The Pharma Innovation Journal 2021; 10(9): 312-315

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(9): 312-315

www.thepharmajournal.com
Received: 17-07-2021
Accepted: 24-08-2021

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# Growth, yield and economics of groundnut (*Arachis hypogaea* L.) as influenced by micronutrient fertilization on coastal sandy soils of Andhra Pradesh

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## Abstract
**Background:** Groundnut yields obtained by farmers in India are generally low due to imbalanced fertilization resulting in deficiency of micronutrients and affecting growth and yield of groundnut. In view of this the field experiment was carried out at Agricultural College Farm, Bapatla, Guntur, Andhra Pradesh during *rabi* season of 2020to assess the response of groundnut (*Arachis hypogaea* L.) to sole and combined application of micronutrient fertilizers (Zinc, Boron and Iron) through soil and foliar application.
**Methods:** Experiment was laid out in randomized block design with three replications and ten treatments comprised of control (Only RDF), RDF+FYM@ 10t $ha^{-1}$, and other treatment combinations consisting of soil and foliar application of each micronutrient (Zn/B/Fe) and combined application of micronutrients (Zinc+ Boron+ Iron) along with RDF.
**Results:** From the results it was observed that highest values in growth parameters *viz*., plant height(41.6cm), number of branches $plant^{-1}$ (8.43) and drymatter accumulation(5845 kg $ha^{-1}$), yield attributes 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 ($T_1$). However it was found on par with treatments applied with combination of micronutrient fertilizers through soil and foliar methods. It can be concluded that combined soil application of all micronutrients found better than foliar application of each micronutrient alone and recorded the highest net returns and benefit cost ratio.

**Keywords:** B:C ratio, farm yard manure, foliar application, leaf area index, micronutrients

## Introduction
Groundnut (*Arachis hypogaea* L.) is an important oilseed crop of tropical and sub-tropical countries, where it is cultivated for edible oil and vegetable protein. India ranks first in groundnut acreage and is the second largest producer in the world. In India 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). The productivity of groundnut in India is 1422 kg $ha^{-1}$which is low compared to global average productivity of 1680 kg $ha^{-1}$ (FAOSTAT, 2018-19) [3]. 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 (Prasad *et al.*, 2009) [9]. Groundnut performs better in terms of yield and quality when good cultivars are sown under optimum nutrient management coupled with organic and inorganic nutrient management. Indiscriminate use of chemical fertilizers for the supply of major nutrients and declining use of secondary nutrients and organic sources of inputs over time led to the deficiency of secondary and micronutrients. Particularly deficiency of boron, iron and zinc are emerging as one of the major constraints for sustainable production in rain-fed areas. Reports indicated that Zn, B and Fe deficiency causes remarkable losses in yields of groundnut (Singh *et al.*, 2004) [12]. 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. Hence, inclusion of micronutrient fertilizer in the fertilization programme becomes an imperative need to improve the yield of groundnut crop. To find better micronutrient management practice for coastal sandy soils, the present investigation was undertaken with an objective to find out the effect of individual and combined application of micronutrients *viz.* Zinc, Boron and Iron through soil and foliar methods on growth and yield of groundnut.

## Materials and Methods

Field experiment was conducted on Groundnut cv. Kadiri-6 at Agricultural College Farm, Bapatla, ANGRAU, Guntur (Andhra Pradesh), India during *rabi* season, 2020. The soil of the experimental site was sandy loam in texture with neutral pH (6.80) in soil reaction, Electrical conductivity is 0.26 dSm$^{-1}$, low in organic carbon (0.48%), available nitrogen (200.6 kg ha$^{-1}$), medium in phosphorus (25.64 kg ha$^{-1}$) and available potassium (210.45 kg ha$^{-1}$), low in zinc (0.5 ppm), iron (2.3 ppm) and boron (0.5 ppm). A total of ten treatments were tested in a randomized block design with three replications (Table 1).

Groundnut was sown @ 125 kg seed ha$^{-1}$ with rows 30 cm apart and 10 cm plant to plant spacing. The crop was fertilized with the recommended dose of fertilizer (RDF) 25 kg N ha$^{-1}$, 40 kg $P_2O_5$ ha$^{-1}$ and 50 kg $K_2O$ ha$^{-1}$ that were placed in furrows after sowing. The source for N, P and K were given in the form of Urea, DAP and MOP respectively. Sulphur was applied in the form of gypsum which was applied to all the plots uniformly at the flowering stage. Well decomposed farm yard manure was applied to the respective plot @ 10 t ha$^{-1}$. Soil application of Zinc as $ZnSO_4$ @ 16 kgha$^{-1}$, iron as $FeSO_4$ @ 10 kgha$^{-1}$ and boron as borax @ 10 kg ha$^{-1}$ were applied to the respective plots as per the treatments at the time of sowing. Foliar application of $ZnSO_4$ @ 0.2%, $FeSO_4$ @ 0.5% and borax @ 0.25% at 30 and 60 DAS were applied as per the treatments.

Statistical analysis for the data recorded was done by following the analysis of variance technique for randomized block design as suggested by Gomez and Gomez (1984) [4]. Statistical significance was tested by applying F-test at 0.05 level of probability and critical differences were calculated for those parameters which turned to the significant ($P$< 0.05) in order to compare the effects of different treatments.

**Table 1:** Micronutrient fertilization treatments applied to groundnut

| | |
|---|---|
| $T_1$ | Control |
| $T_2$ | FYM @ 10 t ha$^{-1}$ |
| $T_3$ | Soil application of Zinc sulphate ($ZnSO_4$) @ 16 kg ha$^{-1}$ as a basal |
| $T_4$ | Soil application of Ferrous sulphate ($FeSO_4$) @ 10 kg ha$^{-1}$as a basal |
| $T_5$ | Soil application of Borax @ 10 kg ha$^{-1}$ as a basal |
| $T_6$ | Soil application of $ZnSO_4$ @ 16 kg ha$^{-1}$ + $FeSO_4$ @ 10 kg ha$^{-1}$ + Borax @ 10 kg ha$^{-1}$ as a basal |
| $T_7$ | Foliar application of $ZnSO_4$ @ 0.2% at 30 DAS and 60 DAS |
| $T_8$ | Foliar application of $FeSO_4$ @ 0.5% at 30 and 60 DAS |
| $T_9$ | Foliar application of Borax @ 0.25% at 30 and 60 DAS |
| $T_{10}$ | Foliar application of $ZnSO_4$ @ 0.2% +$FeSO_4$ @ 0.5% + Borax @ 0.25% at 30 and 60 DAS |

*RDF (25 N: 40 $P_2O_5$: 50 $K_2O$) kg ha$^{-1}$ and Gypsum @ 500 kg ha$^{-1}$ is applied to all treatments.

## Results and Discussion

### Growth parameters

Groundnut growth parameters *viz*., plant height (cm), number of branches plant$^{-1}$, drymatter accumulation at harvest, number of nodules plant$^{-1}$ and leaf area index (LAI) at 60 DAS were significantly influenced by different micronutrient treatments (Table 2). Application of RDF along with FYM @ 10 t ha$^{-1}$ ($T_2$) recorded significantly taller plants (41.6 cm), more number of branches plant$^{-1}$ (8.43), highest drymatter accumulation (5825 kg ha$^{-1}$) at harvest, more number of nodules plant$^{-1}$ (98.27) and highest LAI (3.46) at 60DAS compared to control ($T_1$) and foliar application of each micronutrient alone ($T_8$, $T_7$ and $T_9$). However it was found on par with the treatments $T_6$, $T_{10}$, $T_5$, $T_3$ and $T_4$. The highest growth with application of FYM @ 10 t ha$^{-1}$ along with RDF might be due to increased availability and uptake of macro and micronutrients and improving of soil conditions for water and nutrient supply required for better plant growth and dry matter accumulation. Among soil and foliar application of micronutrients, the combined application of $ZnSO_4$ + $FeSO_4$ + Borax either as soil or foliar application methods along with recommended dose of fertilizer (RDF) recorded highest values in growth parameters. Soil application of each micronutrient alone recorded maximum growth than when they were applied individually through foliar application. It might be due to availability of macro and micronutrients required for plant growth resulting in production of more number of leaves, branches, nodules and larger leaf area with the supply of all the micronutrients (Zinc, Boron and Iron). These results are in conformity with findings of Sultana (2001) [13], Elayaraja and Singaravel (2012) [2] and Sabra *et al*. (2019) [11].

### Yield and Yield attributes

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 3.

Among the treatments tested, $T_2$ (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 $T_1$, $T_8$, $T_7$ and $T_9$. However, it remained on par with treatments received with soil application of sole and combined application of micronutrients ($T_6$, $T_5$, $T_3$ and $T_4$) and combined foliar application ($T_{10}$). Whereas, the treatment $T_2$ (RDF + FYM @ 10 t ha$^{-1}$) recorded significantly the highest shelling percentage (74.48%) and found on par with all the remaining treatments except $T_1$ (control). The maximum kernel yield (1864 kg ha$^{-1}$) was recorded with $T_2$ (RDF + FYM @ 10 t ha$^{-1}$) treatment, and proved its superiority over treatments ($T_1$, $T_8$, $T_7$, $T_9$ and $T_{10}$). However, it was found on par with soil application of micronutrient treatments ($T_6$, $T_5$, $T_3$ and $T_4$). 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) [2], Abd-EL Kaderand Mona (2013) [1], Kamalakannan (2017) [7], Nakum *et al*. (2019) [8] and Sabra *et al*. (2019) [11]. There was no significant influence on harvest index due to the application of micronutrients.

## Economics

The data (Table 4) 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 $T_2$ (RDF + FYM @ 10 t $ha^{-1}$) and found significant over $T_1$, $T_8$, $T_7$, $T_9$ and $T_{10}$. However, it was found on par with soil application of micronutrient treatments ($T_6$, $T_5$, $T_3$ and $T_4$). Whereas, significantly higher net returns (Rs 77229 $ha^{-1}$)were registered with $T_6$ over control ($T_1$) and foliar application of each micronutrient ($T_2$, $T_8$ and $T_7$) and it was found on par with the treatments $T_5$, $T_3$, $T_4$, $T_{10}$ and $T_9$. The highest benefit cost ratio (3.52) was recorded significantly with combined soil application of micronutrients ($T_6$) over other treatments and found on par with the treatments $T_5$, $T_4$, $T_3$ and $T_{10}$.This might be because of higher productivity and favourable response of groundnut to the RDF + Zn+ Fe + B. Similar results were reported by Rahevar *et al.* (2015) [10]. 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) [13] and Gowthami and Ananda (2019) [5].

**Table 2:** Effect of micronutrient fertilization on growth parameters of groundnut

| Treatments | Plant height (cm) at harvest | No. of branches plant$^{-1}$ at harvest | Leaf area index (LAI) at 60 DAS | No of Nodules plant$^{-1}$ at 60 DAS | Drymatter accumulation (kg $ha^{-1}$) at harvest |
|---|---|---|---|---|---|
| $T_1$: Control (RDF) | 27.9 | 5.13 | 2.16 | 61.63 | 4224 |
| $T_2$: RDF+FYM @ 10 t $ha^{-1}$ | 41.6 | 8.43 | 3.46 | 98.27 | 5845 |
| $T_3$: RDF+ soil application of $ZnSO_4$@ 16 kg $ha^{-1}$ as a basal | 37.6 | 7.40 | 3.02 | 89.17 | 5229 |
| $T_4$: RDF+ soil application of $FeSO_4$@ 10 kg $ha^{-1}$ as a basal | 37.1 | 7.30 | 2.95 | 88.00 | 5191 |
| $T_5$: RDF+ soil application of Borax @ 10 kg $ha^{-1}$ as a basal | 38.4 | 7.77 | 3.13 | 91.87 | 5324 |
| $T_6$: RDF+ soil application of $ZnSO_4$@ 16 kg $ha^{-1}$ + $FeSO_4$@ 10 kg $ha^{-1}$+ Borax @ 10 kg $ha^{-1}$ as a basal | 40.0 | 8.33 | 3.23 | 94.27 | 5584 |
| $T_7$: RDF+ foliar application of $ZnSO_4$@ 0.2% at 30 and 60 DAS | 34.2 | 6.03 | 2.38 | 75.00 | 4910 |
| $T_8$: RDF+ foliar application of $FeSO_4$@ 0.5% at 30 and 60 DAS | 33.8 | 5.80 | 2.32 | 70.27 | 4742 |
| $T_9$: RDF+ foliar application of Borax @ 0.25% at 30 and 60 DAS | 34.7 | 6.40 | 2.43 | 77.13 | 4969 |
| $T_{10}$:RDF+ foliar application of $ZnSO_4$@ 0.2% +$FeSO_4$@ 0.5% + Borax @ 0.25% at 30 and 60 DAS | 39.0 | 8.27 | 2.94 | 87.27 | 5163 |
| SE m± | 2.15 | 0.38 | 0.17 | 4.08 | 252.72 |
| CD (P=0.05) | 6.41 | 1.14 | 0.52 | 12.12 | 750.88 |

**Table 3:** 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 (%) |
|---|---|---|---|---|---|---|
| $T_1$: Control (RDF) | 7.47 | 1769 | 1087 | 2455 | 41.89 | 61.23 |
| $T_2$: RDF+FYM @ 10 t $ha^{-1}$ | 12.93 | 2506 | 1864 | 3339 | 42.93 | 74.48 |
| $T_3$: RDF+ soil application of $ZnSO_4$@ 16 kg $ha^{-1}$ as a basal | 11.27 | 2228 | 1614 | 3002 | 42.73 | 73.24 |
| $T_4$: RDF+ soil application of $FeSO_4$@ 10 kg $ha^{-1}$ as a basal | 10.80 | 2216 | 1596 | 2975 | 42.72 | 72.42 |
| $T_5$: RDF+ soil application of Borax @ 10 kg $ha^{-1}$ as a basal | 11.67 | 2271 | 1642 | 3053 | 42.78 | 72.86 |
| $T_6$: RDF+ soil application of $ZnSO_4$@ 16 kg $ha^{-1}$ + $FeSO_4$@ 10 kg $ha^{-1}$+ Borax @ 10 kg $ha^{-1}$ as a basal | 12.47 | 2393 | 1763 | 3191 | 42.90 | 73.40 |
| $T_7$: RDF+ foliar application of $ZnSO_4$@ 0.2% at 30 and 60 DAS | 9.67 | 2057 | 1423 | 2853 | 42.00 | 70.02 |
| $T_8$: RDF+ foliar application of $FeSO_4$@ 0.5% at 30 and 60 DAS | 9.47 | 1977 | 1357 | 2765 | 41.81 | 68.95 |
| $T_9$: RDF+ foliar application of Borax @ 0.25% at 30 and 60 DAS | 9.87 | 2092 | 1484 | 2877 | 42.17 | 70.93 |
| $T_{10}$:RDF+ foliar application of $ZnSO_4$@ 0.2% + $FeSO_4$@ 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 |

**Table 4:** 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 |
|---|---|---|---|---|
| $T_1$: Control (RDF) | 26570 | 95770 | 69200 | 2.60 |
| $T_2$: RDF+FYM @ 10 t $ha^{-1}$ | 58320 | 135548 | 77229 | 1.32 |
| $T_3$: RDF+ soil application of $ZnSO_4$@ 16 kg $ha^{-1}$ as a basal | 27832 | 120511 | 92680 | 3.33 |
| $T_4$: RDF+ soil application of $FeSO_4$@ 10 kg $ha^{-1}$ as a basal | 27440 | 119887 | 92447 | 3.37 |
| $T_5$: RDF+ soil application of Borax @ 10 kg $ha^{-1}$ as a basal | 27970 | 122848 | 94879 | 3.39 |
| $T_6$: RDF+ soil application of $ZnSO_4$@ 16 kg $ha^{-1}$ + $FeSO_4$@ 10 kg $ha^{-1}$+ Borax @ 10 kg $ha^{-1}$ as a basal | 28602 | 129422 | 100820 | 3.52 |
| $T_7$: RDF+ foliar application of $ZnSO_4$@ 0.2% at 30 and 60 DAS | 29286 | 111377 | 82092 | 2.80 |
| $T_8$: RDF+ foliar application of $FeSO_4$@ 0.5% at 30 and 60 DAS | 29245 | 107069 | 77825 | 2.66 |
| $T_9$: RDF+ foliar application of Borax @ 0.25% at 30 and 60 DAS | 29226 | 113248 | 84022 | 2.87 |
| $T_{10}$: RDF+ foliar application of $ZnSO_4$@ 0.2% + $FeSO_4$@ 0.5% + Borax @ 0.25% at 30 and 60 DAS | 29617 | 118496 | 88879 | 3.00 |
| SE m± | | 5617.26 | 5617.26 | 0.19 |
| CD (P=0.05) | | 16689.7 | 16689.7 | 0.57 |

## Conclusion

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.

## Acknowledgement

The corresponding author is thankful to Acharya N. G. Ranga Agricultural University (ANGRAU) for financial support.

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