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Effects of Plant Density, Nitrogen and Gypsum on Yield Parameters of Groundnut (*Arachis hypogea* L.) in Regosols of Batticaloa District

K. Sivanesarajah, U.R. Sangakkara[1] and S. Sandanam[2]

Postgraduate Institute of Agriculture
University of Peradeniya
Peradeniya.

ABSTRACT. *An experiment was conducted to study the effect of four plant densities in combination with two levels of nitrogen and three levels of gypsum, on yield and yield components of groundnut in the regosols of Batticaloe during the period January to May 1992.*

Increase in plant density from 148,148 to 352,733 plants/ha increased yield (dry weight basis) by 74%, number of pods per unit area by 97% and shelling percentage by 7.76%. Further increases in plant density did not influence yield. On per plant basis, however, the dry weight of pods and number of pods were highest at a plant density of 148,148 plants/ha. Nitrogen levels did not have any effect on yield components. Application of gypsum (500kg/ha) at flower initiation increased dry weight of pods by 34%, number of pods per unit area by 22%, shelling percentage by 10% and 100 kernel weight by 9.5%.

INTRODUCTION

The potential for the production of groudnut in Sri Lanka is high, as it is ideally suited for subsistence farmers, needs very little input, and has low pest and disease problems (Gibbons, 1980). Farmers in Sri Lanka do not embark on its cultivation on a large scale, because the average yield (900 kg/ha) is generally low (Anonymous, 1989-1990), although in other countries such as China, yields of 1990 kg/ha has been reported (FAO, 1990).

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1 Department of Crop Science, Faculty of Agriculture, University of Peradeniya, Peradeniya.

2 Department of Agronomy, Faculty of Agriculture, Eastern University, Chenkalady.

Optimum plant density is a pre-requisite for maximum yield. The nutrient requirement for plant growth varies with plant density. Increasing plant density results in suppression of the biological yield of individual plants, but production increases on the basis of unit land area (Yoyock, 1979). Nitrogen is reported to be the major limiting factor for optimal growth of groundnut, and significant response to added N has been reported when the crop was not inoculated or when the soil fertility was poor (Kanwar *et al.*, 1983). Calcium is one of the elements that has been reported to have a favourable influence on fruitification (Bolhius and Stubs, 1955) of groundnut. Skelton and Shear (1971) reported that the omission of ^{45}Ca decreased the percentage of fruits containing seeds.

Adequate studies have not been carried out to test the effect of plant density and response of groundnut to nitrogen and calcium in the regosols of the Batticaloe District, where this species is a popular crop. The present study was therefore conducted to determine the potential of increasing yield in groundnut by manipulating plant density with added nitrogen and calcium.

MATERIALS AND METHODS

A field investigation was carried out at the Ramakrishna Mission Farm, Kallady, 2 miles south of Batticaloa town during January - May 1992. This region falls within the dry zone of Sri Lanka, in the agro-ecological zone DL_2. The mean annual rainfall ranges from 1600-2130 mm. The texture of the soil was sandy (less than 20% silt and clay) with structureless single grains.

Four spacings *viz.* 45x15 cm (148,148 plants/ha), 33x10.5 cm (288,600 plants/ha), 27x10.5 cm (352,733 plants/ha) and 24x10.5 cm (396,826 plants/ha) were tested, in combination with two levels of nitrogen (15 and 30 kg/ha) and three levels of gypsum (0, 250 and 500 kg/ha) using the groundnut variety MI-1. Nitrogen was applied in two stages (basal and top dressing at 1 month after planting) with super phosphate (48 kg P_2O_5/ha) and muriate of potash (26.57 kg K_2O /ha). Gypsum was applied after earthing up and beds were made into ridges and furrows. The experiment was carried out as a 4x2x3 factorial, using randomized complete block design, replicated three times. The plot size was 3mx3m.

Yield components of groundnut *viz.* pod yield, pod number, shelling percentage, 100-kernel weight and yields were determined. Pod weight and pod numbers were assessed at 8, 10, and 12 weeks after planting. Shelling percentage and 100-kernel weight were assessed at 12 weeks after planting. The data were analyzed by using the SAS statistical package (1993).

RESULTS AND DISCUSSION

The dry weight of pods at different stages of growth was influenced by plant density. An increase in plant density from 148,148 to 288,600 plants/ha increased the dry weight of pods by 42% at harvest. A further increase from 288,600 to 352,733 plants/ha increased yield by another 31%, but further increments in plant density did not increase the dry weight of pods (Figure 1). An increase in yield of groundnut in response to increase in plant density has been reported by Muhammed and Durairaj (1974), and Gopalaswamy *et al.*, (1979). In the present study, maximum dry weight of pods was obtained at a spacing of 27x10.5 cm with a plant density of 352,733 plants/ha.

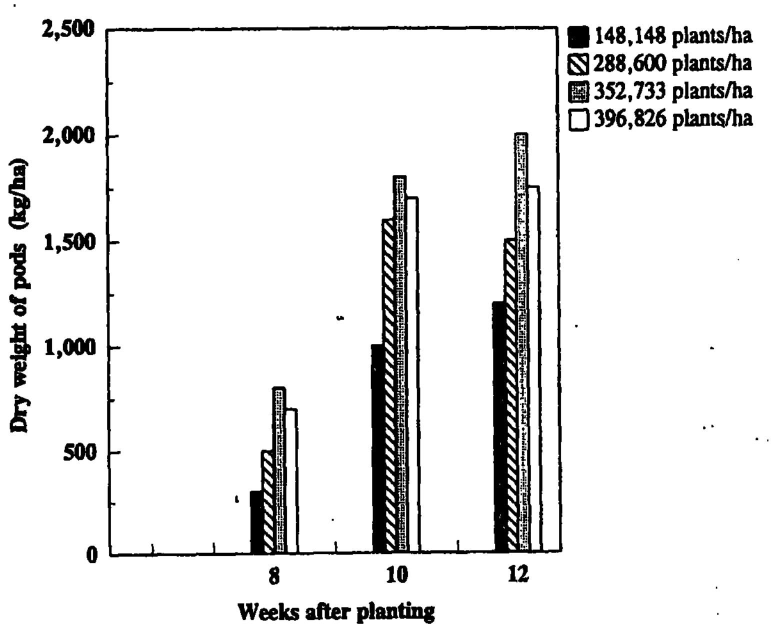

Figure 1. Variation in Dry weight of pods

As the plant density increased, yield per plant decreased (Table 1). But, greater yields per plant obtained at lower plant densities did not compensate for the contribution of yield made by more plants at higher densities. Similar results have been reported by Gopalaswamy *et al.*, (1979) and Bell *et al.*, (1987) with a density of 394,000 plants/ha in Australia.

Table 1. Dry weight of pods/plant (g) with different plant densities at different stages of growth.

Plant density (Plants/ha)	Weeks after planting 8	10	12
148,148	1.95	6.08	7.12
288,600	2.90	5.32	5.54
352,733	1.77	5.22	5.47
396,826	1.73	4.09	4.37
LSD (p=0.05)	0.51	0.80	0.84

Correlations between the pod yield at harvest with plant density revealed the following relationship.

$$Y = 32.187 + (8.122*10^{-3})X + (9*10^{-10})X^2$$

where;

Y = yields of dry pods (kg/ha)
X = plant density ('000)

Numbers of pods/ha steadily increased with increasing plant density at all stages (Figure 2). At harvest, the number of pods/ha increased by 64% when the plant density was increased from 148,148 to 288,600 plants/ha. An increase in plant density to 352,733 plants/ha increased number of pods by 33%. A further increment had no effect. The higher number of pods/unit area at high plant densities was probably resulted from an increase in number of plants/unit area, as suggested by Muhammed and Dorairaj (1974); Enyi (1977) and Gopalaswamy *et al.*, (1979).

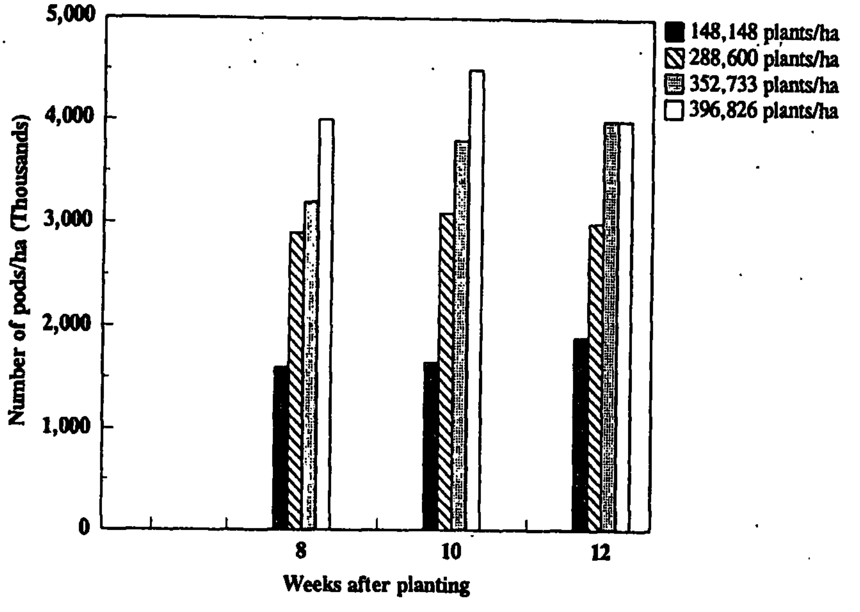

Figure 2. Variation in Number of Pods.

Changes in the number of pods/plant at different plant densities at different stages of growth are given in Table 2. As the plant density increased from 148,148 to 396,826 plants/ha the number of pods per plant decreased. This reduction was significant at 12 weeks after planting (Table 2). However, increasing plant density from 288,600 to 396,826 had no significant influence on the number of pods per plant. A larger number of pods/plant at lower densities (Table 2) did not compensate for the increase in pod number/ha (Figure 2) brought about by increased plant densities.

Apart from the number and dry weight of pods, 100 kernel weight and shelling percentage were influenced by plant density. An increase in plant density from 148,148 to 352,733 plants/ha, increased shelling percentage by 7.76%. At densities of 396,826 and 352,733 plants/ha, shelling percentage was not different, but higher than at densities of 288,600 and 148,148 plants/ha (Table 3). Gopalaswamy *et al.*, (1979) reported that plant density does not affect shelling percentage, while Bhan and Misra (1972)

Table 2. Changes in number of pods/plant with different plant densities at different stages of growth.

Plant density (Plants/ha)	Weeks after planting 8	10	12
148,148	10.51	11.39	12.39
288,600	9.72	11.17	10.45
352,733	9.50	10.45	11.39
396,826	10.20	10.95	10.12
LSD (p=0.05)	-	-	1.77

Table 3. Shelling percentage and 100 kernel weight at different plant densities.

Plant density (Plants/ha)	Shelling Percentage	100 kernel weight (g)
148,148	65	26
288,600	67	28
352,733	70	30
396,826	72	31

reported an increased shelling percentage at lower plant densities. In this study, shelling percentage was higher at higher densities. This may be due to better grain formation and proper filling at higher densities as suggested by Enyi (1977).

An increase in plant density from 148,148 to 288,600 plants/ha had no influence on 100-kernel weight, but an increase from 288,600 to 352,733 plants/ha increased kernel weight by 6%. Further increase of plant density to 396,826 plants/ha had no influence on 100-kernel weight (Table 3). Gopalaswamy *et al.*, (1979) reported that 100-kernel weight was highest at wider spacings (lower densities). The results of this study indicate that 100-kernel weight increased with increasing plant density. This can only be explained in terms of better grain filling under high densities.

Nitrogen

Levels of nitrogen did not have significant influence on the dry weight of pods, number of pods, shelling percentage or 100-kernel weight.

Gypsum

Gypsum applied at the rate of 500 kg/ha increased yields by 34% compared to the control (Figure 3). The recommended rate of application of gypsum in Sri Lanka varies between 300-500 kg/ha (Seneviratne and Appadurai, 1966). The requirement of calcium supplied by gypsum, for pod formation and development as reported by Ramanathan and Ramanathan (1982) and Anandan *et al.*, (1985) was confirmed by this study.

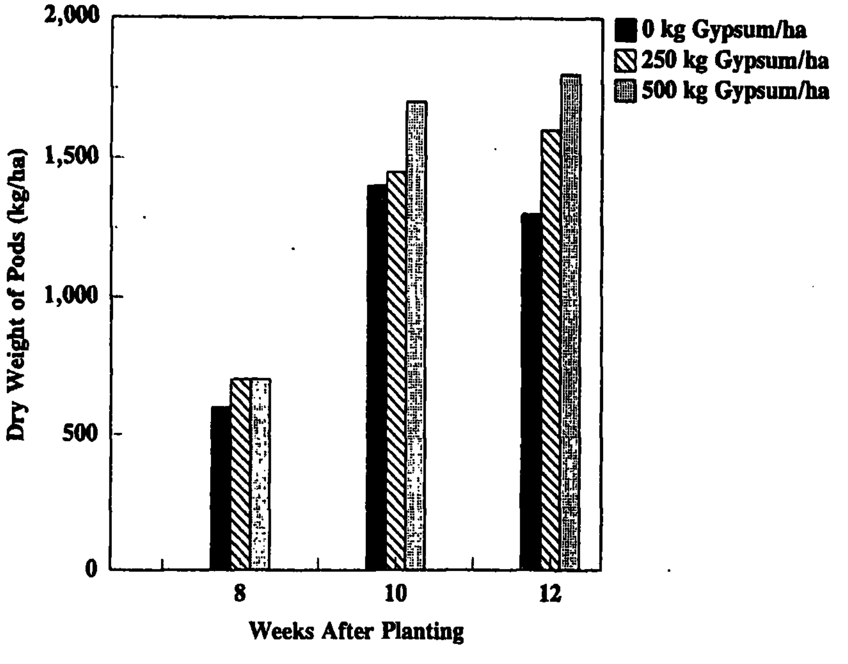

Figure 3. Variation in Dry Weight of Pods.

Groundnut is reported to respond to both calcium and sulphur application (Chahal and Viramani, 1973). The effect of gypsum was reported to be more pronounced than that of elemental sulphur (Verma *et al.*, 1973) thus signifying the effect of calcium.

Gypsum application influenced the number of pods per plant. Application of 500 kg/ha gypsum increased number of pods by 22% (Figure 4) at harvest. Similar results have been reported by Radder and Birader (1973). Calcium reduces ovule abortion; and importance of calcium in the fruiting zone for pod formation and pod development has been reported by Chahal and Viramani (1974), and Ramanathan and Ramanathan (1982).

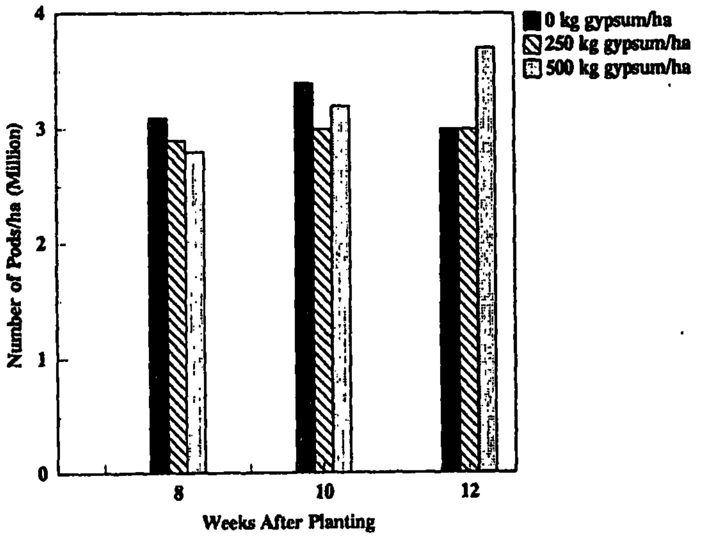

Figure 4. Variation in Number of Pods.

Shelling % and 100 kernel weight resulted from different levels of gypsum application are given in Table 4. Application of gypsum at the rate of 500 kg/ha enhanced shelling percentage by 10% and 100-kernel weight by 9.5% over the control.

Table 4. Shelling percentage and 100 kernel weight with different levels of gypsum.

Gypsum levels (kg/ha)	Shelling percentage	100 kernel weight (g)
0	65	28
250	68	29
500	70	31

A significant interaction was noticed among the plant density, levels of nitrogen and gypsum. There was no interaction between nitrogen and gypsum with respect to shelling percentage (Table 5). The highest shelling percentage of 74.9 was obtained with 30 kg N/ha and 500 kg gypsum/ha at density of 352,733 plants/ha. A comparable shelling percentage was obtained at lower level of nitrogen (15 kg/ha) at lower plant density (148,148 plants/ha) with the highest level of gypsum (500 kg/ha). In the present investigation, shelling percentage was greater at higher densities (396,826 and 352,733 plants/ha) with highest level of gypsum. This may be due to better grain formation and proper grain filling under higher plant densities as reported by Enyi (1977).

Table 5. The influence of plant density, nitrogen and gypsum on shelling percentage.

Plant density (plants/ha)	15 kg N/ha Gypsum kg/ha			30 kg N/ha Gypsum kg/ha		
	0	250	500	0	250	500
148,148 S_4	59.60	60.30	70.71	60.05	61.69	65.27
288,600 S_3	59.36	66.90	72.52	59.36	62.92	62.93
352,733 S_2	64.91	64.96	65.21	67.11	69.87	74.90
396,826 S_1	67.58	68.51	69.20	67.84	68.86	73.24

LSD (p=0.05) 3.67

A significant interaction was evident among plant density, nitrogen and gypsum, but there was no interaction between nitrogen and gypsum on 100-kernel weight (Table 6). The highest 100 kernel weight was obtained with 30 kg N/ha and 500 kg gypsum/ha at higher densities (396,826 and 352,733 plants/ha). Similar 100-kernel weight was obtained at a lower nitrogen level (15 kg N/ha) at lower plant densities (288,600 and 148,148 plants/ha) with the highest gypsum level. In this experiment, 100-kernel weight increased with enhanced plant density at the highest level of gypsum (500 kg/ha). This may be explained in terms of better grain filling under high densities, as suggested by Enyi (1977).

Table 6. The effect of plant density, nitrogen and gypsum on 100 kernel weight (g).

Plant density (plants/ha)	15 kg N/ha Gypsum kg/ha			30 kg N/ha Gypsum kg/ha		
	0	250	500	0	250	500
148,148	25.92	26.22	30.75	26.11	26.82	28.38
288,600	25.81	29.09	31.53	25.81	27.35	27.36
352,733	28.22	28.24	28.35	29.18	30.38	32.57
396,836	29.38	29.79	30.08	29.50	29.94	31.85

LSD (p=0.05) 1.59

CONCLUSIONS

The results of this experiment, indicate that yield could be increased significantly by increasing the plant density to 352,733 plants/ha from presently recommended density of 148,148 plants/ha. This increase requires application of gypsum at 500 kg/ha at flower initiation time.

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