RESPONSE OF GROUNDNUT TO ZINC, BORON AND ORGANICS ON THE YIELD AND NUTRIENT AVAILABILITY IN COASTAL SANDY SOIL

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ABSTRACT:

The light texture sandy soils are also well known for the deficiency of micronutrients especially zinc and boron. The zinc (Zn) and boron (B) plays an important role in improving the yield and quality of groundnut. A field experiment was conducted to find out the response of groundnut to Zn and B on the nutrient availability and yield of groundnut in coastal sandy soil. . The experiment was carried out in a farmer's field at Ponnanthittu coastal village, near Chidambaram Taluk, Cuddalore district, Tamil Nadu. The Physico-chemical properties and nutrient status of initial soil were: pH- 8.39, EC- 1.61dSm^{-1} , organic carbon- 2.7 g kg^{-1} and Zn – 0.70 mg kg^{-1}, B- 0.07 mg kg^{-1}, respectively. Control, 100% NPK, 150% NPK, 150% NPK + $ZnSO_4$ @ 30 kg ha^{-1}, 150% NPK + Borax @15 kg ha^{-1} and 150% NPK + $ZnSO_4$ @ 30 kg ha^{-1} + Borax @15 kg ha^{-1} were the treatments studied in a Randomized Block Design (RBD) with four replications, using groundnut variety VRI 2. All the treatments received a common dose of Composted Coirpith application @ 12.5 t ha^{-1}. The results clearly indicated that, 150% NPK along with $ZnSO_4$ @ 30 kg ha^{-1} and Borax @ 15 kg ha^{-1} with composted coirpith application significantly increased the nutrient availability and yield of groundnut. This treatment recorded the highest pod yield of 2466 kg ha^{-1} and haulm yield of 3354 kg ha^{-1} as compared 100% recommended NPK alone 1878 and 2663 kg ha^{-1} of pod and haulm yield, respectively.

KEY WORD: *Zinc, Boron, groundnut, Coastal Sandy Soil, growth, yield, nutrient availability.*

INTRODUCTION:

The major production constraints in coastal sandy soils are mainly the low organic matter, deficiency of macro and micro nutrients and poor nutrient retention property of soil. The poor retention and leaching of nutrients also necessitates for the increased rate of nutrients application in such soil as compared to normal soils. Further, Low organic matter, poor nutrient retention and deficiency of micronutrients are common feature of coastal sandy soil. Zn and B are recognized as a key elements in promoting growth, yield and quality of groundnut. Organic matter helps in increasing adsorptive power of soil for cations, anions and micronutrients. These adsorbed ions are released slowly for the benefit of crop during entire growth period. Organic manures improve the organic carbon status, available primary and secondary nutrients and also supply sufficient amount of micronutrients in available forms (Badanur *et al.,* 1990 and Khar, 1993). Hence, in the present study was undertaken to find out the influence of zinc and boron along with organics on nutrient availability and yield of groundnut.

MATERIALS AND METHOD:

A field experiment was carried out in a farmer's field during December – March, 2007 at Ponnanthittu coastal village, to find out the response of micronutrients on the nutrient availability and yield of groundnut in coastal sandy soil. The various treatments included were, T_1- Control, T_2- 100% NPK; T_3-150% NPK; T_4- 150% NPK + $ZnSO_4$ @ 30 kg ha^{-1}; T_5-150% NPK + borax @ 15 kg ha^{-1} and T_6- 150% NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} along with composted coirpith @ 12.5 t ha^{-1} common to all treatments. The experiment was carried out in a Randomized Block Design (RBD), with four replications, using groundnut variety VRI 2. The experimental soil had sandy texture with pH- 8.39; EC-1.61 d Sm^{-1}; organic carbon- 2.7 g kg^{-1}, Zinc 0.7 mg kg^{-1} and Boron status of 0.07 mg kg^{-1}. The alkaline $KMnO_4$ – N; Olsen- P and NH_4OAc- K, were low, low and medium status, respectively. Calculated amount of inorganic fertilizer doses of Nitrogen (17 kg N ha^{-1}), Phosphorus (34 kg P_2O_5 ha^{-1}) and Potassium (54 kg K_2O ha^{-1}) were applied through urea, single super phosphate and muriate of potash, respectively. Required quantities of Zinc Sulphate and Borax as per the treatment schedule were incorporated. The soil samples were collected at flowering stage (FS), peg formation (PFS) and harvest stages (HS) and analyzed for major (N, P and K) and micronutrients (Zn and B) status of soil (Jackson, 1973). At harvest stage, pod and haulm yield were also recorded.

RESULTS AND DISCUSSION:

Growth characters:

The application of zinc + boron along with organics significantly and positively influenced the growth characters of groundnut at all the critical stages of crop growth. The highest plant height and dry matter production was found with treatment T_6, application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} + CCP @ 12.5 t ha^{-1} which recorded 65.15 cm plant height and 5296 kg ha^{-1} of dry matter production, respectively. This was followed by the treatments T_5, 150 per cent NPK + borax @ 15 kg ha^{-1} + CCP (61.12 cm and 5012 kg ha^{-1}) and treatment T_4, application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + CCP (57.02 cm and 4695 kg ha^{-1}). The lowest plant height (42.74 cm) and dry matter production (3473 kg ha^{-1}) were recorded in the control (without $ZnSO_4$ and borax) at harvest stage.

In coastal sandy soil, application of 150 per cent of recommended NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} along with CCP @ 12.5 t ha^{-1} recorded the highest plant height and dry matter production. This might be due to the significant improvement in plant height may be due to significant improvement in nodulation. This observation was in accordance with those of Tomar *et al.* (1990) and Saxena and Chandel (1997). Indeed, they reported that application of zinc enhances the plant growth enhancement through auxin and better dry matter production. Zinc improved DMP though the nodulation and N fixation by enhanced root growth and by activation of several enzyme systems and auxins. Whereas, boron influenced the nitrogen and carbohydrate metabolism of plants which might have contributed for the better plant growth (Malewar *et al.*, 1982).

Yield:

The significant influence of zinc + boron along with organics in increasing the pod and haulm yield of groundnut was well evidenced in the present study.

Of all the treatments, the combined application of both the micronutrients *viz.*, $ZnSO_4$ + borax along with 150 per cent NPK and organics recorded the higher pod yield (2466 kg ha^{-1}) and haulm yield (3354 kg ha^{-1}) as compared to pod and haulm yield of 1878 and 2663 kg ha^{-1} in 100 per cent NPK which represented 31.30 and 25.95 per cent yield increase and pod and haulm yield of 2080 and 2854 kg ha^{-1} in 150 per cent NPK which represented 18.55 and 17.52 per cent yield increase.

The groundnut yield increased with application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} along with CCP @ 12.5 t ha^{-1}. This might be due to the application of micronutrients and organics helped in the slow and steady rate of nutrient release into soil solution to match the required absorption pattern of groundnut thereby increased the yield. This corroborates the earlier report of Subramaniyan *et al.* (2001). Further the rapid mineralization of N, P and K from inorganic fertilizers and steady supply of these nutrients from coirpith, might have met the nutrient requirement of crop at all the critical stages of crop growth. In addition, the beneficial influence of micronutrients *viz.,* Zn and B through activation of various enzymes and basic metabolic rate in plants, facilitated the synthesis of nucleic acids and hormones, which in turn enhanced the pod yield due to greater availability of nutrients and photosynthates. These results are in agreement with those of Helpyati (2001) and Sumangala (2003).

AVAILABLE MAJOR NUTRIENTS

Alkaline $KMnO_4$-N

The available nitrogen status in soil was significantly influenced by the application of zinc and boron along with composted coirpith at all the critical stages of crop growth. The highest available nitrogen (161.37 kg ha^{-1}) status at harvest stage was recorded with the combined application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} + CCP (T_6). This was followed by treatment T_5, application of 150 per cent NPK + borax @ 15 kg ha^{-1} + CCP and T_4, application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + CCP. The control registered the lowest alkaline $KMnO_4$-N content of 124.44 kg ha^{-1} in the soil.

Increased N availability might be attributed to the direct addition and slow release of N from manures added to soil. Addition of micronutrients increased the nodulation and atmospheric N fixation by increased nitrogenase activity thereby the availability of N is increased. Further, the addition of organics stimulated the growth and activity of microorganisms which increased the nutrient release and the effect was further enhanced by the addition of NPK fertilizers. These findings are in conformity with the earlier work of Tripathy *et al.* (1999); Ganeshappa (2000) and Singaravel *et al.* (2004).

Olsen-P

The available P in the soil was significantly increased due to the application of zinc + boron along with organics. The treatment 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} + CCP @ 12.5 t ha^{-1} (T_6) recorded the highest available P content of 19.50 kg ha^{-1} at harvest stage. This was followed by treatments T_5, 150% NPK + borax @ 15 kg ha^{-1} + CCP @12.5 t ha^{-1} which recorded an Olsen-P content of 18.52 kg ha^{-1}.

The rapid solubilization of native and applied phosphorus as a result of the carbonic acid produced due to higher microbial respiration, protection provided by humic, fulvic and humin substances resulting from the organic carbon recycling might explains the reason for higher P availability. The findings of Sudarsan and Ramaswami (1993) and Tomar *et al.* (1995) corroborate the present findings.

NH_4OAc-K

The available K in the soil was also significantly increased at FS, PFS and at harvest stages of crop growth due to the application of zinc, boron along with organic manures. The application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} + CCP @ 12.5 t ha^{-1} (T_6) registered the highest NH_4OAc-K content of 236.66 kg ha^{-1} at harvest stage. This treatment was followed by T_5, application of borax @ 15 kg ha^{-1} and T_4, application of $ZnSO_4$ @ 30 kg ha^{-1} along with organics.

Higher K availability with NPK + Zn + B along with CCP application might be due to higher native K in addition to added potassium. These findings are in conformity with Gopala Gowda *et al.* (1995). Further, the addition of organic along with NPK fertilizers reduced the K fixation and more K was released due to the clay organic matter interaction contributing higher K to soil available pool. This corroborates the earlier report of Ravankar *et al.* (1999) and Singaravel *et al.* (2006).

AVAILABLE MICRO NUTRIENTS

DTPA-Zinc

The application of zinc and boron along with composted coirpith significantly increased the Zn availability in the soil.

The availability of DTPA-Zn in the soil significantly increased with the application of different treatments. The highest available zinc status at harvest stage (1.24 mg kg^{-1}) was recorded with the combined application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} +CCP (T_6). This was followed by treatment T_4, application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + CCP and T_5, application of 150 per cent NPK + borax @ 15 kg ha^{-1} + CCP. The control registered the lowest DTPA-Zn availability of 0.79 mg kg^{-1} at harvest stage. The increased zinc and boron availability might be attributed to the direct addition these nutrients by fertilizer and organic manures. Further the complexation of micronutrients with applied organics might have mobilized and increased the availability of Zn and B in soil. These findings are accordance with Raniperumal *et al.* (1991) and Singaravel *et al.* (2004).

Hot water-Boron (Fig. 1)

The availability of boron in the soil was also increased at all stages of groundnut with the application of zinc + boron along with organics. Among different treatments, the highest boron content of 0.091 mg kg^{-1} at harvest stage was recorded with application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} + CCP @ 12.5 t ha^{-1} (T_6). The application of borax @ 15 kg ha^{-1} (T_5) and $ZnSO_4$ @ 30 kg ha^{-1}

(T_4) along with 150 per cent NPK + CCP by registering a B availability of 0.088 and 0.082 mg kg^{-1} at harvest followed the above treatment.

In coarse textured soil, the low availability of B is mainly due to leaching. Organic manures application in such soil along with B increases B retention in soil by forming complexes, such complexes becomes slowly available to plants and hence increases the recovery of added B (Mandal *et al.,* 1993).

CONCLUSIONS:

The results of the present investigation clearly indicated that for increasing the nutrient availability and yield of groundnut in coastal sandy soil, the treatment combined application of 150 per cent NPK + $ZnSO_4$ @ 30 kg ha^{-1} + borax @ 15 kg ha^{-1} + composted coirpith @ 12.5 t ha^{-1} would be beneficial.

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Table 1. Influence of zinc, boron and organics on the growth and yield of groundnut

Treatments	**Plant height (cm)**			**Dry matter production (kg ha^{-1})**			**Yield (kg ha^{-1})**	
	FS	**PFS**	**HS**	**FS**	**PFS**	**HS**	**Pod**	**Haulm**
T_1-Control	19.78	30.25	42.74	1212	1819	3473	1463	2232
T_2-100% NPK	23.63	34.90	48.62	1350	2073	4017	1878	2663
T_3-150% NPK	26.34	37.95	52.67	1549	2301	4374	2080	2854
T_4-150% NPK + Zn @ 30 kg ha^{-1}	28.68	40.69	57.02	1676	2490	4695	2213	3032
T_5-150% NPK + B @ 15 kg ha^{-1}	30.84	43.30	61.12	1788	2637	5012	2345	3187
T_6-150% NPK + Zn @ 30 kg ha^{-1} + B @ 15 kg ha^{-1}	32.95	45.88	65.15	1884	2768	5296	2466	3354
SE_D	0.91	1.15	1.65	40.71	57.54	126.49	52.50	72.00
CD (p=0.05)	1.87	2.35	3.40	83.87	118.54	260.56	108.16	148.32

Table 2. Influence of zinc, boron and organics on the major nutrients availability (kg ha^{-1})

Treatments	Alkaline $KMnO_4$-N			Olsen-P			NH_4OAc-K		
	FS	PFS	HS	FS	PFS	HS	FS	PFS	HS
T_1-Control	149.78	135.78	124.44	13.41	12.07	11.55	232.93	194.45	172.21
T_2-100% NPK	159.01	145.32	134.23	15.69	14.32	14.93	251.87	211.32	190.09
T_3-150% NPK	167.56	153.33	142.46	17.53	15.44	16.18	267.38	226.86	201.56
T_4-150% NPK + Zn @ 30 kg ha^{-1}	176.42	161.22	149.91	19.31	16.63	17.35	280.33	241.48	211.90
T_5-150% NPK + B @ 15 kg ha^{-1}	184.75	168.46	156.06	20.68	17.75	18.52	293.09	253.00	222.55
T_6-150% NPK + Zn @ 30 kg ha^{-1} + B @ 15 kg ha^{-1}	192.78	175.22	161.37	21.86	18.81	19.50	305.94	264.95	236.66
SE_D	3.52	3.06	2.39	0.52	0.45	0.39	5.41	4.69	4.05
CD (p=0.05)	7.25	6.30	4.93	1.08	0.93	0.81	11.15	9.67	8.35

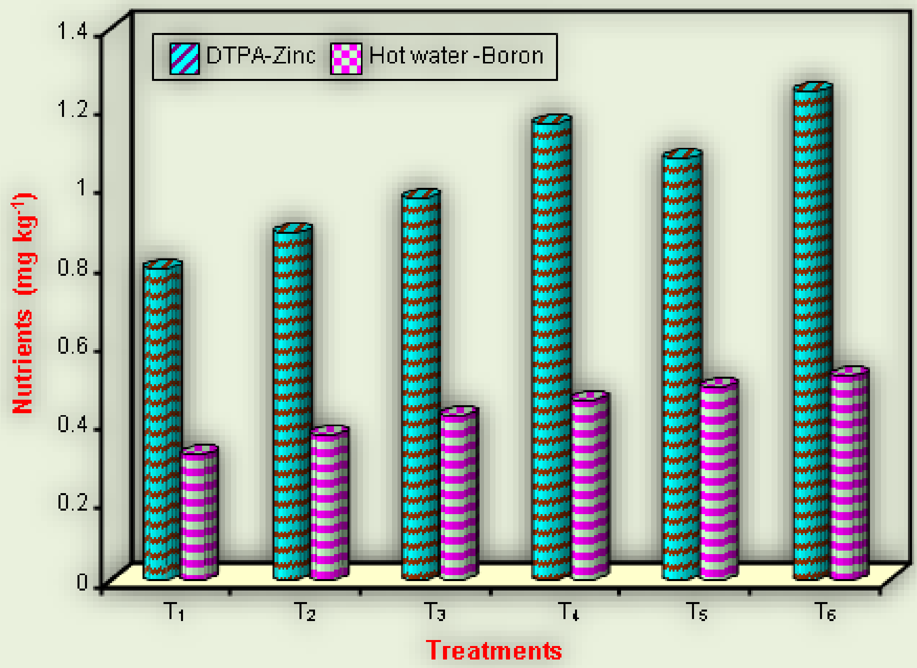

Fig. 1. Influence of zinc, boron and organics on the Zn and B content in soil at harvest stage