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Spatial variability of soil nutrients and precision nutrient management for targeted yield levels of groundnut (*Arachis hypogaea* L.)

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Abstract

A field study was conducted during *rabi* / summer 2014-15 to know the spatial variability and precision nutrient management practices on targeted yield levels of groundnut. The experimental field has been delineated into 36 grids of 9 m x 9 m using geospatial technology. Soil samples from 0-15 cm were collected and analysed. Spatial variability exists for available nitrogen, phosphorous and potassium and they varied from 99 to 197 kg N, 12.1 to 64.0 kg P_2O_5 and 166 to 402 kg K_2O ha^{-1}, respectively. This was addressed through precision nutrient management strategy with target yield approach. Application of NPK through drip irrigation in 6 equal splits at fortnightly interval recorded significantly higher growth and yield attributes. Application of variable rates of NPK based on NPK variability of grids through drip irrigation in six equal splits at fortnightly interval recorded 27.28 per cent higher groundnut pod yield (25.24 q ha^{-1}) over blanket application to soil as per UASB package of practice (19.83 q ha^{-1}). The actual yields exceeded the target yield levels (1500, 2000 and 2500 kg ha^{-1}) by 37.0, 19.9 and 9.3 per cent respectively.

***Key words*:** Spatial variability, precision nutrient management, yield, Groundnut

Introduction

In the agricultural economy of India, Groundnut (*Arachis hypogaea* L.), king of oilseeds is commonly called as poor man's almond. The area under groundnut in India was estimated to be 4886.3 thousand hectares with a production of 57.79 lakh tones. Gujarat accounts for 36 per cent of the total production of groundnut and it's the largest producer in India followed by Tamil Nadu (20.78%), Andhra Pradesh (15.23%), Rajasthan (8.23%), Maharashtra (8.23%) and Karnataka (7.82%) (Gracy *et al*., 2013).

In Karnataka, groundnut is gaining importance because of profitability and sustained demand in the market. Being exhaustive crop, mineral nutrition is the key to optimize the production. Groundnut crop yielding 20 to 25 q ha^{-1} of economic yield, requires 160-180 kg N, 20-25 kg P_2O_5, 80-100 kg K_2O which indicates higher demand for nitrogen, phosphorous and potassium.

Traditionally crops are grown under blanket recommendation of fertilizers with conventional method of irrigation, lead to low nutrient use efficiency and lower profits, which failed to exploit its full potential under spatial variability of soil nutrients (Pampolino *et al*., 2012). This management protocol often results in over-application in some field areas and under application in others due to spatial variation in soil available nutrients (Majumdar *et al*., 2013). So, it is imperative to use fertilizers judiciously to reduce the dependence on non renewable sources and to increase profits. Site specific management of zones within field on cluster basis coupled with target yield approach is known to enhance the nutrient use efficiency. In this background, grid based application of nutrients through drip irrigation with split application as per crop demand was carried out in groundnut.

Materials and Methods

A field experiment was conducted during *rabi* / summer 2014-15 at Zonal Agricultural Research Station, UAS, GKVK, Bangalore. The experimental site was situated at 13^o 05' 22" North latitude and 77^o 34' 04" East longitude with an altitude of 933 m above mean sea level. Thirty six grids of 9.0 m x 9.0 m were formed. Soil samples from each grid were collected during November 2014 from the four equidistant spots and at the centre of the grid from 0 - 15 cm soil depth. Available N, P_2O_5 and K_2O were analysed. Based on the variability in soil for available NPK required for targeted yields of 15, 20 and 25q groundnut per ha were calculated using STCR equations. Fertilizer N required = 6.39T – 0.48Soil available N, Fertilizer P_2O_5 required = 15.50 T - 10.20Soil available P_2O_5 and Fertilizer K_2O required = 8.68 T - 0.80 Soil available K_2O. Where, T is targeted yield. The average quantity of N, P_2O_5 and K_2O used for targeted yields of groundnut are given below.

Table 1: Average quantity of nitrogen, phosphorus and potassium applied for targeted yield levels of groundnut

Targeted yield (q ha^{-1})	Nitrogen	Phosphorus	Potassium
	----------kg ha^{-1} ----------		
15	31	10	17
20	64	24	26
25	85	57	51

Recommended dose of 25:75:38 kg N, P_2O_5 and K_2O ha^{-1} was the control

The fertilizers were applied adopting three methods *viz*., M_1: application of nutrients as per UAS (B) package of practice (50% N and entire P & K as basal and remaining N at 30 days after sowing as top dress), M_2: Application of fertilizer in 12 equal splits at weekly interval through drip irrigation, M_3: Application of fertilizer in 6 equal splits at fortnightly interval through drip irrigation. The experiment was laid out in split plot design. The methods of application comprised of main plot and fertilizer levels for targeted yield and the recommended NPK (control) comprised the sub plot treatments. In all there were 12 treatments.

Groundnut variety ICGV-91114 was sown on 31st Dec. 2014 by following a spacing of 30 cm X 10 cm. Fertilizers through Urea, MOP and water soluble MAP were applied as per the treatments. Data on growth, yield and yield attributes were recorded and analyzed statistically.

Results and Discussion

Grid-wise status of soil available nitrogen, phosphorus and potassium during November 2014 are depicted in Fig. 1. The data revealed that, the grids varied spatially in available NPK from 99 to 197 kg N ha$^{-1,}$ 12.1 to 64 kg P_2O_5 ha^{-1} and 166 to 402 kg K_2O ha^{-1}. This permits site-specific nutrient management either through yield based management concepts or through grid based concept (Tawainga *et al.*, 2003).

The quantity of nitrogen, phosphorous and potassium applied for targeted yield levels of groundnut clearly reveals saving in phosphatic fertilizer required for targeted yield levels due to application of NPK through grid based precision nutrient management strategy over blanket recommended dose.

Growth, yield attributers and yield are presented in Table 2 and the results indicated that there was a significant variation with respect to nutrient management practices. Application of NPK through drip irrigation in 12 equal splits at weekly interval recorded significantly taller plants (40.1 cm) and more number of branches (7.8) over blanket soil application but it was on par with the application of NPK through drip irrigation in 6 equal splits at fortnightly interval (38.2 cm and 7.6 respectively). The increased plant height was due to increased efficiency in nutrient availability which contributed for prolonged greenness and larger leaf surface. Significantly higher pod dry weight (68.52 g plant^{-1}) was observed with the application of fertilizers through drip irrigation in 6 equal splits at fortnightly interval over soil application as per UASB package of practices (55.28 g plant^{-1}). Among the targets, targeted yield of 25 q ha^{-1} recorded significantly more pod dry weight (75.18 g plant^{-1}). Similar trend was observed with respect to SPAD values recorded at 90 days after sowing.

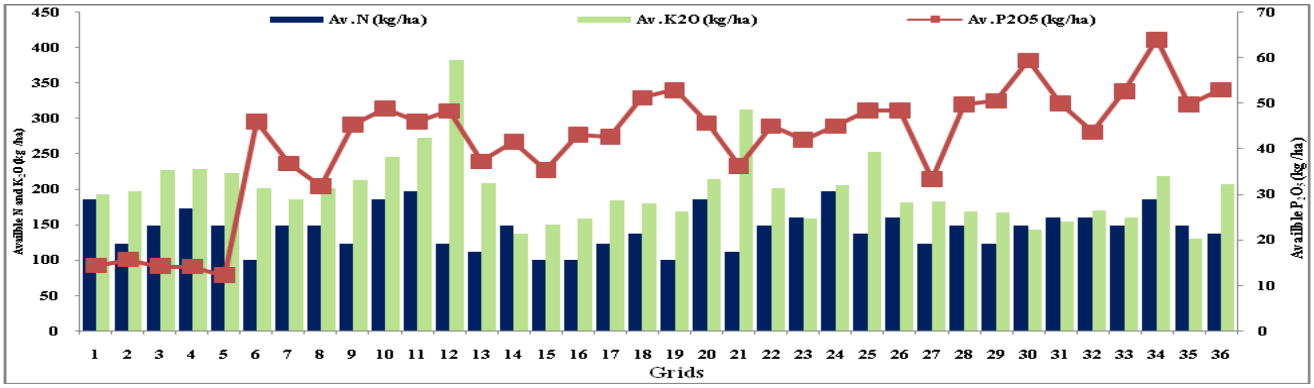

Fig. 1: Spatial variability of soil available NPK (Nov.2014)

Application of fertilizers through drip irrigation in 12 equal splits at fortnightly interval recorded significantly higher number of pods per plant (44.2) over blanket application as per UAS (B) package of practices (27.3) and which was on par with the application of nutrients through drip irrigation in 6 equal splits at fortnightly interval (43.6). Among the targets, fertilizers applied for targeted yield of 25q ha^{-1} recorded significantly more number of pods per plant (49.4) and it was followed by targeted yield of 20 q ha^{-1} as compared to other treatments. Significantly higher test weight (30.62 g) was registered with the application nutrients through drip irrigation in 6 equal splits at fortnightly interval over normal blanket application as per UAS (B) package of practice (27.23 g) but was on par with the application through drip irrigation in 12 equal splits at weekly interval (29.11g).

Table 2: Growth, yield and yield attributes of groundnut as influenced by nutrient management practices and targeted yield levels

Treatments	Plant height (cm)	Branches plant $^{-1}$	SPAD values	Pods plant $^{-1}$	Pods dry weight (g plant $^{-1}$)	Test weight (g)	Pod yield (q ha^{-1})	Haulm yield (q ha^{-1})	Shelling (%)
Main plots (Application method)									
M_1	36.3	7.0	42.73	27.3	55.28	27.23	19.83	25.67	66.3
M_2	40.1	7.8	44.94	44.2	67.27	29.11	24.02	30.00	65.7
M_3	38.2	7.6	45.92	43.6	68.52	30.62	25.24	31.08	67.7
S.E.m±	**1.1**	**0.2**	**0.44**	**1.1**	**0.30**	**0.23**	**2.87**	**1.21**	**0.26**
CD at 5%	**4.3**	**0.8**	**1.71**	**4.4**	**1.2**	**0.94**	**11.6**	**4.75**	**1.03**
Sub-plots (Targeted yield levels)									
*Y_1	36.1	7.1	43.05	31.7	57.23	28.43	20.55	27.29	65.8
Y_2	38.4	7.6	44.65	37.0	67.31	29.30	23.97	29.14	66.5
Y_3	41.7	8.1	45.66	49.4	75.18	29.93	27.35	31.69	67.4
Y_4	36.4	7.0	44.77	35.2	55.02	28.28	20.25	27.54	66.5
S.E.m±	**0.5**	**0.1**	**0.59**	**1.1**	**0.52**	**0.51**	**2.35**	**1.27**	**0.28**
CD at 5%	**1.4**	**0.4**	**1.75**	**3.3**	**1.56**	**NS**	**7.05**	**3.77**	**0.82**
Interactions (M x Y)									
S.E.m±	**0.8**	**0.2**	**0.49**	**1.9**	**0.9**	**0.88**	**0.41**	**2.20**	**0.48**
CD at 5%	**NS**	**NS**	**NS**	**NS**	**2.7**	**NS**	**NS**	**NS**	**NS**

***** Y_1: 15 q ha^{-1} Y_2: 20 q ha^{-1} Y_3: 25 q ha^{-1} Y_4: RDF

Application of nutrients through the drip irrigation in 6 equal splits at fortnightly interval recorded significantly higher pod yield (25.24 q ha^{-1}) over soil application as per UAS, B package of practice (19.83 q ha^{-1}) and fertilizer application through drip irrigation in 12 equal splits at weekly interval (24.02 qha^{-1}). Drip fertigation of NPK in 6 equal splits at fortnightly interval also produced significantly higher haulm yield (31.08 q ha^{-1}) as compared to all other treatments. However it was on par with the application of fertilizer through drip irrigation in 12 equal splits at weekly interval (30 q ha^{-1}). Among the targets, significantly higher pod yield of 27.35 q ha^{-1} was recorded as against the target 25q ha^{-1}. The actual yields exceeded the targeted yield levels (15, 20 and 25q ha^{-1}) by 37.0, 19.9 and 9.3 per cent respectively. The positive response to higher level of nutrients on pod yield to be ascribed to overall improvement in crop growth which enabled the plant to absorb more nutrients and moisture as a consequence the plants are able to synthesize more of photosynthates. Thus there is balance in source and sink which resulted in higher economic yield of groundnut. The nutrient supplied through drip irrigation at 6 and 12 equal splits matched with crop demand, which lead to efficient utilization of applied fertilizer. Similar results were also reported by Jain *et al.* (2012).

Summary and Conclusions

Precision nutrient management significantly increased pod yield, haulm yield, pod number and test weight of groundnut. Growth parameters viz., plant height, number of branches and plant dry weight followed the similar trend as that of yield and yield attributing characters. So, grid based application of NPK through drip irrigation in 6 equal splits at fortnightly interval found to be more economically feasible and profitable than conventional uniform application.

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