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Effect of gypsum application on yield performance of groundnut (A*rachis hypogea* L.) Varieties in Kilinochchi district, Sri Lanka

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Abstract

Groundnut (*Arachis hypogea* L.) is an important oil crop grown in Sri Lanka. Application of fertilizer is substantially contributing to the yield increment; however improper management of fertilizer is the specific drawback in quality and quantity in groundnut. Therefore, the application of balanced fertilizer and minerals play an important role in the cultivation of groundnut. An experiment was conducted at the Department of Agronomy, Faculty of Agriculture, Kilinochchi to assess the effect of different rates of gypsum application on yield performance of groundnut varieties from January to May 2019. Two-factor factorial experiment was conducted in Randomized Complete Block Design (RCBD) with three replications. Four different rates of gypsum application such as 0 kg/ha (T_1 - Control), 75 kg/ha (T_2), l25 kg/ha (T_3), and 175 kg/ha (T_4) were used as the first factor and five groundnut varieties, namely Tissa

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(V_1), Lanka Jumbo (V_2), Tikiri (V_3), Indi (V_4), and ANK G1 (V_5) were used as the second factor. All the agronomic practices were done according to the recommendations of the Department of Agriculture. The yield parameters were recorded, and the shelling percentage was calculated. Data were analyzed using SAS 9.1 package to perform ANOVA. The best treatment was identified through the means separation using Duncan's Multiple Range Test (DMRT) at p = 0.05. The yield parameters of fresh and dry weight of pods / plant, hundred pods and seeds weight, number of mature and immature pods and total yield were higher in gypsum applied treatments rather than control and the highest in T_4 (175 kg/ha gypsum) treatment. All the yield parameters were significantly different in Lanka Jumbo and ANK G1 from other varieties. However, the number of mature pods and shelling percentage were similar among the varieties. The highest shelling percentage (96 %) was recorded in Lanka Jumbo under 175 kg/ha gypsum application (T_4). The highest yield parameters were recorded in Lanka Jumbo variety, whereas the lowest was in ANK G1. There was no interaction effect among gypsum application and varieties in the yield parameters. From this study, it can be concluded that the application of 175 kg/ha gypsum (T_4) to the variety of Lanka Jumbo (V_2) can be selected as suitable treatment combination to obtain the substantial yield from groundnut in *Yala* season.

Keywords: groundnut, gypsum, shelling percentage, varieties, yield parameters

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) belongs to the family Fabaceae. It is also called peanut, earthnut, monkey nut, pinda, goober, and manila nut (Beghin *et al.,* 2003). It contains 48 - 50 % of oil, 26 - 28 % of protein, and 11 - 27 % of carbohydrates, minerals, and vitamins (Mukhtar, 2009). Groundnut is having several economic importance like extraction of edible oil, eaten as roasted nut, used to prepare peanut milk, butter, snacks, and confectionaries. Oil of groundnut is used in the industries to produce soap, cosmetic cream, plasters, and oil. After oil extraction, the cake is used as a protein supplement in animal feed. Being a legume crop, groundnut enriches soil nutritional status by fixing nitrogen without draining the nonrenewable energies and without disturbing the agro-ecological balance (Reddy and Kaul, 1986), and thereby increasing the productivity of other crops in the cropping systems.

Groundnut is grown on nearly 23.95 million ha worldwide with a total production of 36.45 mt million tons and an average yield of 1520 kg ha^{-1} (FAOSTAT, 2019). In dry and intermediate zones of Sri Lanka, it can be grown as a rainfed crop in highlands during *Maha* season and irrigated crop in paddy lands during *Yala* season. Groundnut is grown mainly in Moneragala, Kurunegala, Ampara, Badulla, Puttalam, and Rathnapura districts of Sri Lanka. It was cultivated to an extent of 11,609 ha with a total production of 21,953 t and an average yield of 1890 kg ha^{-1} in Sri Lanka (DOA, 2019). In Northern Province of Sri Lanka, groundnut is cultivated in 3,914 hectares of land and its production was 6,305 t (Vavuniya 807 hectares, Mullaitivu 2648 hectares, Kilinochchi 154 hectares, Mannar 170 hectares, and Jaffna 135 hectares) (DOA, 2018 - 2019). Eight varieties of groundnut were released by the Department of Agriculture (DOA) such as Red Spanish, Number 45, Tissa, Walawe, Indi, Tikiri, ANK G1, and Lanka Jumbo and out of these at present, Red Spanish and number 45 are not cultivated in large extent (www.agridept.ac.lk).

Groundnut is grown in well-drained sandy loam or clay loam soil. Deep well-drained soils with a pH of 6.5–7.0 and high fertility are ideal for groundnut cultivation. Balanced use of fertilizer is said to play an important role in sustainable crop production (Afridi *et al.*, 2002). In addition to primary nutrients N, P, K, calcium, and sulfur also plays an important role in enhancing the production and productivity of groundnut. Sulfur is very crucial for the formation of sulfur-containing amino acids and oil synthesis as well as it is also improving both the yield and quality of crops (Patel and Patel 1994). Calcium nutrition is also considered a yield-limiting factor for groundnut production. Calcium absorbed by the roots is not translocated to the developing pod whereas calcium required for pod formation is absorbed directly from the soil solution. Calcium and sulfur as main nutrients also act significant position in raising yield and efficiency of groundnut. Sulfur is incredibly vital for the creation of amino acids with sulfur and oil production, and it also enhances yield as well as quality (Kalamkar, 2006).

The application of calcium ($CaCO_3$) is important for proper kernel development in groundnut (DOA, 2006). Calcium carbonate can be used as a calcium source but compared to Gypsum; it is slow releasing of nutrients due to less solubility. Therefore, gypsum ($CaSO_4.2H_2O$) can be used at the flowering stage to ensure the adequate availability of Ca in the fruiting zone to enhance the pod development. Chapman *et al*. (1993) reported that the less amount of soluble calcium in the pegging zone causes low

peg formation. The researchers found that the groundnut pegs and pods treated with gypsum had significantly less pod rot than the untreated.

There is no extensive study was done regarding the rate of gypsum application and its impact on the yield of groundnut especially in Northern region of Sri Lanka. The use of gypsum may be considered as an important factor for increasing groundnut yield in Northern area. With this view, the present study was undertaken to evaluate the effect of different rates of gypsum application on yield performance of different groundnut varieties in Kilinochchi District of Sri Lanka. The main objective of this study was to assess the impact of varying rates of gypsum application in yield responses of selected groundnut varieties. Sub-objective of the studies was to evaluate the number of pods and shelling percentage under the different rates of gypsum application with different varieties of groundnut.

MATERIALS AND METHODS

A field experiment was carried out at the Faculty of Agriculture, Ariviyal Nagar, Kilinochchi (belongs to the agro-ecological region of DL_3) from January to May 2019. The experimental site soil is well drained, clay loam in texture. The area receives mean annual rainfall ranges from 1040 mm to 1560 mm. The daily mean minimum and maximum temperature is 28 °C and 33 °C, respectively. Two-factor factorial experiment was carried out in Randomized Complete Block Design (RCBD) with three replications. Different rates of gypsum such as 0 kg/ha (T_{1-} Control), 75 kg /ha (T_2), 125 kg /ha (T_3), and 175kg /ha (T_4) were used as the first factor, and five groundnut varieties *viz*. Tissa (V_1), Lanka Jumbo (V_2), Tikiri (V_3), Indi (V_4), and ANKG1 (V_5) were used as the second factor. Certified seeds were collected from the district agriculture research and training Centre, Kilinochchi. Unshelled seeds were mixed with captan fungicide (4 g/kg) and kept for 2 - 3 hours. Planting was done in the recommended spacing of 45 cm × 15 cm with the rate of one seed per hill. In each plot, 24 seeds were planted. Gap filling was done by replanting the groundnut plants which were produced in the small cups simultaneously during field planting and the same plant population was maintained in the field for each treatment. All other management practices were carried out according to the recommendations of the Department of Agriculture (http: //www. agridept.gov.lk/index.php/en/crop-recommendations/988). The earthing-up was done 37 days after planting (Thilini *et al.*, 2018) at the height of 5 cm from the collar region (Ragulan *et al*., 2016). At the time of earthing-up, the gypsum was applied according to the treatments.

Groundnut varieties were harvested at different periods when those varieties reached maturity by vein yellowing and leaves start to shed. Tissa and ANKG1 varieties were harvested 95 days after planting and Lanka Jumbo, Indi, Tikiri Varieties were harvested at 110 days after planting. After harvesting, the pods were separated from the plants and allowed to sundry for 5 days until the pods are dried.

The yield parameters such as fresh weight of pods per plant (g), dry weight of pods per plant (g), number of mature pods per plant, number of immature pods per plant, 100 pods weight (g), 100 seed weight (g) and the total yield were recorded and shelling percentage (%) was calculated by five randomly selected plants from each plot.

The shelling percentage was calculated using the following equation (Ouedraogo *et al*., 2012)

$$\text{Shelling percentage (\%)} = \frac{\text{Dry Kernal weight}}{\text{Dry pod weight}} \times 100$$

To find the significant difference between treatments ANOVA was performed by using the statistical package SAS (9.1) and mean separation was done by using Duncan's Multiple Range Test at p value of 0.05.

RESULTS AND DISCUSSION

Fresh pods weight /plant (g)

There were significant differences with the treatments in all varieties at p=0.05 (Figure 1). There was no interaction effect between varieties and the rate of gypsum application. The fresh pods' weight /plant was high in gypsum application treatment compared to zero level application (T_1-Control). The highest fresh pods weight/ plant was observed in the T_4 (175 kg/ha gypsum application) treatment. There was a significant difference in Lanka Jumbo and ANK G1 varieties and other varieties showed a non-significant effect in fresh pods weight/plant (Figure 2). The highest fresh pods weight /plant (136.75 g) was recorded in Lanka Jumbo under T_4 and the lowest (78 g) in ANK G1 under T_1 treatment.

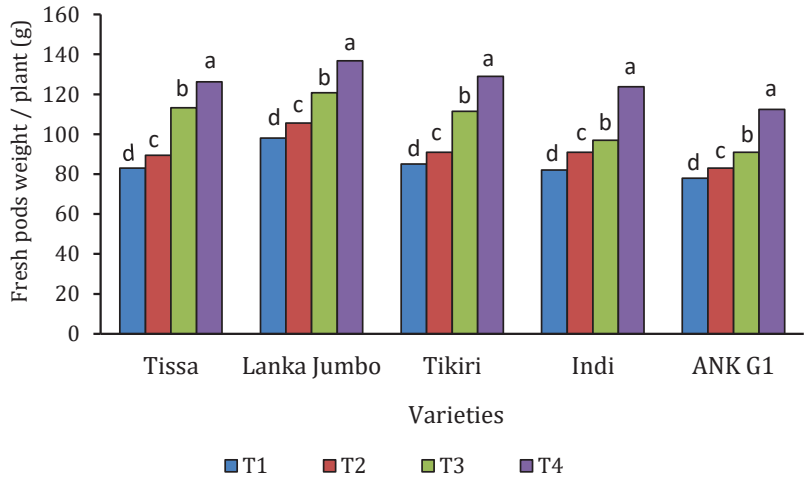

Figure 1: Fresh pods weight /plant with different varieties of groundnut. Means with the same letter within a given variety are not significantly different at p=0.05.

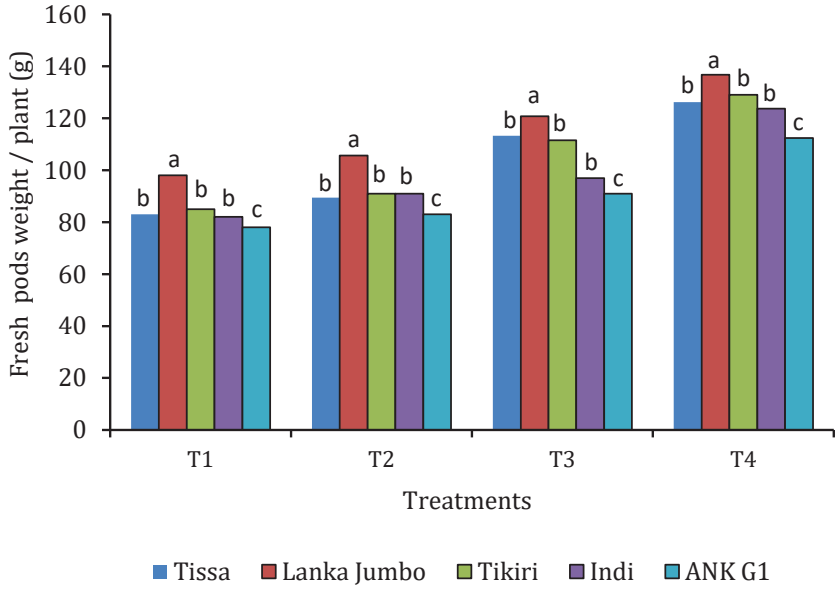

Figure 2: Fresh pods weight /plant with different gypsum treatments. Means with the same letter within a given treatment are not significantly different at p=0.05.

Dry pod weight /plant

Dry pod weight per plant showed the same trend of fresh pods weight per plant. The dry pod weight/plant was high in gypsum application treatments compared to zero level application. The highest dry pods weight/plant was observed in the T_4 (175 kg/ha gypsum application) and the lowest in T_1 (Control). The highest dry pods weight /plant (106.25 g) was recorded in Lanka Jumbo under T_4 and the lowest (67 g) in ANKG1 under T_1 treatment.

Hundred pod dry weight (g)

The hundred pod weight significantly differed among treatments except for T_2 and T_3, but all gypsum applied treatments obtained higher weight than the zero application (T_1). There was no interaction effect between varieties and treatments (Figure 3) There was a significant difference between Lanka Jumbo and ANK G1 (Figure 4). The highest 100 pods dry weight (176 g) was recorded in Lanka Jumbo under T_4 treatment and the lowest (135.36 g) in ANK G1 under T_1 treatment.

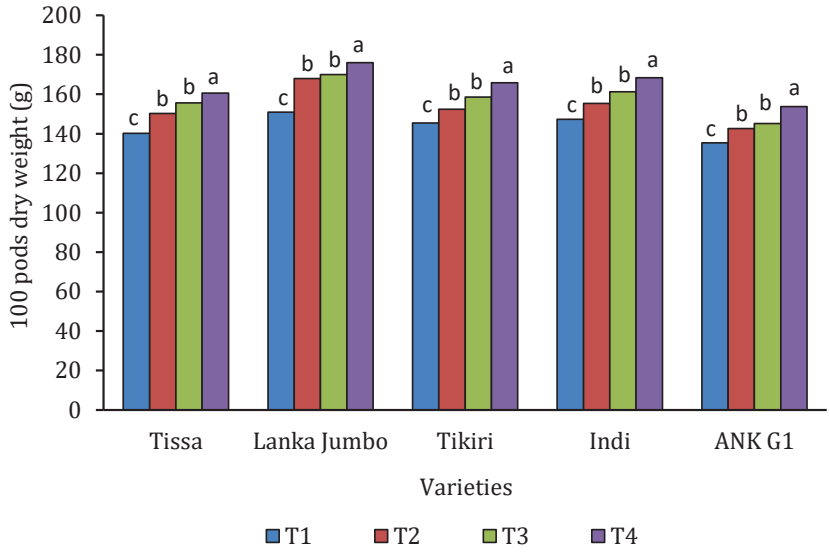

Figure 3: Hundred pods dry weight with different varieties of groundnut. Means with the same letter within a given variety are not significantly different at p=0.05.

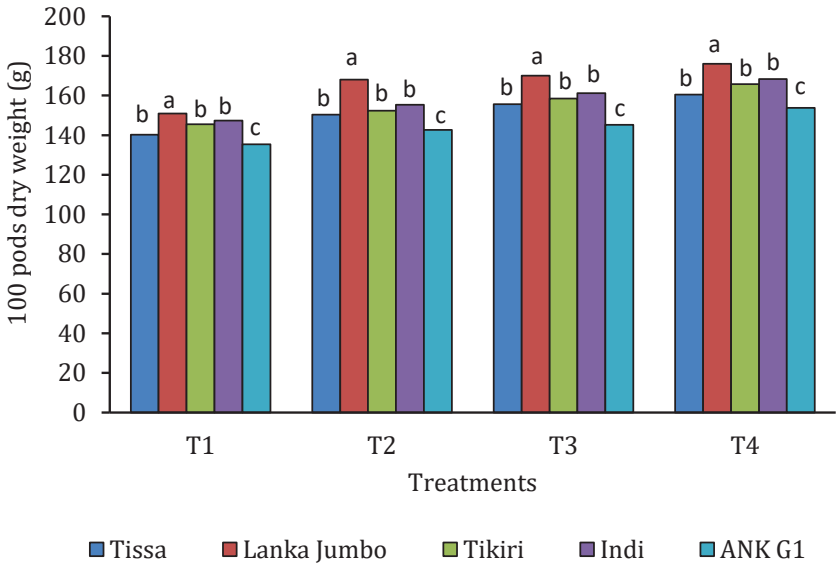

Figure 4: Hundred pods dry weight with different gypsum treatments. Means with the same letter within a given treatment are not significantly different at p=0.05.

Hundred seeds dry weight (g)

Similar to hundred pod dry weight, 100 seed dry weight also showed the same trend. The highest 100 seed weight of 95.33 g was observed in Lanka Jumbo under the T_4 treatment and the lowest was observed in the ANKG1 variety under T_1 treatment. The weight of the seed depends on the genetic characters as well as the rate of gypsum application.

Mature pods per plant

The number of mature pods per plant was significantly varied with the rate of gypsum application except for T_3 and T_2 (Figure 5). There was no interaction effect among gypsum application and varieties. Matured pod number was significantly highest in T_4 and lowest in T_1. There was no significant difference between varieties in the same treatment (Figure 6). The highest mature number of pods of 57 was observed in Lanka Jumbo variety under T_4 and the lowest number of 37 was observed in ANKG1 variety under T_1. This variation may also be due genetic characteristics of these varieties (Naeem *et al*., 2015).

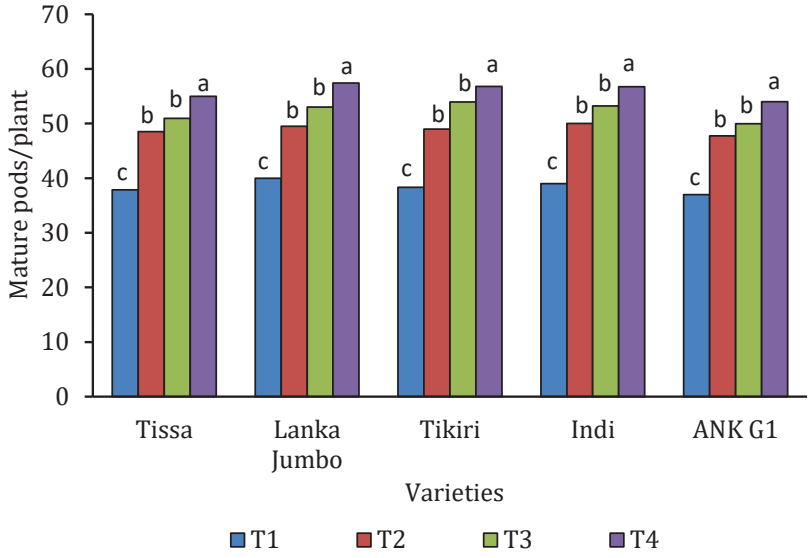

Figure 5: Mature pods /plant with different groundnut varieties. Means with the same letter within a given variety are not significantly different at p=0.05.

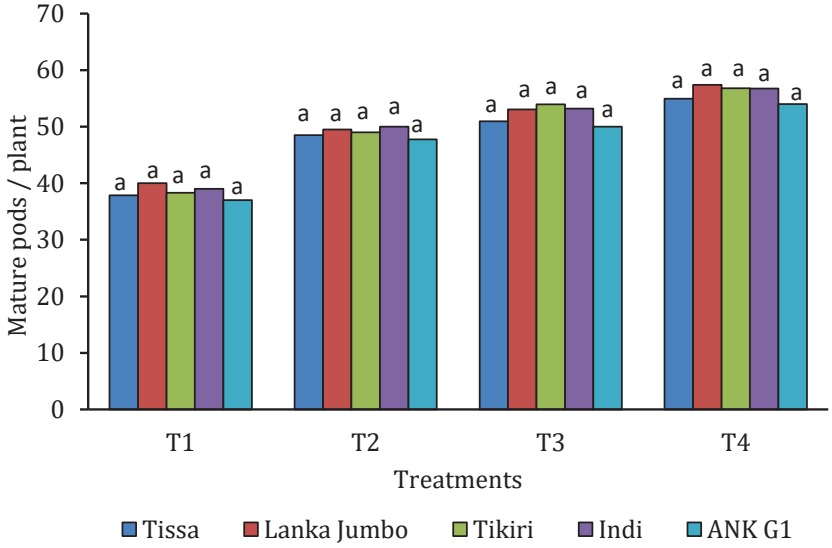

Figure 6: Mature pods /plants with different gypsum treatments. Means with the same letter within a given treatment are not significantly different at p=0.05.

Immature pods /plants

The number of immature pods per plant was significantly differed with rate of gypsum application (Figure 7) in all tested varieties of groundnut. There was no interaction effect among treatments and varieties. The immature pod number was significantly highest in T_1 and lowest in T_4 in all varieties. It may be the effect of gypsum application. There was a significant difference between varieties in the same treatment (Figure 8). The highest immature number of pods of 22 was observed in ANK G1 variety under T_1 (0 level) and the lowest number of 8 was observed in Lanka Jumbo variety under T_4.

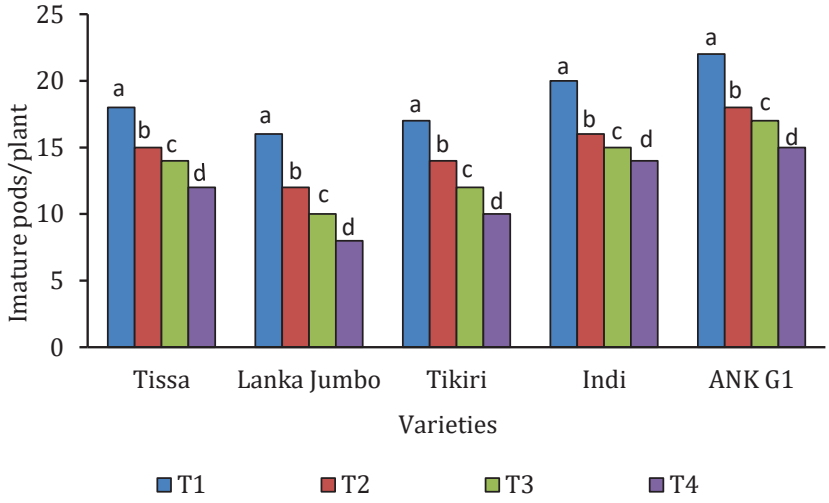

Figure 7: Immature pods per plant with groundnut varieties. Means with the same letter within a given variety are not significantly different at p=0.05.

Shelling percentage

There was a significant difference among treatments in all varieties in shelling percentage (Figure 9). There was no interaction effect between treatments and varieties. The highest shelling percentage was observed in T_4 treatment in each variety. The highest shelling percentage was observed in a variety of Lanka Jumbo compared to other varieties (Figure 10). The highest shelling percentage (96 %) was observed in the Lanka Jumbo variety under the T_4 treatment. A higher shelling percent indicates

less seed case (pod) weight and more seed weight (Jeyaramraja and Woldesenbet, 2014). Ouedraogo *et al*. (2012) indicated that the sandy soil

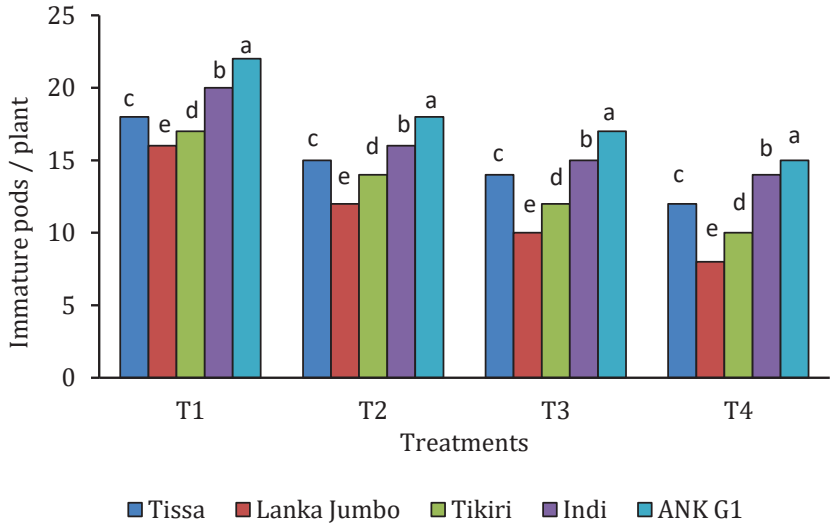

Figure 8: Immature pods per plant with treatments. Means with the same letter within a given treatment are not significantly different at p=0.05.

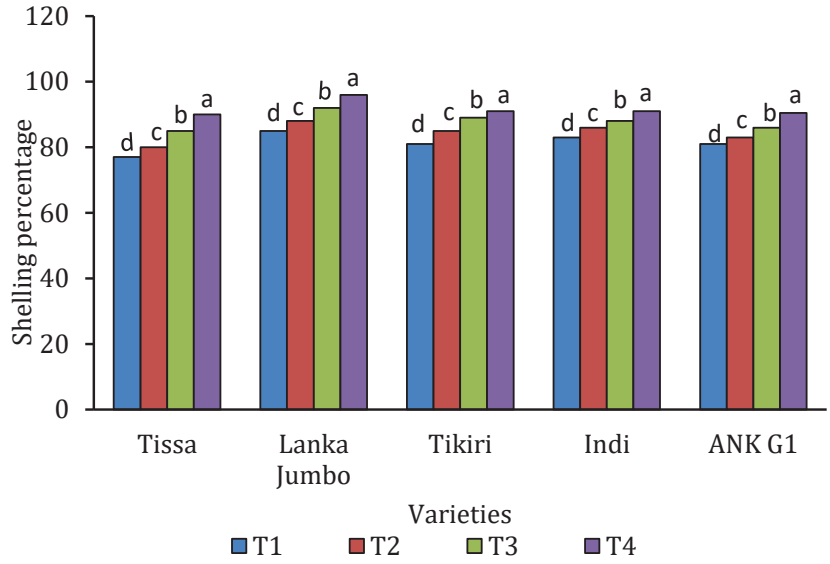

Figure 9: shelling percentage with groundnut varieties. Means with the same letter within a given variety are not significantly different at p=0.05.

structure, temperature, and rainfall allowed the expression of the genetic potential of the landraces that had a high rate of pod filling.

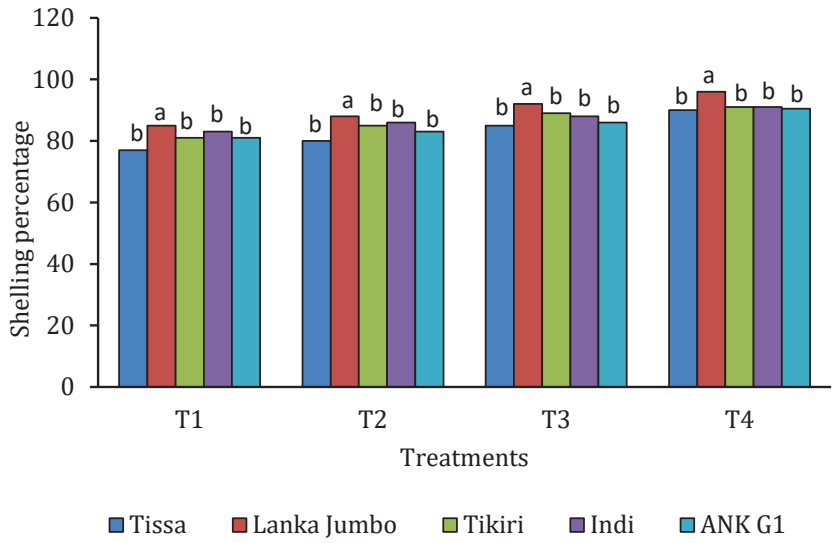

Figure 10: Shelling percentage with treatments. Means with the same letter within a given treatment are not significantly different at p=0.05.

Yield of groundnut

The average total groundnut yield (t /ha) was significantly different among the treatments in each variety (Figure 11). There was no interaction effect between varieties and treatments. The highest yield was observed in T_4 treatment and the lowest in T_1 treatment in all varieties. There was a significant difference between varieties except for Tisssa, Tikiri, and Indi in the same treatment (Figure 12). The highest groundnut yield (4.5 t / ha) was observed in the Lanka Jumbo groundnut variety (V_2) under the T_4 when compared with the other treatments. The lowest yield of 3.2 t /ha was observed in the ANK G1 (V_5) under the T_1. The yield was significantly higher in the Lanka Jumbo variety than other varieties. Some research studies demonstrated that groundnut yield increased with applying of fertilizer including sulfur and calcium such as single superphosphate, elemental sulfur, gypsum, and ammonium sulfate in the alkali soils (Maccio *et al*., 2002; Murata, 2003; Sumner, 1995). Wiatrak *et al*. (2006) indicated that gypsum application may help to increase peanut yields in years with

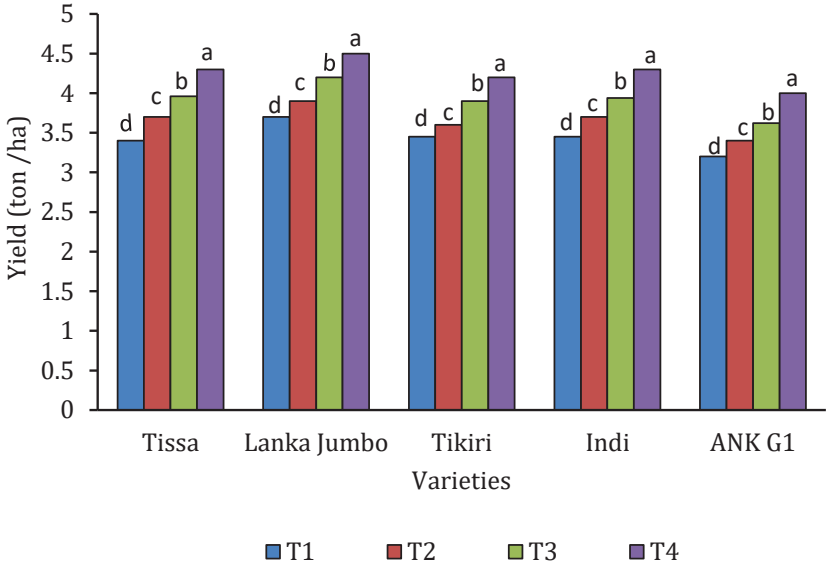

Figure 11: Yield (ton /ha) with groundnut varieties. Means with the same letter within a given variety are not significantly different at p=0.05.

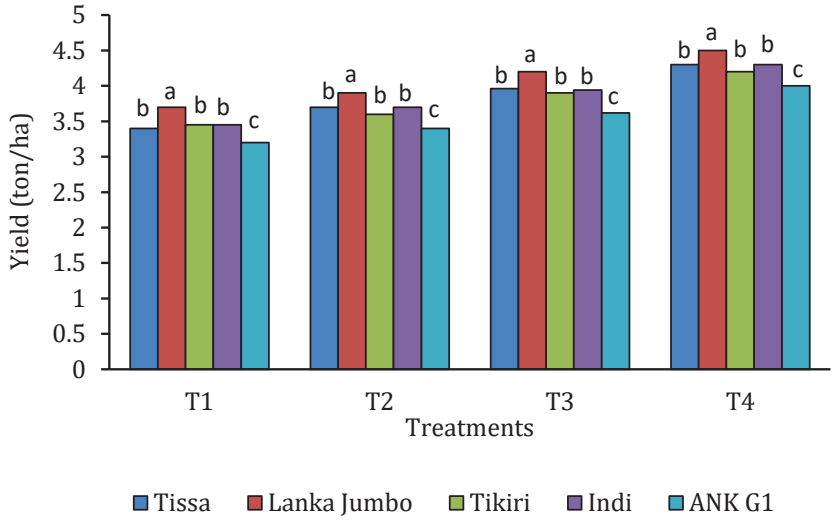

Figure 12: Yield (ton /ha) with treatments. Means with the same letter within a given treatment are not significantly different at p=0.05.

high potential yield by increasing Ca availability in the fruiting zone. They reported that peanut yields were higher with gypsum application compared to the treatment without gypsum application.

CONCLUSIONS

The rate of gypsum application of each variety of groundnut significantly influenced the yield parameters. Among the gypsum application, 175 kg /ha showed the highest yield than the other rates of application. Among the varieties, Lanka Jumbo variety gave the highest yield. The highest shelling percentage was obtained in Lanka Jumbo variety under 175 kg/ ha gypsum application (T_4). Therefore, Lanka Jumbo variety and 175 kg/ ha gypsum application combination can be recommended to Kilinochchi to obtain a high yield in Groundnut.

SUGGESTIONS

This experiment should be repeated during *Maha* season for evaluating the performance of groundnut varieties under different climatic conditions. Research should be carried out with other rates of gypsum application and groundnut varieties.

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