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Impact of Bio-fertilizers and Micro-nutrients on yield and yield contributing characters of Groundnut (*Arachis hypogia* L.)

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ABSTRACT: *A field experiment was conducted during the summer season of 2013 in Junagadh Agricultural University, Junagadh, to evaluate the effect of micro-nutrients and bio-fertilizers on morpho-physiological parameters of summer groundnut (*Arachis hypogaea *L.) variety GJG-31. The yield and yield attributing charecters i.e., pods plant^{-1}, shelling per cent (%), 100-kernel weight, pod yield (Kg ha^{-1}), haulm yield (Kg ha^{-1}), oil content (%) and harvest index were recorded maximum at harvest under the combined application of RDF + Mo + Zn +* Rhizobium+ *PSB (T_{10}). Significantly the lowest values of these yield attributing characters were observed in control.*

INTRODUCTION

Groundnut (*Arachis hypogaea L.*) is an important oil seeds, as well as food crop ranking 13th among the principal economic crops of the world. Among the oilseed crop grown in India, groundnut occupies pre dominant position Therefore, the groundnut is rightly called as "king of oilseeds" in India. Groundnut is one of the most nutritious foods because of its high protein and oil contents.The major reason for low yield of groundnut is mainly mineral deficiency. Among the micronutrients, the deficiency of zinc has been identified in all the groundnut growing states and, that of Mo has been found in Gujarat, Madhya Pradesh and NE states. The yield losses of 15-20% and 13-19% in groundnut due to Zn and Mo deficiency have been reported by Singh **[9]**. The molybdenum plays key role to catalase nitrate reduction and its fixation in legumes. It also increases the dry matter production along with improving nodulation in groundnut. The zinc is involved in many enzyme systems and carbonic anhydrate is a very specific.

Use of bio-fertilizers in integrated nutrient management is important for optimization of plant nutrition. The black calcareous soils are, even though, high in P content but plants face P deficiency due to low amount of available P. Therefore, to solublize and mobilize mineral bound P, use of Phosphorus solubilizing bacteria (PSB) can be helpful. 'Plants require all essential nutrients in balance proportion and deviation from this may results in mineral disorders. We conducted this study with the objectives of evaluating the effect of Zn, Mo, Rhizobium and PSB on morpho-physiological parameters and productivity of summer groundnut (*Arachis hypogaea* L.).

MATERIALS AND METHODS

A field experiment was conducted at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh during summer season of 2013. There were eleven treatment combinations consisting of Control, Recommended dose of fertilizers (RDF), RDF + Zn, RDF + Mo, RDF + PSB (Bacillus megaterium), RDF + Rhizobium (NC 92), RDF + Zn+ PSB, RDF + Zn + Rhizobium, RDF + Mo + PSB, RDF + Mo + Rhizobium, RDF + Mo + Zn + Rhizobium+ PSB. Experiment was laid out in randomized block design with three replications.

Dry sowing of groundnut variety GJG 31 was done on raise bed with plastic mulching using seed rate of 5 kg/ha and maintaining spacing of 20 cm between rows and plants. The recommended dose of fertilizer was 25 kg Nha-1 and 50 kg P2O5 ha-1. N

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and P2O5 were applied using urea and single super phosphate, respectively. Plants were harvested after attaining physiological maturity. The data collected from the experiment were subjected to statistical test by following 'Analysis of variance technique' as suggested by Panse and Sukhatme **[7]**.

RESULT AND DISCUSSION

Number of Pods Per Plant

The maximum number of pods/plantis recorded in treatment T_{10} (RDF + Mo + Zn + *Rhizobium*+ PSB). It may be due to more number of leaves and shoots plant^{-1} which enable the plant to produce and sink more photosynthates/carbohydrates to the lower parts of palnts and thus more number of pods plant^{-1} were produced **[5]**. Higher number of pods plant^{-1} in the inoculated plants may be due to increased activity of microbes which enhances de-novo synthesis for pod development **[10]**. Micro-nutrients like zinc also responsible for high chlorophyll content and molybdenum for nitrogen fixation which was finally inturn in greater sink size and increased amount of photosynthates **[11]**. These composite effects were lead to higher number of pods and the better source-sink relationship.

Shelling per cent (%)

The Highest shelling percent is recorded in the treatment T_{10} (RDF + Mo + Zn + *Rhizobium*+ PSB). Gayatri *et al.* **[3]** repoted that the integrated application of PSB, *Rhizobium* and FYM increases significantly increased the shelling per cent. The possible reason for increase in shelling is the better photo-assimilation power and synthesis of photo-assimilates. Groundnut is mainly protein containing oil seed crop having higher amount of protein and oil in its seeds which was enhanced by the application of Zn (sulphure containing: for oil) and Mo (N assimilation, further for proteins synthesis) that in turn gives higher seed weight in comparison to shell. Higher test weight also support the increase in shelling per cent **[12]**.

100 Kernel Weight (g)

The maximum test weight is recorded in combined application of biofertilizer and micronutrients(T_{10}). It may be due to the applications of Zn and Mo along with biofertilizers lead to increase in the reserved material (photosynthates) and due to decreased supply limitation (Sara *et al.*, 2013). Their composite effects on source sink relation resulted in more transmission of propagated material towards the kerne **[4]**.

Pod Yield (Kg ha^{-1})

The pod yield was recorded highest in the treatment which comprises the combine application of biofertilizers and micronutrients (T_{10}). The beneficial effects of *Rhizobium* have increased the availability of nitrogen which in turn resulted into higher production of assimilates (proteins, lipids and carbohydrates) as well as their balanced partioning between source (vegetative part - haulm) and sink (reproductive part - pod) and ultimately increased the pod yield as well as haulm yield **[1]**. Maximum yield in inoculated plants may be attributed to the symbiotic relationship of *Rhizobium* (bacteria) with the roots of leguminous crops, which fix the atmospheric nitrogen into the roots of groundnut and thus the yield was increased.

Increase in yield of groundnut might be due to the fact that micro-nutrients exerted a beneficial effect on chlorophyll content in the leaves and so it indirectly increases the production of photosynthates **[8]**. Micronutrient enhanced photosynthesis, production of photosynthates and their partitioning between vegetative and reproductive structures which might have helped in improving the yield attributes (number of pods per plant, number of kernels per pod, seed index, shelling per cent) and finally the pod as well as haulm yield (Nadia, 2012).

Haulm Yield (kg ha^{-1})

Highest haulm yield recorded in treatment T_{10} (RDF + Mo + Zn + *Rhizobium*+ PSB). This was result due to micronutrient enhanced photosynthesis, production of photosynthates and their partitioning between vegetative and reproductive structures which might have helped in improving the biological yield and finally the pod as well as haulm yield. The beneficial effects of *Rhizobium* as explained earlier might have increased the availability of nitrogen which in turn resulted into higher production of assimilates (proteins, lipids and carbohydrates) as well as their balanced partioning between source (vegetative part - haulm) and sink (reproductive part - pod) and ultimately increased the pod yield as well as haulm yield **[3]** .

Oil Content (%)

The maximum oil content recorded in the treatment which comprises the combined application of biofertilizers and micronutrients (T_{10}). The application

Table 1
Effect of bio-fertilizers and micro-nutrients on pod yield, oil content, haulm yield, pod per plant, shelling(%), test weight and harvest index of groundnut at harvest.

S. No	Treatments	Pod plant^{-1}	Shelling (%)	Test weight (g)	Pod Yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Oil content (%)	Harvest index
T_0	Control	13.44	63.7	31.21	2183.81	4374.09	43.96	31.67
T_1	RDF	15.44	65.0	35.52	2256.38	4620.97	46.93	32.21
T_2	RDF + $ZnSO_4$	15.00	66.0	33.92	2535.24	4932.22	47.25	32.87
T_3	RDF + Mo	15.94	66.7	34.52	2269.52	4437.75	44.86	32.31
T_4	RDF + PSB	16.63	69.0	38.11	2649.51	5140.79	48.10	33.92
T_5	RDF + *Rhizobium*	18.13	65.0	38.88	2890.48	5326.26	48.19	36.10
T_6	RDF + Zn+ PSB	16.20	64.3	33.71	2337.16	4815.89	47.51	32.94
T_7	RDF + Zn + *Rhizobium*	15.63	66.7	34.05	2273.65	4954.16	46.70	34.06
T_8	RDF + Mo + PSB	13.88	68.0	38.01	2438.10	4968.09	44.63	33.08
T_9	RDF + Mo + *Rhizobium*	13.81	68.0	38.19	2300.32	4446.16	47.16	34.43
T_{10}	RDF + Mo + Zn + *Rhizobium*+ PSB	18.31	69.3	41.34	3144.44	5485.19	48.28	36.44
	S.Em±	0.81	1.21	1.78	192.05	478.23	0.90	0.93
	C.D. at 5%	2.41	3.58	5.26	566.53	1410.76	2.66	2.75
	C.V.%	9.08	3.16	8.54	13.49	17.03	3.35	4.80

of *Rhizobium* increases the oil per cent due to the fact that higher N absorption had enhanced more Acetyl Co-A formation, which was directly related with oil formation **[1]**. Application of *Rhizobium* and phosphorus solubilizing bacteria gave higher oil content and oil yield of groundnut **[4]**. Through there was no direct role of N, P in oil content of groundnut their indirect role in synthesis of essential metabolites were responsible for increased oil content and oil yield. Increase in oil content by zinc sulphate application might be attributed to involvement of sulphur in the biosynthesis of oil. Sulphur is involved in the formation of glucosides and glucosinolates and sulphydril-linkage and activation of enzymes, which aid in bio-chemical reaction within the plant.

Harvest Index

Maximum harvest index was recorded in the treatment T_{10} (RDF + Mo + Zn + *Rhizobium*+ PSB). It may be due to the transmission scale of photosynthetic materials from the photosynthetic levels to grain. The application of *Rhizobium* and phosophate solubilizing bacteria increases the nitrogen fixation and available phosphate to plants which leads to higher photosynthesis. It is evident that the treatments that have a greater harvest index have more protein, lipid and carbohydrate transmission from green parts of the plant to the grain. Zinc applications had positive effect on plant growth leading to increased LAI, plant height, number of leaves, biological and straw yields and 1000 grain weight culminating in improved grain yield. The apparent mechanism for achieving these improvements was the increase in leaf area index, providing an improved resource generating base for the crop i.e. an improved carbohydrate source. The consequence of this improved source was the improvement in overall biomass and consequently improvements in yield components of the crop. The increase in the harvest index by molybdenum and seed inoculation was may be largely owing to the boost in seed yield **[8]**.

CONCLUSION

The performance of groundnut crop in respect to application of biofertilizers and micro-nutrients in well irrigated conditions may improve most of all parameters regarding yield and yield attributing characters. Therefore, biofertilizers such as *Rhizobium* (NC 92) and phosphorus solubilizing bacterium (*Bacillus megaterium*) and micro-nutrients such as zinc ($ZnSO_4$) and molybdenum ($(NH_4)_6Mo_7O_{24}$) may be boon for groundnut growers.

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