Effect of Soil and Foliar Application of Micronutrients on Yield parameters of Groundnut (K-6) (*Arachis hypogaea* L.) in Red Sandy loamy Soils

Prudhvi Naga Rajeswari[1*]; Lipi Rina[2]; Kasinam Daruk[3]; Sonbeer Chack[4]

[*1]PG scholar, Department of Agronomy, Himalayan University, Jollang, Itanager-791111, Arunachal Pradesh, India
[2,3,4]Assistant Professor, Department of Agronomy, Himalayan University, Jollang, Itanager-791111, Arunachal Pradesh, India
*Corresponding Author

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Abstract— *A field experiment entitled* ***—Effect of Soil and Foliar application of micronutrients on Yield parameters of Groundnut (Arachis hypogaea** L.)* ***(K-6) in Red Sandy Loamy Soils*** *was conducted during rabi'2024. The experiment was laid out in Randomized Block Design (RBD) and replicated thrice with ten treatments. The treatments consisted of T_1(Control), T_2(RDF + FYM@ 10 t ha^{-1}), T_3 (RDF+ soil application of $ZnSO_4$@ 16 kg ha^{-1} as a basal), T_4(RDF + soil application of $FeSO_4$@ 10 kg ha^{-1} as a basal), T_5(RDF + soil application of borax @ 10 kg ha^{-1}asabasal),T_6 (RDF + soil application of $ZnSO_4$@ 16kgha^{-1} + $FeSO_4$@ 10kgha^{-1}+ borax @ 10 kg ha^{-1} as a basal),T_7FoliarApplication of$ZnSO_4$@0.2 % at 30DAS and 60 DAS, T_8 Foliar application of$FeSO_4$@0.5% at30and 60 DAS, T_9 Foliar application of borax @0.25 % at 30and 60 DAS,T_{10}Foliar application of $ZnSO_4$ @ 0.2 % + $FeSO_4$ @ 0.5 % + borax @0.25% at 30 and 60 DAS. The results indicated that application of each and combined micronutrients through soil methods significantly influenced the Yield parameters and quality parameters of groundnut crop. The yield Parameters and yield viz. number of pods plant^{-1}(12.93), pod yield (2506 kg ha^{-1}) and haulm yield (3339 kg ha^{-1}) of groundnut were recorded with application of RDF + FYM @10 t ha^{-1} and found significant over control (T1). From the findings it can be concluded that Application of FYM and combined soil application of all micronutrients followed by individual micronutrient application alone found better than foliar application of each micronutrient alone. The highest Yield parameters were obtained with the combined soil application of all micronutrients.*

Keywords— FYM, Micro Nutrients, Foliar Application, Yield Parameters.

I. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the important legume and oil seed crops of tropical and semiarid tropical countries, where it is a major source of edible oil and vegetable protein. Groundnut kernels contain 47-53 % oil, 25-30 % protein, 20 % carbohydrates and 5 % fiber and ash, and make a substantial contribution to human nutrition. Its oil cake is used as an important nutrient rich cattle feed. Inclusion of groundnut in cropping sequence serves as an important rotation crop as it fixes atmospheric nitrogen and increases the fertility of soil.

Globally, groundnut cultivation is mainly confined to Asia. India ranks first in terms of groundnut output area and second in terms of production volume. The global production of groundnut is 47.02 million metric tons (USDA2018- 19). In India, groundnut is cultivated in an area of 4.91 million hectares producing 9.18 million tonnes with a productivity of 1868 kg ha^{-1} (Ministry of Agriculture and Farmers Welfare, GOI, 2018-19). It is India's top oil seed product and is also referred to as peanut, monkey nut, and manila nut. In the world, groundnuts are used for 12% seed purposes, 37% confectionery uses, and 50% oil extraction uses. Approximately 46.70 percent of groundnuts are used for oil production, according to Satish *et al.*

Major production constraints which could be attributed to lower productivity of groundnut in India are mainly due to low fertile marginal lands with low input supply, low plant population, incidence of pests and diseases, imbalanced use of nutrients and lack of application of micronutrients especially zinc, iron and boron. In India, multi-nutrient deficiencies are widely causing poor crop yields (Singh, 2009a).Groundnut responds well to secondary and micronutrient fertilization. The estimated yield loss in groundnut due to the deficiencies of Fe, Zn and B in India are 10-22, 30-40% and 16- 26%respectively.Therefore, it is most essential to pay a great attention to the nutrition of the groundnut to enhance its productivity. Soil analysis of Indian fields has indicated that they are medium to low in the iron, zinc and boron content, which are found to play an important role in plant nutrition. The micronutrients are applied by both soil and foliar methods. The most significant advantage of soil-applied nutrients is that this method supplies nutrients where the plants are designed to take in nutrients *i.e*., at the roots. The roots of higher plants are adapted to uptake nutrients and water from the soil and distribute them throughout the plant through the plant‘s conductive tissues. The foliar applied nutrients promote rapid uptake of nutrients as these nutrients are applied directly to the plant rather than the soil. Now the studies on independent use of these micronutrients and combined effect of these nutrients on yield and yield attributes is well documented, in groundnut production.

II. MATERIALS AND METHODS

The field experiment was conducted during *rabi 2024-25* at Vidavalur (Farmer’s Farm), the Field situated at 14°35’ N latitude and 80° 06’ E longitude at an altitude of 5.05 meters above mean sea level (MSL). It is about 5 km away from Bay of Bengal in SPSR Nellore District of Andhra Pradesh, India. The experimental plot's soil was Red sandy loam in texture, virtually neutral in soil reaction (pH 6.75), low in organic carbon (0.55 %), available N (210.6 kg/ha), available Phosphorous (20.40 kg/ha), and available K (200.50 kg/ha) and low in zinc (0.5 ppm), iron (2.25 ppm) and boron (0.45ppm).

The experiment was designed in the Randomized Block Design (RBD) method, with ten treatments Replicated thrice. RDF of 20:40:50 NPK kg/ha and gypsum at 500kg/ha was applied to all treatments except control, and the Micro nutrients Zinc, Boron and Iron were applied as Soil application and foliar spray according to the treatments. The ten treatment combinations are given under Table 1.

TABLE 1
MICRONUTRIENT FERTILIZATION TREATMENTS APPLIED TO GROUNDNUT.

T1	Control
T2	FYM @ 10 t ha^{-1}
T3	Soil application of Zinc sulphate (ZnSO4) @ 16 kg ha^{-1} as a basal
T4	Soil application of Ferrous sulphate (FeSO4) @ 10 kg ha^{-1}as a basal
T5	Soil application of Borax @ 10 kg ha^{-1} as a basal
T6	Soil application of ZnSO4 @ 16 kg ha^{-1} + FeSO4 @ 10 kg ha^{-1} + Borax @ 10 kg ha^{-1} as a basal
T7	Foliar application of ZnSO4 @ 0.2% at 30 DAS and 60 DAS
T8	Foliar application of FeSO4 @ 0.5% at 30 and 60 DAS
T9	Foliar application of Borax @ 0.25% at 30 and 60 DAS
T10	Foliar application of ZnSO4 @ 0.2% +FeSO4 @ 0.5% + Borax @ 0.25% at 30 and 60 DAS

***RDF (25 N: 40 P2O5: 50 K2O) kg ha^{-1} and Gypsum @ 500 kg ha^{-1} is applied to all treatments.**

Kadiri-6 variety is used for this experiment. Manual seeding was done at a seed rate of 125 kg/ha at a depth of 3-4 cm and spacing of 30 cm X 10 cm. Plant growth parameters were documented at regular intervals from germination to harvest, and yield parameters were recorded after harvest. These factors were statistically analyzed using the Randomized Block Design analysis of variance (ANOVA). Statistical significance was tested by applying F-test at 0.05 level of probability and critical differences were calculated for those parameters which turned out to be significant ($P<0.05$) in order to compare the effects of different treatments.

III. RESULTS AND DISCUSSIONS

3.1 Yield and Yield Parameters:

The data on yield and yield attributes *viz*., number of pods $plant^{-1}$, pod yield, kernel yield, haulm yield, harvest index and shelling percentage as influenced by micronutrient fertilization are presented in Table 2. Among the treatments tested, T2 (RDF + FYM @ 10 t ha^{-1}) recorded significantly more number of pods $plant^{-1}$ (12.93), pod yield (2506 kg ha^{-1}) and haulm yield (3339 kg ha^{-1}) over treatments T1, T8, T7 and T9. However, it remained on par with treatments received with soil application of sole and combined application of micronutrients (T6, T5, T3 and T4) and combined foliar application (T10). Whereas, the treatment T2 (RDF + FYM @ 10 t ha^{-1}) recorded significantly the highest shelling percentage (74.48%) and found on par with all the remaining treatments except T1 (control). The maximum kernel yield (1864 kg ha^{-1}) was recorded with T2 (RDF + FYM @ 10 t ha^{-1}) treatment, and proved its superiority over treatments (T1, T8, T7, T9 and T10). However, it was found on par with soil application of micronutrient treatments (T6, T5, T3 and T4). This increase in yield and yield attributes might be due to availability of sufficient nutrients by mineralization of basic organic and inorganic sources of nutrients to plant which was reflected on formation of higher sink capacity that led to increased number of pods plant^{-1}, pod yield, kernel yield, haulm yield and shelling percentage. Among soil and foliar application of micronutrients, application of micronutrients in combination increased the supply of micronutrients required for growth and development which resulted in increase of dry matter accumulation in the reproductive parts and formation of higher sink capacity with the application of micronutrients. These results are in conformity with findings of Elayaraja and Singaravel (2012), Abd-EL Kaderand Mona (2013), Kamalakannan (2017), Nakum *et al*. (2019) and Sabra *et al*. (2019). There was no significant influence on harvest index due to the application of micronutrients.

TABLE 2
EFFECT OF MICRONUTRIENT FERTILIZATION ON YIELD ATTRIBUTES AND YIELD OF GROUNDNUT

Treatments	No of pods plant^{-1}	Pod yield (kg ha^{-1})	Kernel yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest Index	Shelling (%)
T1: Control (RDF)	7.47	1769	1087	2455	41.89	61.23
T2: RDF+FYM @ 10 t ha^{-1}	12.93	2506	1864	3339	42.93	74.48
T3: RDF+ soil application of ZnSO4@ 16 kg ha^{-1} as a basal	11.27	2228	1614	3002	42.73	73.24
T4: RDF+ soil application of FeSO4@ 10 kg ha^{-1} as a basal	10.80	2216	1596	2975	42.72	72.42
T5: RDF+ soil application of Borax @ 10 kg ha^{-1} as a basal	11.67	2271	1642	3053	42.78	72.86
T6: RDF+ soil application of ZnSO4@ 16 kg ha^{-1} + FeSO4@ 10 kg ha^{-1}+ Borax @ 10 kg ha^{-1} as a basal	12.47	2393	1763	3191	42.90	73.40
T7: RDF+ foliar application of ZnSO4@ 0.2% at 30 and 60 DAS	9.67	2057	1423	2853	42.00	70.02
T8: RDF+ foliar application of FeSO4@ 0.5% at 30 and 60 DAS	9.47	1977	1357	2765	41.81	68.95
T9: RDF+ foliar application of Borax @ 0.25% at 30 and 60 DAS	9.87	2092	1484	2877	42.17	70.93
T10:RDF+ foliar application of ZnSO4@ 0.2% + FeSO4@ 0.5% + Borax @ 0.25% at 30 and 60 DAS	10.60	2190	1548	2973	42.72	71.43
SE m±	0.78	113.15	104.51	141.8	1.49	2.14
CD (P=0.05)	2.34	336.18	310.52	421.47	NS	6.36

3.2 Economics:

The data (Table 3) on cost of cultivation (Rs ha^{-1}), gross returns (Rs ha^{-1}), Net returns (Rs ha^{-1}) and benefit: cost (B:C) ratio was significantly influenced by sole and combined application of micronutrients through soil and foliar method. The highest gross returns (Rs 135548 ha^{-1}) realized with T2 (RDF + FYM @ 10 t ha^{-1}) and found significant over T1, T8, T7, T9 and T10. However, it was found on par with soil application of micronutrient treatments (T6, T5, T3 and T4). Whereas, significantly higher net returns (Rs 77229 ha^{-1})were registered with T6 over control (T1) and foliar application of each micronutrient (T2, T8 and T7) and it was found on par with the treatments T5, T3, T4, T10 and T9. The highest benefit cost ratio (3.52) was recorded significantly with combined soil application of micronutrients (T6) over other treatments and found on par with the treatments T5, T4, T3 and T10.This might be because of higher productivity and favorable response of groundnut to the RDF + Zn+ Fe + B. Similar results were reported by Rahevar *et al*. (2015) . Combination of RDF with FYM was proved less profitable because of higher cost involved in supplying larger quantities of manure to meet the nutrient requirement of crop compared to fertilizers. These results are in agreement with the findings of Sultana (2001) and Gowthami and Ananda (2019).

TABLE 3
ECONOMICS OF DIFFERENT TREATMENTS OF GROUNDNUT AS INFLUENCED BY MICRONUTRIENT FERTILIZATION

Treatments	Cost of cultivation (₹ ha^{-1})	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
T1: Control (RDF)	26570	95770	69200	2.60
T2: RDF+FYM @ 10 t ha^{-1}	58320	135548	77229	1.32
T3: RDF+ soil application of ZnSO4@ 16 kg ha^{-1} as a basal	27832	120511	92680	3.33
T4: RDF+ soil application of FeSO4@ 10 kg ha^{-1} as a basal	27440	119887	92447	3.37
T5: RDF+ soil application of Borax @ 10 kg ha^{-1} as a basal	27970	122848	94879	3.39
T6: RDF+ soil application of ZnSO4@ 16 kg ha^{-1} + FeSO4@ 10 kg ha^{-1}+ Borax @ 10 kg ha^{-1} as a basal	28602	129422	100820	3.52
T7: RDF+ foliar application of ZnSO4@ 0.2% at 30 and 60 DAS	29286	111377	82092	2.80
T8: RDF+ foliar application of FeSO4@ 0.5% at 30 and 60 DAS	29245	107069	77825	2.66
T9: RDF+ foliar application of Borax @ 0.25% at 30 and 60 DAS	29226	113248	84022	2.87
T10: RDF+ foliar application of ZnSO4@ 0.2% + FeSO4@ 0.5% + Borax @ 0.25% at 30 and 60 DAS	29617	118496	88879	3.00

IV. CONCLUSION

The application of RDF along with FYM @ 10 t ha^{-1} registered significantly higher growth parameters noted after harvest of groundnut, the combined soil and foliar application of micronutrients (T_6 andT_{10}) and individual soil application of micronutrients (T_5, $T_3$and T_4) were found statistically comparable. The highest gross returns was obtained with application of RDF along with 10 tonnes of FYM (T_2), whereas, the highest net returns and benefit cost ratio were obtained with the combined soil application of micronutrients (T_6).

Thus, it can be concluded that combined soil application of all micronutrients followed by individual micronutrient application alone found better than foliar application of each micronutrient alone. The highest net returns and benefit cost ratio were obtained with the combined soil application of all micronutrients. However, combined foliar application of all micronutrients proved on par with soil application of micronutrients.

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