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Effect of Different Levels and Frequency of Nitrogen Application on the Nodulation of Groundnut(*Arachis hypogea* L) in Regosols

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Abstract

This investigation was conducted in order to study the effect of levels and frequency of nitrogen application on the nodulation of groundnut in the regosols. The experiment tested five levels of nitrogen (0,15,30,45 and 60 kg/ha).A uniform application of 15 kg N/ha,45 kg K_2O/ha and 60 kg P_2O_5/ha was made as basal dressing. Topdressing at the rate of 15 , 30 and 45 kg N/ha was done either as a single application or in two split doses. There was a significant increase in nodulation at lower level of nitrogen i.e upto 30 kg/ha,thus emphasizing that a minimal amount of applied nitrogen is necessary for nodulation. There was also an indication of reduction in nodulation at the highest level of nitrogen tested.

Introduction

Groundnut (*Arachis hypogaea* L) is an annual member of the family Papilionaceae. Which is both pulse and one of the most economically important oil seed crop grown all over the world. Because of this' nature it is called "King of oil seeds" in Indian agriculture (Thedchanamoorthy, 1984).

Total area under groundnut cultivation in the world is about 2.00 million ha. This gave a total production of 2.26 million tones with an average yield of 1124kg/ha (FAO, 1990). Sri Lanka exported 143 MT and 170 MT of groundnut during 1985 and 1986 respectively (Division of Agricultural economics and programme; DAO, 1986). The price scheme for groundnut with shell remains from 1991 to 1994 as 8.15 Rs/kg (Central Bank report, 1994).

In Sri Lanka groundnut is grown in an extent of 10,453 ha of land with the total production of 5,617 MT(Agricultural Implementation Programme, 1993/94). The major groundnut producing districts in Sri Lanka are the Moneragala, Mullaitivu, Kurunagala, Puttalam, Hambantota, Trincomalee, Ampara, Vavuniya and Batticaloa (Agricultural Implementation Programme, Batticaloa district, 1993/94).

In the Batticaloa district groundnut is grown in an extent of about 298 ha with a total production of 204 m.t. In the Batticaloa district Manmunai south A.G.A division gave highest production (Agricultural Implementation Programme, Batticaloa district, 1993/94).

Sandy regosols is one of the major soil groups in Batticaloa district. These soils are sandy with high infiltration rate, low water holding capacity, low nutrient status and low nutrient retention capacity. In these soils, addition of organic mannures with the attendant improvement of soil physical properties may increase the yield (Thevika, 1986). Agronomically the addition of optimum level of fertilizers with split or single application at recommended crop spacing (30 x 15cm) also may increase the yield.

In, general sandy regosols are deficient in nutrients. Therefore application of fertilizers is essential to increase yield and quality of groundnut and judicious use of cultivation and increase fertilizer use efficiency (Kanwar *et al*,1978). The quantity of nitrogen to be applied depends on the fertility of the soil, plant population, rainfall distribution, other nutrient available and contribution from symbiotically fixed nitrogen (Reddy, 1988).

Nitrogen is the most important nutrient required by plants, because nitrogen is a constituent of all protein tissues and stored protein and is also involved in all metabolic activities.

Groundnut, being the leguminous plant fixes atmospheric nitrogen. But the amount fixed is not sufficient to give maximum production. So applications of nitrogen is essential at the same time that is expected to do some effect on nodulation. But so far no systematic evidences is available on the response to nitrogen on regosols as split application of topdressing (urea) also expected to give responses specially in regosoles of Batticaloa. Sandy regosols of Batticaloa was characterized by Thevika,(1986). Hence, this investigation was undertaken to study the effect of different level of nitrogen with split application of topdressing in the form of urea on the nodulation of groundnut variety (MI-1) in the regosols in Vantharumoolai.

Materials and Methods

This study was conducted at the Eastern University, Sri Lanka, Vantharumoolai which falls in the low country dry zone of Sri Lanka during the period of January to April 1995.The texture of soil at the experimental site was sandy.

Groundnut (*Arachis hypogaea*) variety - MI-1 (obtained from the seed farm at Pelwehara) was used in the experiment. It is an erect type of 3 to 3 1/2 month duration with medium size pods and seeds with a pink testa. The yield has been reported as 2800-3000 Kg/ha under good management (Dept. of Agriculture, 1990).

This experiment was carried to study the effect of five levels of nitrogen (0, 15, 30, 45 and 60 Kg N/ha) with time of nitrogen application (top dressing at different times). The basal application of nitrogen (15 kg/ha) remained constant for all the plots except those receiving zero level of nitrogen there were eight combinations of treatments.

a) **Levels of nitrogen**

N_0 - 0 Kg/ha
N_1 - 15 Kg/ha
N_2 - 30 Kg/ha
N_3 - 45 Kg/ha
N_4 - 60 Kg/ha

b) **Top dressing**

T_0 - No top dressing
T_1 - Top dressing once - one month after planting.
T_2 - Top dressing twice - one month after planting and one and a half month after planting.

The treatment Combinations were N0T0, N1T0, N2T1, N2T2, N3T1, N3T2, N4T1 and N4T2.

The experiment was conducted in a Randomized Complete Block Design (RCBD) with four replicates. Size of the plot was 3.15 m x 2.1 m. There were eight treatment combinations.

Each treatment plot had seven rows with 20 plants in each row with a total of 140 plants per plot. Out of these seven rows, two rows on either side of the plot were used as guard rows and plants from the central five rows were uprooted for assessment. The plants were spaced 15 cm in the row and 30 cm between rows.

Nitrogen was applied in the form of urea (46% N) and 15 Kg N/ha (basal) was given to all plots except the control plots. The rest of the nitrogen was applied as top dressing (once or twice) either at 1 and $1^1/_2$ months after planting. Phosphorus and potassium were applied basally in the form of triple super phosphate (45% P_2O_5) and muriate of potash (60% K_2O) at the rate of 60 Kg P_2O_5/ha and 40 Kg K_2O/ha respectively. Gypsum also was applied 30 days after planting at the rate of 400 Kg/ha.

Results and Discussion

Root

The effect of different treatments on root growth (dry weight Kg/ha) is presented in various stages of growth in Fig: 1

At 30 Days After Planting (DAP), the dry weight of root in plots which received basal fertilizer (15 Kg N/ha, 60 Kg P_2O_5/ha and 45 Kg K_2O/ha) was significantly higher by 26.65% than that in the control and the differences among other treatments were not significant. This may be the application of top dressing at 26 DAP did not show any immediate effect.

At 60 DAP, Dry Weight of root in plot not receiving any fertilizer was the lowest and applying 15 Kg N/ha (N_1T_0) as basal dressing increased dry weight of root by 10.26%. Although there was a trend of increasing root dry weight as nitrogen level increased, the difference in root dry weight among treatments receiving 30 Kg N/ha and 45 Kg N/ha were not significant. However, dry weight of root in plot which received N at 45 Kg/ha in two split doses (N_3T_2) was significantly higher (by 13.95%) than that in plot which received basal fertilizer (N_1T_0) only. Treatments where nitrogen was applied at the rate of 60 Kg/ha (N_4T_1 and N_4T_2) gave higher root weight than all other treatments. But there was no significant difference in root dry weight between treatments receiving 60 Kg N/ha as single dose and 60 Kg N/ha in two split doses. Nicholaids in and Cox (1970) reported that the nitrogen content of root has been shown to increase with increasing rate of nitrogen.

At 90 DAP, dry weight of root in plot which received basal fertilizer (N_1T_0) was significantly higher (by 14.9%) than that in the control and was significantly lower (by 9.26%) than plot which received 30 Kg N/ha in single dose (N_2T_1). At the same time dry weight of root in plot which received 30 Kg N/ha in two split doses (N_2T_2) was significantly higher (by 6.78%) than that in plot which received 30 Kg N/ha in single dose (N_2T_1) and was significantly lower (by 11.11%) than in plot which received 45 Kg N/ha in single dose (N_3T_1). Treatments where nitrogen was applied at the rate of 60 Kg/ha (N_4T_1 and N_4T_2) gave higher root yield than all other treatments except where nitrogen was applied at 45 Kg/ha in two split doses (N_3T_2). Kumuthini (1994) tested two levels of nitrogen (15 and 30 Kg/ha) on sandy soil but did not get any significant effect in growth of root.

Therefore the results indicate that there was a gradual increase in root dry weight with increase in level of nitrogen up to 60 Kg/ha. The split doses gave a better response than that obtained with a single dose specially at lower level of nitrogen.

Nodulation

Nodules

The effect of different treatments on dry weight of effective nodules (Kg/ha) at various stages of growth is presented in Fig: 2

At 30 Days After Planting (DAP) dry weight of effective nodules in plots which received basal fertilizer (15 Kg N/ha, 60 Kg P_2O_5/ha and 45 Kg K_2O/ha) was increased significantly (by 81.21%) than that in the control and there was a significant difference among other treatments. This may be due to addition of nitrogen as basal dressing.

At 60 DAP, dry weight of effective nodules in plot which receive basal fertilizer (N_1T_0) was significantly higher (by 54.17%) than that in the control. Treatments where nitrogen was applied at the rate of 60 Kg/ha and 30 Kg/ha in single dose (N_2T_1) gave significantly higher dry weight of effective nodules than that in other treatments except where nitrogen was applied at 30 Kg/ha in two split doses (N_2T_2). Although there was a trend of reducing effective nodules dry weight as nitrogen level increased beyond the treatment which received nitrogen at 30 Kg/ha in single dose (N_2T_1) the decrease in effective nodule dry weight was not significant except in the treatments which received nitrogen at 60 Kg/ha (N_4T_1 and N_4T_2), where the plot which received single dose gave significantly higher effective nodule dry weight (by 20.83%) than that in control which received two split doses. Allos and Batholomeco (1959) found that elemental nitrogen was fixed only when a small amount of combined nitrogen were present.

At 90 DAP, the dry weight of nodules in plots which received basal fertilizer (N_1T_0) was significantly higher (by 53.58%) than that in the control and also gave significantly higher response than that in other treatments except In the treatment which received nitrogen at 30 Kg/ha. Although there was a trend of reducing effective nodule dry weight as nitrogen level increased beyond the 30 Kg/ha the differences in effective nodules dry weight among those treatments were not significant. Webber (1960) found that the amount of symbiotically fixed nitrogen depended mainly upon the availability of soil nitrogen. Nodule weight, number, size and the amount of nitrogen symbiotically fixed were inversely related to the increasing fertilizer nitrogen. Kumuthini (1994) tested two levels of nitrogen (15 and 30 Kg/ha) on sandy soil but did not get any response to nodulation. Thoraton (1946); Lyons and Early (1952); Beard and Hoover (1971); Harper and Cooper (1971) reported that nitrogen fixation would be inhibited completely when nitrogen was applied in excess of plant requirement and that only under those conditions the nodule mass would be reduced.

The above results indicate that higher nodulation was observed in the plot which received basal fertilizer and in treatments which received nitrogen at 30 Kg/ha. Nitrogen applied at higher level beyond 30 Kg/ha decrease nodulation. At the same time lower nodule yield was observed in plot which not received any fertilizer (control), thus emphasizing that a minimal amount of applied nitrogen is necessary for nodulation.

Nodule Number

The effect of different treatments on number of effective nodules per hectare at various stages of growth is presented in Fig: 3

At 30 DAP the number of effective nodule in plot which received basal fertilizer (N_1T_0) was significantly higher (by 41.24%) than that in the control and the differences among the other treatments were not significant. This may be due to the addition of nitrogen as basal dressing.

At 60 DAP, the number of nodules in plot which received basal fertilizer was significantly higher (by 48.5%) than that in the control and was significantly lower (by 13.04%) than that in plot which received 30 Kg N/ha in single dose (N_2T_1). The number of effective nodules in plot which received nitrogen at 30 Kg/ha in two split doses (N_2T_2) was significantly higher (by 13.43%) than that in plot which received nitrogen at 45 Kg/ha in single dose (N_3T_1) and was significantly lower(by 12.11%) than that in plot which received nitrogen at 30 Kg/ha in single dose (N_2T_1) but the difference was not significant than that in plot which received nitrogen at 45 Kg/ha in two split doses. The number of effective nodules in treatments which received nitrogen at 60 Kg/ha was significantly lower (by 18.34%) than that in plot which received nitrogen at 45 Kg/ha in two split doses (N_3T_3) and also total number of effective nodules in this level of nitrogen (60 Kg/ha) was lower than that in the 30 DAP. This may be due to the immediate effect of higher dose of nitrogen (60 Kg/ha). Gloria (1971) reported that application of nitrogen only increased the number of nodules during the raining season planting. Nodule number and the size are usually reduced when the supply of fertilizer nitrogen is increased. Sivraj (1978) reported that nitrogen deficiency in groundnut plant lead to general chlorosis of leaves and reduced greater numbers and bigger nodules at depths of 40 cm.

At 90 DAP, number of effective nodules in plot which received basal fertilizer (N_1T_0) was significantly higher (by 65.43%) than that in control. The number of effective nodules in plot which received nitrogen at 15 Kg/ha (basal) and 30 Kg/ha in single dose gave significantly higher response than the other treatments except in plot where nitrogen applied at 30 Kg/ha in two split doses (N_2T_2) and in treatments which received nitrogen at 45 Kg/ha (N_3T_1 and N_3T_2). Although there was a trend of reducing number of nodules as nitrogen level increased beyond the 30 Kg/ha the differences in number of nodules were not significant. Hatfield et al (1974) found that the addition of nitrogen for two weeks following seedling emergence increased the number of nodules and the result provided evidences of the importance of soil nitrogen for the initiation of growth of groundnut even with adequate nodulation.

Although there was a significant increase in nodulation with addition of lower level of nitrogen up to the level of 30 Kg/ha nodulation was reduced as the nitrogen level increased beyond 30 Kg/ha. This results showed that addition of higher level of nitrogen affect the nodulation. There was also an indication that at the highest level of nitrogen tested split doses reduce nodulation.

Conclusion

An experiment conducted to study the response to five levels of fertilizer nitrogen(0,15,30,45 and 60 kg/ha) with a uniform basal fertilizer(15kgN/ha, 40 kg K_2O/ha and 60 kg P_2O_5/ha) and topdressing as single and two split doses at the levels of 30, 45 and 60kg/ha showed that in general there was a response to applied nitrogen levels ranging from 15-60 kg/ha for root dry weight. The nodulation increased as nitrogen level increased up to the level of 30kg/ha, nitrogen applied at higher level beyond 30kg/ha decreased nodulation. This emphasizing that a minimal amount of applied nitrogen is necessary for nodulation (Nodule number and dry weight).

Figure 1: Effect of different levels and frequency of nitrogen application on dry weight of root.

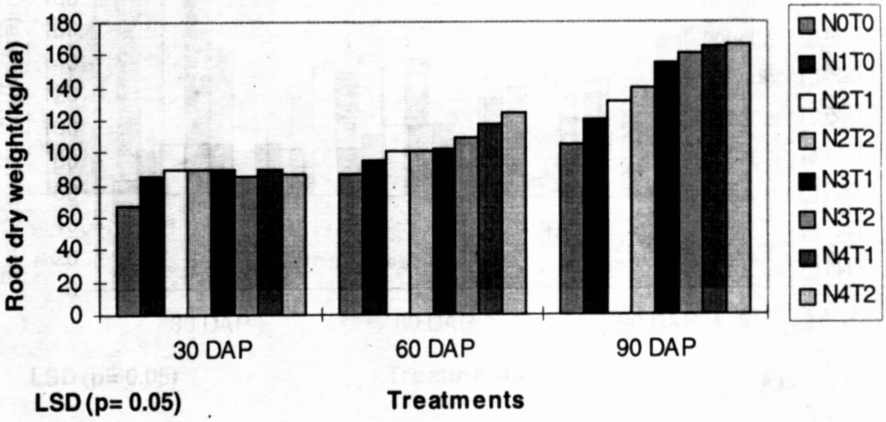

Figure 2: Effect of different levels and frequency of nitrogen application on dry weight of nodules(kg/ha)