higher biomass production and accumulation of carbohydrates and essential auxins which resulted in enhanced the growth and yield of sunflower. These results are in agreement with those of Wabekwa *et al.* [11] and Ramesh, [6].

Major nutrients (NPK) uptake:

The uptake of NPK was significantly influenced by the different methods of micronutrients (zinc + boron) application along with sulphur and organics at all the critical stages *viz.,* flowering, capitulum formation and at harvest stages of sunflower. Among the various treatments tried, the combined application of $ZnSO_4$ + borax through soil and foliar spray along with sulphur, organics and recommended dose of NPK recorded the highest N uptake at different stages of crop growth as compared to with or without secondary, micronutrients and organics. The treatment T_{10}, application of RDF + sulphur as gypsum (S)+ composted coirpith (CCP) @ 12.5 t ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + borax @ 10 kg ha^{-1} (SA) through soil and foliar spray of $ZnSO_4$ and borax @ 0.5 per cent) registered the highest N (58.63 and 24.82 kg ha^{-1}), P (6.10 and 5.43 kg ha^{-1}) and K (39.07 and 15.98 kg ha^{-1}) uptake by seed and stalk, respectively. This was followed by T_8, application of RDF + S + CCP @ 12.5 t ha^{-1} along with $ZnSO_4$ @ 25 kg ha^{-1} + borax @ 10 kg ha^{-1} (SA) and T_9, application of recommended dose of NPK + S + CCP @ 12.5 t ha^{-1} along with $ZnSO_4$ and borax @ 0.5%. The treatments T_8 and T_9 were found to be on par with each other. This was followed by the treatments arranged in the descending order like T_6> T_7 > T_4 > T_5 > T_3 and T_2. The lowest NPK uptake was registered in control (RDF alone).

The increased NPK uptake with application of RDF + $ZnSO_4$ @ 25 kg ha^{-1} + borax @ 10 kg ha^{-1} through soil and foliar spray @ 0.5% twice along with CCP registered the highest NPK uptake by sunflower seed and stalk as compared to individual application of Zn and B either through soil or foliar alone or without organics. The increased NPK uptake by sunflower with application of organics along with micronutrients may be due to improvement of the soil environment which encouraged proliferation of roots resulting in more absorption of water and nutrients from larger rhizosphere. Moreover, the higher nutrient uptake with organic manure might be attributed to solubilization of native nutrients, chelation of micronutrient complex intermediate organic molecules produced during decomposition of added organic manures, their mobilization and accumulation of nutrients by crop plants. This was in accordance with the earlier findings of Ravi and Channal, [8] and Salwai *et al.* [9].

Sulphur, Zinc and Boron uptake:

A significant increase in S, Zn and B nutrition due to the application of RDF + organics + sulphur and micronutrient (zinc + boron) fertilization was well documented in the present investigation. As like NPK uptake, the highest S, Zn and B uptake by sunflower at all the critical stages was recorded with the application of RDF + CCP @ 12.5 t ha^{-1} + S @ 200 kg ha^{-1} (gypsum) along with $ZnSO_4$ SA @ 25 kg ha^{-1} + borax SA @ 10 kg ha^{-1} through soil and foliar spray of $ZnSO_4$ + borax @ 0.5 per cent twice (T_{10}). It recorded a S uptake (9.54 and

10.14 kg ha-1), Zn (21.05 and 152.33 g ha^{-1}) and B uptake (3.91 and 6.58 g ha^{-1}) by seed and stalk, respectively. This was followed by treatments T_8, RDF + CCP + S (gypsum @ 200 kg ha^{-1}) along with $ZnSO_4$ SA @ 25 kg ha^{-1} + borax SA @ 10 kg ha^{-1} through soil application which recorded a S uptake (8.88 and 9.47 kg ha-1), Zn (205.61 and 143.00 g ha^{-1}) and B uptake (3.66 and 6.17g ha^{-1}) by seed and stalk, respectively. However, it was found to be equally efficacious with the treatment T_9 (RDF + CCP + S + $ZnSO_4$ + borax @ 0.5% through foliar). This was followed by the treatments arranged in the descending order like T_6> T_7 > T_4 > T_5 and T_3. These treatments were also statistically significant. The control (RDF alone) recorded the lowest S, Zn and B uptake in seed and stalk, respectively as compared to treatment T_2.

The highest S uptake was recorded with the combined application of RDF + sulphur as gypsum @ 200 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + borax @ 10 kg ha^{-1} through soil and foliar spray of $ZnSO_4$ + borax @ 0.5% along with CCP @ 12.5 t ha^{-1}. This might be attributed to the increased sulphur containing amino acids, increased crop yield and available S status of soil. Addition of organics improved the soil environment which increased the S availability. These findings conform the earlier report of Sidhu *et al.* [10]. Further, the highest micronutrients (Zn and B) uptake by the treatment (T_{10}), might be attributed to increase total dry matter production, growth and yield components of sunflower. Further, improvement in the availability and higher absorption by sunflower resulted in higher uptake of Zn and B nutrients. The increased uptake of micronutrients with the zinc and boron has been well documented by Ramesh [6] and Beema [1].

Table 1. Effect of composted coirpith, secondary and micronutrients fertilization on the yield characters and yield of sunflower

Treatments	**Head diameter (cm)**	**Total number of seeds capitulum^{-1}**	**100 seed weight (g)**	**Seed yield (kg ha^{-1})**	**Stalk yield (kg ha^{-1})**
T_1	9.03	538	3.32	980	1506
T_2	10.52	596	3.62	1132	1716
T_3	11.42	651	3.87	1243	1909
T_4	13.30	769	4.37	1458	2279
T_5	12.29	703	4.13	1375	2088
T_6	15.19	886	4.89	1675	2763
T_7	14.28	827	4.64	1557	2534
T_8	16.55	970	5.31	1816	3020
T_9	16.14	947	5.18	1783	2971
T_{10}	17.58	1028	5.62	1911	3218
SE_D	0.39	25.42	0.10	46.07	80.16
CD (p=0.05)	0.82	53.39	0.23	96.76	168.34

Table 2. Effect of composted coirpith, secondary and micronutrients fertilization on the major nutrients uptake (kg ha^{-1}) by sunflower

Treatments	**Nitrogen**				**Phosphorus**				**Potassium**			
	FS	**CFS**	**HS**		**FS**	**CFS**	**HS**		**FS**	**CFS**	**HS**	
			Seed	**Stalk**			**Seed**	**Stalk**			**Seed**	**Stalk**
T_1	4.45	24.30	32.17	9.67	1.63	2.51	2.35	2.03	8.23	15.41	14.32	6.12
T_2	5.47	27.54	35.11	11.71	1.85	3.12	3.10	2.69	9.70	18.36	17.78	7.39
T_3	5.92	31.48	37.76	13.59	2.04	3.48	3.54	3.12	11.04	22.68	21.00	8.60
T_4	6.84	38.76	43.30	17.83	2.68	4.37	4.32	3.80	15.07	28.27	27.08	10.62
T_5	6.33	35.19	40.37	15.68	2.38	4.00	3.92	3.49	12.98	25.31	24.15	9.65
T_6	7.86	44.56	50.17	20.68	3.07	5.18	5.12	4.62	18.48	35.90	32.13	12.98
T_7	7.37	41.55	46.68	19.19	2.86	4.79	4.75	4.23	17.21	31.84	29.39	11.64
T_8	8.44	49.29	55.49	23.30	3.41	5.62	5.67	5.06	20.53	40.91	36.02	14.39
T_9	8.30	47.53	53.84	22.62	3.31	5.51	5.58	4.95	19.79	40.02	35.01	14.15
T_{10}	8.91	51.87	58.63	24.82	3.64	6.02	6.10	5.43	22.50	44.80	39.07	15.98
SE_D	0.18	1.05	1.21	0.55	0.07	0.13	0.13	0.11	0.50	1.04	0.90	0.29
CD (p=0.05)	0.39	2.21	2.55	1.17	0.16	0.28	0.29	0.25	1.05	2.19	1.90	0.61

Table 3. Effect of composted coirpith, secondary and micronutrients fertilization on the sulphur, zinc and boron uptake by sunflower

Treatments	Sulphur (kg ha^{-1})				Zinc (g ha^{-1})				Boron (g ha^{-1})			
	FS	CFS	HS		FS	CFS	HS		FS	CFS	HS	
			Seed	Stalk			Seed	Stalk			Seed	Stalk
T_1	0.79	5.68	4.28	4.89	120.10	130.52	98.87	71.51	1.31	1.39	1.51	2.99
T_2	0.88	6.42	5.05	5.51	135.68	148.08	112.21	81.59	1.50	1.68	1.81	3.46
T_3	0.97	7.29	5.54	6.32	153.57	164.31	123.02	89.47	1.73	1.84	2.04	3.81
T_4	1.28	8.66	6.81	7.53	197.93	210.08	150.58	111.05	2.09	2.30	2.72	4.77
T_5	1.25	7.96	6.07	6.84	173.55	183.10	134.34	97.48	1.92	2.04	2.31	4.32
T_6	1.16	10.07	8.04	8.81	236.78	260.70	187.21	127.35	2.46	2.73	3.37	5.51
T_7	1.08	9.35	7.36	8.26	218.80	238.25	169.32	119.39	2.31	2.49	3.10	5.17
T_8	1.43	10.87	8.88	9.47	258.32	288.82	205.61	143.00	2.72	3.00	3.66	6.17
T_9	1.39	10.73	8.75	9.36	252.72	280.59	201.86	136.22	2.65	2.92	3.59	6.09
T_{10}	1.52	11.65	9.54	10.14	274.50	307.14	219.05	152.33	2.89	3.18	3.91	6.58
SE_D	0.03	0.23	0.21	0.20	6.25	7.07	4.70	3.67	0.06	0.06	0.08	0.14
CD (p=0.05)	0.07	0.50	0.45	0.42	13.13	14.85	9.87	7.72	0.13	0.13	0.17	0.31

CONCLUSION

The results of the study showed that for increased the nutrients uptake and yield of sunflower in coastal saline soil, application of recommended dose of NPK + composted coirpith @ 12.5 t ha^{-1} along with sulphur as gypsum @ 200 kg ha^{-1} + $ZnSO_4$ @ 25 kg ha^{-1} + borax @ 10kg ha^{-1} through soil and foliar spray of both the micronutrients ($ZnSO_4$ + borax) @ 0.5 per cent twice at critical stages like, pre flowering and flowering stage was identified as best treatment combination to recommend to the farmer's of coastal areas to realize the maximum net profit in sunflower yield and to sustain soil health in coastal saline soil.

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