Enhancing the productivity of groundnut as influenced by crop geometry and plant nutrition

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Abstract

Recommendations to obtain maximum yields of groundnut often don't occur with the same row spacing and recommended doses of nutrients due to different crop needs. The proper plant spacing and nutrition determined the yield of a particular variety in a specific agro-ecological environment. A field experiment was conducted at experimental farm, Annamalai University, summer season of 2011 to assess the effect of plant geometry and fertility levels on growth, yield, and profitability of groundnut crop for sustained yield. The treatments consisted of three spacings (25x10 cm, 20x10 cm and 30x10 cm) and three fertility levels (75, 100 and 125% recommended rate of fertilizers and was laid out in split plot design with three replications, in fixed plots. Sowing of crop at 20x10 cm spacing resulted in 28 and 24% higher pod yield and 41 and 47% higher haulm yield over 25x10 cm and 30x10 cm spacing, respectively. Similarly, application of 125% RDF resulted in 7 and 21% higher pod yield and 12 and 32% higher haulm yield compared to 100% RDF and 75% RDF, respectively. The crop also fetched highest gross returns and B:C ratio where it was sown at closer spacing of 20x10 cm with 25% higher dose of NPK.

Keywords: Crop geometry, groundnut, plant nutrition, productivity, profitability.

Introduction:

Out of the nine-oilseed crops grown in India, groundnut accounts for about 45 percent of the total cropped area under oilseeds and 55 percent of the total area under oilseeds production. An average groundnut crop with 20 to 25 q/ha of economic yield requires 160-180 kg N, 20-25kg P, 80-100 kg K, 60-80 kg Ca, 15-20 kg S, 30-45 kg Mg, 3-4 kg Fe, 300-400g Mn, 150-200 g Zn, 140-180 g B, 30-40 g Cu and 8-10 g Mo for better kernel filling and oil synthesis and, hence, are required in higher quantity (Singh, 1999 and Singh *et al.,* **2012).**

Globally it has been cultivated on 24.2 million ha with 28.6 million tons production (DES, DAC, 2015). In India, it is grown on an area of 4.7 million ha with total production and productivity of 6.6 million tonnes and 1400 kg/ ha, respectively (DES, DAC, 2015). Though, India leads the world both in area and production of groundnut, the country ranks eighth in productivity.

The low yield levels are attributed to poor cultivation practices specially planting pattern of the crop with low inputs, low fertilizer efficiency, inadequacy of current fertilizer recommendations and continuously deteriorating soil quality Naim *et al.,* 2010a and Naim *et al.,* 2011. Although, excessive use of mineral fertilizers negatively affects soil environment and reduces profit margins farmers gain, it occurs to boost crop production to meet the increasing demands of consumers. Optimization of mineral fertilization is the key for optimizing groundnut production, as it has very high nutrient requirements (Kabir *et al,* 2013). Several research reports established the fact that the proper row and plant spacing, fertilizer management and other management practices determined the yield of a particular variety in a specific agro-ecological environment (Lourduraj, 1999). All these factors have jointly contributed to low and unstable yields of groundnut crop in India (Howlader *et al.,* 2009 and Madhusudhana, 2013). Hence, the current study was carried out to study the possibility of reducing as well as balancing mineral fertilization levels and coupling it with the crop geometry with an aim to promote growth, increasing and sustaining productivity and profitability of groundnut crop.

MATERIALS AND METHODS

A field experiment was carried out at the experimental farm of Department of Agronomy, Annamalai University during Summer 2011. The soil contained of 0.51 % organic carbon with the pH of 7.3 and electrical conductivity 0.34 dS/m. Soil has low initial N (191.2 kg/ha), marginally low P (12.3 kg/ha) and medium K (206 kg/ha) contents. The recommended dose of NPK for groundnut is 20-60-20 kg/ha. The experiment had 12 treatments, set in a split-plot design with three replications in fixed plots. The main-plot treatments consisted of using two closer spacing as 25x10 cm, 20x10 cm and a standard row spacing of 30x10 cm in combination with sub plot treatments as different fertility levels, 75, 100 and 125% recommended rate of fertilizers. The fertilizer source used for applying N, P and K were urea, single super phosphate and muriate of potash, respectively. The N, P and K fertilizers were applied in full as basal dose. The gross plot size was 5.0 m x 4.5 m in the first week of January 2013. The average maximum air temperature, minimum air temperature, relative humidity and total rainfall were 32.9°C, 20.1°C, 66.1 % and 494 mm respectively during crop growth. Although the total rainfall during crop growing season was adequate for groundnut production. Crop lodging during initial growth phase resulted in poor germination and establishment of groundnut plants.

Before sowing, the kernels were treated with the fungicides dithane M-45 @ 2g/kg seed, bavistin @ lg/kg seed and by *Rhizobium* culture @ 5 g/kg seed. Four irrigations were provided to groundnut and three hand weedings were done to control the weeds. Chlorpyrifos @ 1.5 1 a.i./ha was applied to control termite infestation before sowing and at 40 DAS. There was high incidence of thrips and bud necrosis virus thus, to control thrips infestation the crop was treated with an insecticide dimethoate 30 EC @ 2 ml/litre water at 45 DAS. Imidacloprid (@ 1 ml/3 litre water) + Mancozeb (@ 2 g/litre) at time of disease occurrence were applied against the incidence of fungal diseases as early blight, late blight and stem rot. Five plants in each plot were selected randomly and tagged for taking various biometric observations. Observations were made on dry weight of pods/plant (g), number of mature pods/plant, shelling percentage, test weight (g), number of primary branches/plant and harvest index (%). Shelling percentage was calculated as weight of kernels/weight of pods x 100 and sun dried up to 9% moisture level. Statistical analysis of the data was carried out using analysis of variance technique (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Plant stand

Sowing of groundnut at closer spacing of 20x10 cm resulted in significantly highest initial and final plant stand (000'/ha) compared to 25x10 cm and 30x10 cm spacing (Table 1). The plant stand under influence of sowing crop at different spacing did not achieved optimum plant population because the crop was tended to have shorter vegetative and generative stages due to late planting in month of August resulted in less biomass and short plant height. Application of 25% higher dose of NPK was significantly superior to the fertility treatment where 75% RDF was applied but was at par with the application of 100 % RDF for initial and final plant stand. Sowing crop at closer spacing of 20x10 cm with 25% higher dose of fertilizer resulted in significantly highest initial and final plant stand compared to the spacing of 30x10 cm with 75% RDF.

Growth parameters

The number of branches/plant was significantly highest where the crop was sown at the normal spacing of 30x10 cm (Table 1). Placing crop at 30x10 cm spacing resulted in 14.9 and 15.8% higher number of branches/plant over 20x10 cm and 25x10 cm spacing of the crop. It may be due to wider row to row spacing allows the plant to attain their normal growth to express their full potential. Plant geometry treatments had non significant effect on plant height, dry and fresh weight/plant of groundnut. Placing crop at different spacing did not achieved optimum plant population because the crop was tended to have shorter vegetative and generative stages due to late planting in month of August resulted in less biomass and short plant height.

Planting of crop late in the month of August at different spacing either at 20x10, 25x10 or 30x10 cm did not resulted in optimum plant stand compared to normally sown crop because due to delayed sowing the crop was tended to have shorter vegetative and generative stages resulted in poor crop stand.

Similarly, all the observed growth parameters were significantly influenced under different fertility treatments. Application of 25% higher dose of NPK produced significantly taller plants as compared to 75% RDF but was at par with the application of 100% RDF for the growth parameters. Application of 125% RDF resulted in 3.2 and 5.5% higher number of branches/plant compared to 100 and 75% RDF, respectively. Such increases might be due to the increase in mineral fertilization levels which is known to help in developing extensive root system and that helps the plant in absorbing water and nutrients efficiently from the soil solution. This abundant availability of nutrients in soil pool under higher fertilization resulted in enhanced rate of assimilation which was reflected in higher biomass. Application of 125% RDF resulted in significantly highest fresh (11.9%) and dry weight (18.1%) of plants at harvest followed by 100% RDF application. It might be due to increased levels of mineral fertilization resulted in enhanced vegetative growth. Similarly, Salve and Gunjal, 2011; Sharma and Yadav, 1997 and Gobarah *et al.*, 2006 stated that the increase in plant growth due to higher dose of nutrients application specially P may be attributable to the role of phosphorus in the development of more afterwards in the form of vegetative growth. extensive root system and enhanced nodulation, and thus enables plants to absorb more water and nutrients from of the soil, which is reflected afterwards in the form of vegetative growth.

Table 1. Effect of crop geometry and fertility levels on plant stand and growth parameters of groundnut.

Treatment	Plant height (cm)	No. of branches/ plant	Initial plant population (000')/ha	Final plant population (000')/ha	Dry weight (g/plant)	Fresh weight (g/plant)
Planting geometry						
P1: Plant population @ 3.33 lakh/ha (30 x 10 cm)	30.1	10.1	172	159	26.5	177.3
P2: Plant population @ 4 lakh/ha (25 x 10 cm)	29.4	8.5	188	176	26.3	177.9
P3: Plant population @ 5 lakh/ha (20 x 10 cm)	31.6	8.6	362	351	22.7	167.1
S.Em+	0.74	0.30	7.9	8.4	1.03	5.70
LSD (P=0.05)	NS	1.17	31.1	33.1	NS	NS
Fertility levels FI: 75% RDF	28.9	8.6	229	217	21.4	141.7
F2: 1007c RDF	30.7	9.1	246	234	24.8	179.6
F3: 1257c RDF	31.5	9.4	247	235	29.3	201.0
S.Em+	0.34	0.08	2.0	2.0	0.89	4.89
LSD (P=0.05)	1.05	0.24	6.1	6.2	2.75	15.07
Interaction						
S.Em+	0.59	0.13	3.45	3.461	1.55	8.47
LSD (P=0.05)	NS	NS	10.63	10.67	4.77	26.10

Table 2. Effect of crop geometry and fertility levels on yield attributes and yield of groundnut

Treatment	Pods/ plant	Pod weight/ plant (g)	Kernel weight / plant (g)	100 kernel weight (g)	Shelling (%)	Pod yield (kg/ha)	Haulm yield (kg/ha)	H.I
Main Plots: Planting geometry								
PI: Plant population	19.3	11.3	6.2	34.8	56	1210	4235	0.24
3.33 lakh/ha (30 x 10 cm)								
P2: Plant population	12.9	6.2	3.7	33.1	61	1145	4668	0.23
4 lakh/ha (25 x 10 cm)								
P3: Plant population	13.3	7.5	4.8	35.7	65	1591	7945	0.18
5 lakh/ha (20 x 10 cm)								
S.Em+	0.59	0.35	0.15	1.12	2.6	33.6	205.6	0.018
CD (P=0.05)	2.31	1.37	0.60	NS	NS	131.9	807.4	NS
Sub Plots: Fertility levels								
FI: 75% RDF	12.9	6.4	3.8	32.7	61	1145	4469	0.23
F2: 100% RDF	15.7	8.8	5.4	35.5	61	1350	5805	0.22
F3: 125% RDF	16.8	9.7	5.6	35.4	60	1451	6573	0.20
S.Em+	0.48	0.27	0.13	1.19	2.1	43.5	192.4	0.012
CD (P=0.05)	1.47	0.85	0.41	NS	NS	134.2	592.9	NS
Interaction								
S.Em+	0.82	0.47	0.22	2.05	3.33	75.4	333.3	0.020
LSD (P=0.05)	NS	1.47	0.70	NS	NS	232.4	1027.0	NS

Table 3. Effect of crop geometry and fertility levels on economics of groundnut

Treatments	Gross Return (Rs./ha)	Net return (Rs. /ha)	B: C
Main Plots: Planting geometry			
PI: Plant population @ 3.33 lakh/ha (30 x 10 cm)	51042	20706	1.68
P2: Plant population @ 4 lakh/ha (25 < 10 cm))	48339	18003	1.59
P3: Plant population @ 5 lakh/ha (20 > 10 cm)	67128	36792	2.21
S.Em+	1417.8	1417.8	0.046
CD (P=0.05)	5567.0	5567.0	0.182
Sub Plots: Fertility levels			
FI: 75% RDF	48330	19001	1.65
F2: 100% RDF	56966	26630	1.88
F3: 125% RDF	61213	29870	1.95
S.Em+	1838	1838	0.060
CD (P=0.05)	5663	5663	0.184
Interaction			
S.Em+	3183.0	3183.0	0.103
CD (P=0.05)	9807.1	9807.7	0.319

Table 4. Interaction table for pod and haulm yield of groundnut

Treatments	Pod yield (kg/ha)	Haulm yield (kg/ha)
Plant population @ 3.33 lakh/ha (30 x 10 cm) with 75% RDF	947	3520
Plant population @ 3.33 lakh/ha (30 x 10 cm) with 100% RDF	1175	4234
Plant population @ 3.33 lakh/ha (30 x 10 cm) with 125% RDF	1507	4950
Plant population @ 4 lakh/ha (25 x 10 cm) with 75% RDF	1023	3471
Plant population @ 4 lakh/ha (25 x 10 cm) with 100% RDF	1117	4044
Plant population @ 4 lakh/ha (25 x 10 cm) with 125% RDF	1297	6488
Plant population @ 5 lakh/ha (20 x 10 cm) with 75% RDF	1466	6416
Plant population @ 5 lakh/ha (20 x 10 cm) with 100% RDF	1758	9137
Plant population @ 5 lakh/ha (20 x 10 cm) with 125% RDF	1549	8281
S.Em+	75	333
CD (P=0.05)	232	1027

Yield and Yield attributes

As late planting gave a very short time for both vegetative and generative duration resulted in poor vegetative growth got translated in lower number of pods per plant, shelling percentage, 100-kernel weight, pod filling, and plant height of "Mallika". Moreover, some mature pods were lost due to detaching of some pods under unsuitable soil conditions at the last harvest time in late planting (5 August).

Sowing of the groundnut at 20x10 cm spacing resulted in significantly highest 100 kernel weight, shelling percent, pod and haulm yield but the number of pods/plant, pod and kernel weight/plant, were significantly highest where the crop was sown at wider spacing of 30x10 cm. Sowing of crop at 30x10 cm spacing resulted in 28 and 24% higher pod yield and 41 and 47% higher haulm yield over 25x10 cm and 20x10 cm spacing, respectively. It may be due to widening of space might have provided more nutrients thus resulted in higher production of pegs. Thus, higher pod bearing length was found, yielding higher number of pods/plant. Pod weight/plant and haulm yield of groundnut was significantly superior where 125% RDF was applied but was at par with 100% RDF for the yield traits as number of pods/plant, kernel weight/plant and pod yield of groundnut. Application of 125% RDF resulted in 7 and 21% higher pod yield and 12 and 32% higher haulm yield compared to the treatments where NPK were applied as @ 100 and 75% RDF, respectively. This might be due to the enhanced absorption of nutrients from the soil solution resulting from their abundance when higher fertilization rates were applied, and hence promoted better assimilation leading to profuse growth and ultimately better yield of crop.

The interaction effect of plant geometry and fertility levels were significant for both pod and haulm yield of groundnut. The grain and haulm yield was significantly superior over rest of the treatments where the crop was sown at the spacing of 20 x 10 cm with 100% RDF but was statistically at par with the treatment where 125% RDF was applied to the crop sown at the spacing of 20 x 10 cm. The lowest pod and haulm yield was obtained where the crop was sown at spacing of 30 x 10 cm with 75% RDF.

The application of various doses of fertilizers in combination with different crop geometry treatments to groundnut crop failed to exhibit significant variation in 100-seed weight, shelling per cent and harvest index during experimentation.

Economics

Significantly higher values of gross returns, net returns and B C ratio were obtained where the crop was sown at closer spacing of 20x10 cm and the lowest values were obtained at the crop spacing of 25x10 cm (Table 3). The highest values of gross returns, net returns and B C ratio were obtained where 125% RDF was applied and was at par with treatment where 100% RDF was applied. Application of 75% NPK resulted in lowest B:C ratio (1.65).

Conclusion

Based on one year study it could be concluded that under delayed sowing of groundnut crop in Gwalior region, application of 25% higher dose of primary nutrients at the closer spacing of 20x10 cm resulted in higher productivity and profitability of groundnut crop.

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