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Research Article

EFFECT OF MICRONUTRIENTS APPLIED AS FOLIAR AND SOIL APPLICATION ON GROWTH, YIELD ATTRIBUTES AND YIELD OF RAINFED GROUNDNUT

VASUKI V.*[1] AND SUDHALAKSHMI C.[2]
[1]Department of Millets, Center for Plant Breeding and Genetics, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India
[2]Coconut Research Station, Aliyarnagar, 642101, Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu, India
*Corresponding Author: Email - vasukimanii@gmail.com

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Abstract: Field experiments were conducted at Coconut Research Station, Aliyarnagar, during *kharif* seasons with an objective to increase groundnut yield with increased kernel yield and reduced ill filled pods. Randomized Block Design with three replications was adopted. Sandy loam soil with pH 7.2, low in available N, medium in available P and high in available K. Treatments included *viz*., $ZnSO_4$ @ 10.0 kg (Soil application) (T_1), $ZnSO_4$ @ 20.0 kg (Soil application) (T_2), $ZnSO_4$ @ 5.0 kg (Seed treatment + Foliar application) at 30 DAS (T_3), $ZnSO_4$ @ 10.0 kg (Seed treatment + Foliar application) at 30 DAS (T_4), Boric acid @ 6.0 kg (Soil application) (T_5), Boric acid @ 9.0 kg (Soil application) (T_6), Boric acid @ 3.0 kg (Seed treatment + Foliar application) at 30 DAS (T_7), Boric acid @ 6.0 kg (Seed treatment + Foliar application) at 30 DAS (T_8), $ZnSO_4$ @10.0 kg + Boric acid @ 6.0 kg ha^{-1} (Soil application) (T_9), Control (T_{10}). Results revealed, growth parameters like plant height and number of branches were non-significant and yield parameters like number of matured pods per plant at harvest, dry pod weight per plant (g), sound matured kernels, 100 kernel weight (g) recorded significant difference among themselves. Highest pod yield was recorded with application of $ZnSO_4$ @ 10.0 kg Seed treatment + Foliar application at 30 DAS (2508 kg ha^{-1}), $ZnSO_4$ @ 20.0 kg Soil application (2342 kg ha^{-1}), Boric acid @ 6.0 kg Seed treatment + Foliar application at 30 DAS (2350 kg ha^{-1}) and soil application of $ZnSO_4$ @10.0 kg + Boric acid @ 6.0 kg ha^{-1} recorded the highest pod (2248 kg ha^{-1})) and haulm yield (3872, 3712, 3747, 3635 kg ha^{-1}, respectively along with kernel yield (1716, 1594, 1678, 1582 kg ha^{-1}, respectively). These treatments were on par and comparable with each other. However, highest net returns (Rs. 80,980 ha^{-1}) and B:C ratio (3.32) was recorded with application of $ZnSO_4$ @ 10.0 kg seed treatment + Foliar application at 30 DAS.

Keywords: *Micronutrient, Zinc sulphate, Boric acid, Soil application, Seed treatment, Foliar application*

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Introduction

In India, the most important oilseed crop is Groundnut (*Arachis hypogaea* L.) and ranks first in acreage and second largest producer in world. It is cultivated for edible oil and vegetable protein. Gujarat is the largest producer contributing 33 % followed by Rajasthan (21 %), Tamil Nadu (14 %), Andhra Pradesh (7 %) and Telangana (5 %) to total groundnut production (6.7 million tonnes). Productivity of groundnut in India is 1422 kg ha^{-1} which is low compared to global average productivity of 1680 kg ha^{-1} [1]. This is mainly due to various abiotic and biotic constraints. Abiotic stresses of prime importance include temperature extremes, drought stress, soil factors such as alkalinity, poor soil fertility and nutrient deficiencies [2]. Yield and quality performance of groundnut under organic and inorganic management practices increases with good cultivars. Micronutrients often act as co-factors in enzyme systems and participate in redox reactions, in addition to having several other vital functions in plants. Most importantly, micronutrients are involved in the key physiological processes of photosynthesis and respiration [3, 4] and their deficiency can impede these vital physiological processes thus limiting yield gain. Major supply of nutrients through inorganic sources coupled with reduced usage of organic manures and secondary nutrients posed deficiency of secondary and micro nutrients in the soil and plants. Particularly deficiency of boron, iron and zinc are emerging as one of the major constraints for sustainable production in rainfed areas. Reports indicated that Zn, B and Fe deficiency causes remarkable losses in yields of groundnut [5]. Widely prevalent micronutrient deficiencies warrant the need for research on Zn, B and Fe especially on their usage individually and in mixtures as foliar and soil application.

Seeds may be treated with micronutrients either by soaking in nutrient solution of a specific concentration for a specific duration (seed priming) or by coating with micronutrients. Seed invigoration is a relatively new term and has been interchangeably used for both methods of seed treatment [6]. Improving plant micronutrient status in situations where micronutrient nutrition is inadequately supplied from the soil would increase yield. This, however, requires application of higher doses of fertilizer to soils because of low nutrient-use efficiency [7]. Therefore, micronutrient studies, have been the need of the hour to improvise the yield and quality of the groundnut. Hence, a field experiment was formulated with an objective to find out the effect of individual and combined application of micronutrients *viz*., Zinc and Boron through soil and foliar methods on growth and yield of groundnut.

Materials and Methods

The field experiment was conducted at Coconut Research Station, Aliyarnagar during *kharif* 2012 and 2013. The experiment was laid out in Randomized Block Design with three replications. The soil was sandy loam with organic carbon content of 0.28 %. The nutrient status of the soil was medium in available nitrogen 283 kg ha, high in available phosphorus 35.4 kg ha^{-1} and high in available potassium 316 kg ha^{-1} with soil pH of 7.43. The soil was sandy loam in texture with pH 7.2. The treatments included *viz*., $ZnSO_4$ @ 10.0 kg (Soil application) (T_1), $ZnSO_4$ @ 20.0 kg (Soil application) (T_2), $ZnSO_4$ @ 5.0 kg (Seed treatment + Foliar application) at 30 DAS (T_3), $ZnSO_4$ @ 10.0 kg (Seed treatment + Foliar application) at 30 DAS (T_4), Boric acid @ 6.0 kg (Soil application) (T_5), Boric acid

Table-1 Effect of different micronutrients on plant height, no. of branches at harvest, yield attributes

	Treatments	Plant Height at harvest (cm)	No. of branches @ of harvest (No.)	Shelling percentage (%)	Sound matured kernels (%)	100- Kernel weight (g)
T_1	Zinc sulphate @ 10.0 kg ha^{-1} (Soil application)	66.13	7.2	62.94	84.25	33.9
T_2	Zinc sulphate @ 20.0 kg ha^{-1} (Soil application)	69.73	8.27	68.07	89.55	37.64
T_3	Zinc sulphate @ 5.0 kg ha^{-1} (Seed treatment) + foliar spray on 30 DAS	70.07	7.53	63.5	85.43	33.29
T_4	Zinc sulphate @ 5.0 kg ha^{-1} (Seed treatment) + foliar spray on 30 DAS	64.2	8.2	68.42	91.99	38.37
T_5	Boric acid @ 6.0 kg ha^{-1} (Soil application)	70.73	8.27	63.6	84.8	32.89
T_6	Boric acid @ 9.0 kg ha^{-1} (Soil application)	70.27	7.13	64	84.59	34.62
T_7	Boric acid @ 3.0 kg ha^{-1} (Seed treatment) + foliar spray on 30 DAS	71	7.73	61.18	83.59	33.34
T_8	Boric acid @ 6.0 kg ha^{-1} (Seed treatment) + foliar spray on 30 DAS	66.33	8.33	71.4	89.2	38.25
T_9	Zinc sulphate @ 10.0 kg ha^{-1} (Soil application) + Boric acid @ 6.0 kg ha^{-1} (Soil application)	66.27	7.73	70.38	93.93	39.7
T_{10}	Control (without micronutrient application)	66.67	8.33	64.1	82.77	30.15
	S.Em ±	5.57	0.49	3.44	2.55	2.39
	LSD (0.05)	NS	NS	NS	5.36	5.02

Table-2 Effect of different micronutrients on dry pod yield (kg ha-1), Dry kernel yield and Haulm yield (kg ha-1), Net returns (Rs. ha-1) and B:C ratio

	Treatments	Dry pod weight (kg ha^{-1})	Dry kernel weight (kg ha^{-1})	Dry Haulm yield (kg ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T_1	Zinc sulphate @ 10.0 kg ha^{-1} (Soil application)	1662	1046	2473	41520	2.19
T_2	Zinc sulphate @ 20.0 kg ha^{-1} (Soil application)	2342	1594	3712	73283	3.08
T_3	Zinc sulphate @ 5.0 kg ha^{-1} (Seed treatment) + foliar spray on 30 DAS	1845	1172	2600	49555	2.43
T_4	Zinc sulphate @ 5.0 kg ha^{-1} (Seed treatment) + foliar spray on 30 DAS	2508	1716	3872	80980	3.32
T_5	Boric acid @ 6.0 kg ha^{-1} (Soil application)	1658	1055	2430	41291	2.19
T_6	Boric acid @ 9.0 kg ha^{-1} (Soil application)	1703	1090	2525	43315	2.24
T_7	Boric acid @ 3.0 kg ha^{-1} (Seed treatment) + foliar spray on 30 DAS	1755	1074	2597	45981	2.33
T_8	Boric acid @ 6.0 kg ha^{-1} (Seed treatment) + foliar spray on 30 DAS	2350	1678	3747	74225	3.14
T_9	Zinc sulphate @ 10.0 kg ha^{-1} (Soil application) + Boric acid @ 6.0 kg ha^{-1} (Soil application)	2248	1582	3635	69321	2.97
T_{10}	Control (without micronutrient application)	1572	1007	2242	37383	2.09
	S.Em ±	166	113	362		
	LSD (0.05)	348	238	761		

@ 9.0 kg (Soil application) (T_6), Boric acid @ 3.0 kg (Seed treatment + Foliar application) at 30 DAS (T_7), Boric acid @ 6.0 kg (Seed treatment + Foliar application) at 30 DAS (T_8), $ZnSO_4$ @10.0 kg + Boric acid @ 6.0 kg ha^{-1} (Soil application) (T9), Control (T_{10}). Gypsum @ of 400 kg ha^{-1} was applied as basal. Groundnut variety VRI 6 was sown with spacing of 30 cm x 10 cm. All the growth and yield parameters were recorded at 20 DAS, 40 DAS and at harvest stage. Statistical analysis for the crop data were carried out using the method [8] wherever statistical significance was observed.

Results and discussion

Growth Parameters

The pooled mean of two years *kharif* (2012, 2013) data revealed that the growth parameters like plant height (cm) and the number of branches recorded at harvest registered no significant difference among treatments for different doses of micronutrients and the methods of application as both seed treatment and soil application.

Yield attributes

The yield attributing characters like Sound Matured Kernels (SMK), Shelling percentage recorded non significance for varied treatments. Application of recommended dose of fertilizers RDF (100%) as basal + RDF (50 %) as top dressing at 30 DAS + FYM @ 7.5 t ha^{-1} recorded higher dry pod yield and kernel yield (2936 and 1892 kg ha^{-1}, respectively) and were comparable with RDF (75 %) as basal + RDF (75 %) as top dressing at 30 DAS along with 7.5 t ha^{-1} of FYM higher dry pod and kernel yield (2812 and 1748 kg ha^{-1}, respectively). This may be attributed due to higher dose of RDF along with split application which facilitates easy and timely availability of nutrients. Losses of nutrients due to leaching and volatilization were reduced [9]. Additional application of FYM improves mineralization of nitrogen and phosphorus along with ameliorating effect on soil physical, chemical and biological properties making it more available to crop plants facilitating to produce more yield [10].

Yield

Lowest dry pod yield and kernel yield were recorded with treatments RDF (100 %) as basal, RDF (100 %) basal + FYM @ 7.5 t ha^{-1} and RDF (75 %) as basal + RDF (25 %) as top dressing at 30 DAS with dry pod and kernel yield of 1405, 1619, 1363 and 843, 969, 818 kg ha^{-1}, respectively and were comparable with each other. The haulm yield recorded highest with RDF (100 %) as basal + RDF (50 %) as top dressing at 30 DAS + FYM @ 7.5 t ha^{-1} (4670 kg ha^{-1}) and was comparable with RDF (100 %) as basal + RDF (50 %) as top dressing at 30 DAS + FYM @ 7.5 t ha^{-1} (4676 kg ha^{-1}). The higher haulm yield was attributed due to staggered and timely availability of nutrient and the development of more branches and leaves producing more yield and similar results were recorded by Karunakaran, *et al.*, (2010) [11] and Gagare, *et al.*, (2011) [12]. The lowest haulm yield was recorded with RDF (100 %) as basal and RDF (75 %) as basal + RDF (25 %) as top dressing at 30 DAS (2598 and 2555 kg ha^{-1}, respectively). The harvest index was non-significant among treatments, however numerically highest harvest index of 0.41 was recorded with RDF (100 %) as basal + RDF (50 %) as top dressing at 30 DAS + FYM @ 7.5 t ha^{-1} and lowest HI of 0.37 was recorded with RDF (100 %) as basal + FYM @ 7.5 t ha^{-1} and RDF (75 %) as basal + RDF (25 %) as top dressing at 30 DAS. The results are in accordance with Kathmale, *et al.,* (2000) [13]; Sabale (2002) [14]; Singh, *et al.*, (2013) [15]. Integrated nutrient management with judicious combination of inorganic fertilizers with organic manures improves improve the soil fertility status and facilitates higher yield and harvest index [16].

Econometrics

The economic analysis also recorded highest net returns of 91789 Rs ha^{-1} and B:C ratio of 3.10 was registered with application of RDF (100 %) as basal + RDF (50 %) as top dressing at 30 DAS + FYM @ 7.5 t ha^{-1}. The above was closely followed by RDF (75 %) as basal + RDF (75 %) as top dressing at 30 DAS with a maximum return of Rs. 86610 but with a BCR of 3.05. The additional cost of FYM were not incurred in calculating cost of cultivation. The lowest net return (30626 Rs ha^{-1}) was registered with RDF (75 %) as basal + RDF (25 %) as top dressing at 30 DAS and lowest B:C ratio of 1.81 was recorded with RDF (100 %) as basal + FYM @ 7.5 t ha^{-1}.

Conclusion

From experimental results it can be concluded that, irrigated groundnut when applied with higher rates of nitrogen, phosphorus, and potassium (150 % RDF) along with split application (top dressing at 30 DAS) recorded significant response.

Application of RDF (100 %) as basal + RDF (50 %) as top dressing at 30 DAS along with 7.5 t ha^{-1} of FYM or RDF (75 %) as basal + RDF (75 %) as top dressing at 30 DAS along with 7.5 t ha^{-1} of FYM recorded higher pod yield, kernel yield and harvest index. The B:C ratio was also higher with RDF (100 %) as basal + RDF (50 %) as top dressing at 30 DAS along with 7.5 t ha^{-1} of FYM.

Application of research: Micronutrient deficiencies in recent days are more predominant and affects the yield, especially in groundnut. Application of micronutrients in groundnut enhances the kernel yield and reduced the number of ill filled kernels.

Research Category: Micronutrient and Soil Science

Abbreviations: DAS-Days after sowing, ha-hectare, RDF-Recommended Dose of Fertilizers

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****Principal Investigator or Chairperson of research: Dr V. Vasuki**
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