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Basavaraj Baraker
IGKV, Raipur, Chhattisgarh, India

SK Jha
Scientist IGKV, Raipur, Chhattisgarh, India

SP Wani
Director IDC, ICRISAT, Hyderabad, Telangana, India

Kaushal K Garg
Sr. Scientist-NRM ICRISAT, Hyderabad, Telangana, India

Correspondence
Basavaraj Baraker
IGKV, Raipur, Chhattisgarh, India

Effect of balanced fertilizer management practices on factor of productivity on Groundnut (*Arachis hypogaea* L.) cultivation

Basavaraj Baraker, SK Jha, SP Wani and Kaushal K Garg

Abstract
An experiment was carried out during *Kharif* season of 2016 at Hiregundgal District: Tumkur (Karnataka) at five location under the project of Bhoo Samruddhi collaboration between KSDA (Karnataka State Department of Agriculture) and ICRISAT (International Crop Research Institute for Semi-Arid Tropics Agriculture). To study the "Effect of improved management practices on factor of productivity on Groundnut (*Arachis hypogaea* L.) Cultivation". Application of recommended dose of fertilizer (25:50:25 NPK+ Gypsum @ 500kg ha^{-1} at 30 DAS) along with micro nutrient ($ZnSO_4$@ 25 kg ha^{-1} & Borax @ 10 kg ha^{-1} at basal application) gave higher growth characters *viz.*, plant height, leaf area plant^{-1}, total dry matter plant^{-1}, leaf area index, crop growth rate, relative growth rate, and yield attributes & yield *viz.*, number of pods plant^{-1} (37.02), weight of pods plant^{-1} (32.70 g), pod yield(1633.95 kg ha^{-1}), haulm yield (2059.89 kg ha^{-1}) of groundnut crop. Whereas, lower growth characters, yield attributes & yield were observed in only recommended dose of fertilizer (25:50:25 NPK+ Gypsum @ 500kg ha^{-1} at 30 DAS).

Keywords: recommended dose of fertilizer, micro nutrients, groundnut

Introduction
Groundnut (*Arachis hypogaea* L.) is an annual legume native to South America. It is one of the principal oilseed crop of tropical and sub-tropical regions of the world belongs to the family Leguminoceae. It is commonly called as poor man's almond, wonder nut and is also called as king of oilseeds. It is the world's fourth most important source of edible oil and third most important source of vegetable protein.

Groundnut seed contain about 50% edible oil. The remaining 50% of the seed has high quality protein (21.4 to 36.4%), carbohydrates (6.0 to 24.9%), minerals and vitamins. This contains 20%, saturated and 80% unsaturated fatty acids. Poly saturated fatty acids has 2 types *i.e.* oleic (40-50%) and linoleic (24-35%). It is also fairly rich in calcium, iron and vitamin B complex like thiamine, riboflavin, niacin and vitamin A.

India's resounding success from its past green revolution has been followed by stagnating or declining agricultural productivity, even with increased total fertilizer use in the country over the years. This declining factor productivity is largely due to imbalanced fertilizer use. Fertilizers application is highly skewed in favor of N, with relatively small use of K and P application, and rare use of secondary and micronutrients. Current generalized fertilizer recommendations are also sub-optimal and need upward refinement. So this concept of soil test based balanced nutrient application helps in getting good crop yields.

Material Method
A field experiment (in farmer's field) at five location represented in Table no. 1. It was laid out in factorial randomized block design (FRBD) with control in five replications comprising eight treatment combination. Treatment combination consisting of three factor at two levels *viz.*, recommended dose of fertilizer(25:50:25 NPK+ Gypsum @ 500 kg ha^{-1}) and recommended dose of fertilizer(25:50:25 NPK+ Gypsum @ 500 kg ha^{-1}) + Micro nutrient (ZnSO4@ 25 kg ha^{-1}& Borax @ 10 kg ha^{-1}) s in first factor, broad bed & furrow and flat bed in second factor and third factor consisting of variety ICGV 91114 and K 6. Farmer's practice as control treatment.

Table 1: Name of farmers and GPS location of experimental plots.

Sl. No.	Farmer's name	GPS location of the fields
1	Veerabhadrayya	13 ^{0}43' 51" N, 77 ^{0}13' 21'' E
2	Laxmipathy	13 ^{0}43' 59" N, 77 ^{0}13' 22'' E
3	Gurumoorthy	13 ^{0}43' 34" N, 77 ^{0}13' 19'' E
4	Bhimanna	13 ^{0}43' 48" N, 77 ^{0}13' 17'' E
5	Narasimraju	13 ^{0}43' 38" N, 77 ^{0}13' 38'' E

For observation following methods were adopted:

Plant height

Plant height was measured from ground level to the top of main shoot of randomly selected five observational plants in each treatment at 30, 60, 90 DAS and at harvest. Average value for each treatment at each stage was computed and recorded. The average value was then computed.

Leaf area plant^{-1}

The leaf was measured by leaf area meter. Three plants were sampled from second row of each treatment randomly selected plants in each treatment at 30, 60 and 90 DAS. The average value was then computed and the value is expressed in cm^2.

Total dry matter plant^{-1}

Three plants were sampled from second row of each treatment at30, 60and 90 DAS and at harvest. The plants (excluding roots) were then dried in the oven at 65± 5 ^{0}C till the constant weight. The average value of dry matter per plant (g) was recorded.

Leaf area index

The leaf area per plant at 30, 60and90 DAS was worked out by leaf area meter from three plants selected at random in each plot and expressed as leaf area per plant. Later leaf area index was calculated by using the following formula given by Sestak *et al.* (1971) [4].

$$LAI = \frac{\text{Leaf area per plant (cm}^2\text{)}}{\text{Land area occupied by plant (cm}^2\text{)}}$$

3.7.1.6 Crop growth rate

The values for CGR were calculated for the stage between 0-30, 30-60 and 60-90 DAS with the help of the following formula (Cheema *et al.,* 1991) [1].

$$CGR(g\ day^{-1}\ plant^{-1}) = \frac{W_2 - W_1}{t_2 - t_1}$$

Where;

W_1 and W_2 = Weight of dry matter of plant (g plant^{-1}) at first and second stages

t_1 and t_2 = Time in days of first and second stages

3.7.1.7 Relative growth rate (RGR)

The values of RGR were calculated for the stage between 0-30, 30-60 and 60-90 DAS with the help of the following formula (Cheema *et al.,* 1991) [1].

$$RGR(g\ g^{-1}\ day^{-1} plant^{-1}) = \frac{\text{Log}_e W_2 - \text{Log}_e W_1}{t_2 - t_1}$$

Where;

Log_e = Natural logarithm (base e)

W_1 and W_2 = Weight of dry matter of plant (g) at first and second stage

T1 and t_2 = Time in days of first and second stages

Yield attributes & yield

Number of pods plant^{-1}

Total number of matured pods from the five randomly selected observational plants counted from each plot and their average values were computed and recorded.

Pod weight (g plant^{-1})

Five observational plants randomly selected from net plot were harvested and allowed to sundry for six days. All the matured pods were stripped, weighed and average weight of pods per plant was recorded for each plot.

Pod yield (kg ha^{-1})

The produce of each treatment was collected separately including the yield of five observational plants. The pod yield was dried in sun for 6 days. The dried pod yield was recorded. The pod yield per treatment was then converted into kilogram per hectare.

Haulm yield (kg ha^{-1})

The plants after stripped off pods from each treatment including five observational plants kept for sun drying in the same plot. After complete drying, haulm was weighed and subsequently the values were converted into kilograms on hectare basis.

Results and Discussion

Plant height

The plant height was significantly influenced due to nutrients at all days of observations except 30 DAS observation. It was significantly higher in the recommended dose of fertilizer along with micro nutrient treatment at 60 DAS (18.81 cm), 90 DAS (27.66 cm) and at harvest (28.25 cm). Whereas, lowest plant height was recorded in only recommended dose of fertilizer treatment at all growth stages except 30 DAS. The plant height higher in the case of the recommended dose of fertilizer along with micro nutrient treatment might be due to micro nutrient like zinc which will enhances the growth hormone.

Leaf area plant^{-1} (cm^2)

The leaf area per plant was significantly influenced due to nutrients at 90 DAS and harvest. It was significantly higher in the recommended dose of fertilizer along with micro nutrient treatment at 60 DAS (1160.67 cm^2) and 90 DAS (2432.63 cm^2). Whereas, the lowest leaf area per plant was recorded in recommended dose of fertilizer treatment at 60 DAS and 90 DAS. The higher leaf area per plant in the recommended dose of fertilizer along with micro nutrient treatment is might be due to involvement of zinc in various enzyme systems, adequate supply of zinc might have promoted cell division and enlargement, which ultimately resulted in higher leaf area.

Total dry matter (g plant^{-1})

The total dry matter per plant was not significantly influenced due to nutrients at 30 DAS but significantly differed at 60 and

90 DAS observation of experiment. It was significantly higher in the recommended dose of fertilizer along with micro nutrient (ZnSO4 @ 25 kg ha^{-1}& Borax @ 10 kg ha^{-1}) treatment at 60 DAS (12.32 g plant^{-1}) and 90 DAS (36.70 g plant^{-1}). Whereas, the lowest total dry matter per plant was recorded in only recommended dose of fertilizer treatment at both 60 and 90 DAS except 30 DAS. The recommended dose of fertilizer along with micro nutrient treatment found higher values because groundnut respond very well to zinc, which will enhance the nitrogen assimilation and carbohydrate metabolism.

Leaf area index

There was no significant difference observed at 30 DAS but at 60 and 90 DAS significant difference was observed in leaf area index of groundnut. It was significantly higher in the recommended dose of fertilizer along with micro nutrient treatment at 60 DAS (3.87) and 90 DAS (8.11). Whereas, the lowest leaf area index was recorded in only recommended dose of fertilizer treatment at both 60 and 90 DAS except 30 DAS.

Crop growth rate (g day^{-1} plant^{-1})

There was no significant difference observed at 0-30 and 60-90 DAS but at 30-60 DAS significant difference was observed in crop growth rate of groundnut. It was significantly higher in the recommended dose of fertilizer along with micro nutrient treatment at 30-60 DAS (0.293 g day^{-1} plant^{-1}). Whereas, the lowest crop growth rate (0.258 g day^{-1} plant^{-1}) was recorded in only recommended dose of fertilizer treatment at both 30-60 DAS. Increased dry matter production under recommended dose of fertilizer along with micro nutrient treatment evidently resulted in higher crop growth rate.

Relative growth rate (g g^{-1} day^{-1})

There was significant difference observed in relative growth rate of groundnut at 30-60 DAS but not at 0-30 and 60-90 DAS. It was significantly higher in the micro nutrient treatment at 30-60 DAS was (0.0313 g g^{-1} day^{-1} plant^{-1}). Whereas, the lowest relative growth rate at 30-60 DAS (0.0295 g g^{-1} day^{-1} plant^{-1}) was recorded in only recommended dose of fertilizer treatment.

Number of pods plant^{-1}

There were significantly maximal number of pods per plant in the recommended dose of fertilizer along with micro nutrient ($ZnSO_4$ @ 25 kg ha^{-1}& Borax @ 10 kg ha^{-1}) treatment (37.02). Though, the minimal number of pods per plant were recorded in only recommended dose of fertilizer treatment (33.76).

Weight of pods plant^{-1} (g)

There was significantly supreme weight of pods per plant in the recommended dose of fertilizer along with micro nutrient treatment (32.70 g). Though, the minimal weight of pods per plant was recorded in only recommended dose of fertilizer treatment (28.37 g).

Pod yield (kg ha^{-1})

There was significantly greater pod yield in the recommended dose of fertilizer along with micro nutrient treatment (1633.95 kg ha^{-1}). Though, the lowest pod yield was recorded in only recommended dose of fertilizer treatment (1394.04 kg ha^{-1}). There was about 14.68% superior pod yield was observed in recommended dose of fertilizer along with micro nutrient treatment ($ZnSO_4$ @ 25 kg ha^{-1}& Borax @ 10 kg ha^{-1}) over only recommended dose of fertilizer treatment. Growth and yield attributes regarding recommended dose of fertilizer along with micro nutrient treatment were superior so the pod yield was higher than the recommended dose of fertilizer. Ganesh *et al.* (2015) [2] reported pod yield maximum under the combined application of RDF + Mo + Zn + Rhizobium + PSB. According to Narh and Naab (2015) [3] the P K + gypsum +Zn treatment had the highest pod yield. Sharma *et al.* (2011) [2] revealed that application of 100% N P K S Zn significantly enhanced the pod and haulm yields of groundnut by 25.9 and 22.4 per cent over 100% N P K, respectively.

Haulm yield (kg ha^{-1})

There was significantly greater haulm yield (2059.89 kg ha^{-1}) was recorded in recommended dose of fertilizer along with micro nutrient ($ZnSO_4$ @ 25 kg ha^{-1}& Borax @ 10 kg ha^{-1}). However, the comparatively less haulm yield was recorded in only recommended dose of fertilizer treatment (1766.73 kg ha^{-1}). There was about 14.23% superior haulm yield was observed in recommended dose of fertilizer along with micro nutrient treatment over only recommended dose of fertilizer treatment. Ganesh *et al.* (2015) [2] found maximum haulm yield (kg ha^{-1}) under the combined application of RDF +Mo +Zn +Rhizobium +PSB.

Summary and Conclusion

Application of recommended dose of fertilizer (25:50:25 NPK+ Gypsum @ 500kg ha^{-1} at 30 DAS) along with micro nutrient ($ZnSO_4$ @ 25 kg ha^{-1} & Borax @ 10 kg ha^{-1} at basal application) gave higher growth characters *viz.*, plant height, leaf area plant^{-1}, total dry matter plant^{-1}, leaf area index, crop growth rate, relative growth rate, and yield attributes & yield *viz.*, number of pods plant^{-1}, weight of pods plant^{-1}, pod yield, haulm yield of groundnut crop as compared to recommended dose of fertilizer (25:50:25 NPK+ Gypsum @ 500kg ha^{-1} at 30 DAS).

Table 2: Plant height (cm) influenced by nutrients at 30, 60, 90 DAS and harvest

	Treatments	Plant height (cm)			
		30 DAS	60 DAS	90 DAS	Harvest
N_1	RDF	8.52	18.05	26.26	27.11
N_2	RDF+MN	8.49	18.81	27.66	28.25
	S.Em ±	0.22	0.25	0.31	0.32
	CD (P=0.05)	NS	0.74	0.91	0.92

Table 3: Leaf area plant^{-1} (cm^2) influenced by nutrients at 30, 60, 90 DAS

	Treatments	Leaf area plant^{-1} (cm^2)		
		30 DAS	60 DAS	90 DAS
N_1	RDF	332.77	1033.91	2321.45
N_2	RDF+MN	340.25	1160.67	2432.63
	S.Em ±	6.80	20.87	29.16
	CD (P=0.05)	NS	60.46	84.46

Table 4: Total dry matter (g plant^{-1}) influenced by nutrients at 30, 60, 90 DAS

	Treatments	Total dry matter (g plant^{-1})		
		30 DAS	**60 DAS**	**90 DAS**
N_1	RDF	3.32	11.06	35.40
N_2	RDF+MN	3.54	12.32	36.70
	S.Em ±	0.09	0.19	0.41
	CD (P=0.05)	NS	0.56	1.18

Table 5: Leaf area index influenced by nutrients at 30, 60, 90 DAS

	Treatments	Leaf area index		
		30 DAS	60 DAS	90 DAS
N_1	RDF	1.11	3.45	7.74
N_2	RDF+MN	1.13	3.87	8.11
	S.Em ±	0.02	0.07	0.10
	CD (P=0.05)	NS	0.20	0.28

Table 6: Crop growth rate (g day^{-1} $plant^{-1}$) influenced by nutrients at 30, 60, 90 DAS

	Treatments	Crop growth rate (g day^{-1} $plant^{-1}$)		
		30 DAS	60 DAS	90 DAS
N_1	RDF	0.111	0.258	0.811
N_2	RDF+MN	0.118	0.293	0.813
	S.Em ±	0.003	0.006	0.017
	CD (P=0.05)	NS	0.018	NS

Table 7: Relative growth rate (g g^{-1} day^{-1} $plant^{-1}$) influenced by nutrients at 30, 60, 90 DAS

	Treatments	Relative growth rate (g g^{-1} day^{-1} $plant^{-1}$)		
		30 DAS	60 DAS	90 DAS
N_1	RDF	0.0173	0.0295	0.0459
N_2	RDF+MN	0.0181	0.0313	0.0458
	S.Em ±	0.0004	0.0003	0.0003
	CD (P=0.05)	NS	0.0010	NS

Table 8: Number of pods $plant^{-1}$, weight of pods $plant^{-1}$, pod yield and harvest index influenced by nutrients

	Treatments	Number of pods $plant^{-1}$	Weight of pods $plant^{-1}$	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
N_1	RDF	33.76	28.37	1394.04	1766.73
N_2	RDF+MN	37.02	32.70	1633.95	2059.89
	S.Em ±	0.80	0.94	34.39	52.28
	CD (P=0.05)	2.31	2.71	99.63	151.45

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