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# Influence of planting densities and phosphorus levels on light interception and quality of groundnut

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## ABSTRACT

To find out the influence of different planting densities and phosphorus levels (P) on light interception and quality of groundnut, a field experiment was laid out in a randomized block design with factorial concept during *rabi,* 2019-20 under high density planting (22.5 x 10 cm - 4.44 lakh ha$^{-1}$; 20 x 7.5 cm - 6.66 lakh ha$^{-1}$; 22.5 x 5 cm - 8.88 lakh ha$^{-1}$ with graded levels of phosphorus (25, 37.5, 50 and 62.5 kg $P_2O_5$ ha$^{-1}$). The study disclosed that Planting density of 4.44 lakh ha$^{-1}$ registered higher light interception at 25 DAS and at harvest but at 50 DAS and 75 DAS 8.88 lakh ha$^{-1}$ recorded higher light interception. Protein and oil content was not influenced by plant densities and phosphorous levels even at higher dose of P application. Phosphorus levels did not show any-significant impact on light interception but plant densities showed significant impact on light interception.

***Key words:*** *Groundnut, Light interception, Phosphorus, Plant density and Quality*

Groundnut (*Arachis hypogaea* L.) significantly contribute to both economic stability and food security. Planting density and soil phosphorus availability shown to have a significant impact on groundnut quality and output. Studies have indicated that crop canopy design and light interception are controlled by planting density, which in turn affects photosynthetic efficiency and biomass accumulation. Kumara *et al.* (2018), has demonstrated that ideal planting density can improve radiation use efficiency and light interception, which in turn can raise groundnut yield and quality attributes. Very dense planting densities can cause intra-specific rivalry for resources, which would limit light penetration, under utilize resources, and eventually lower productivity (Ghassemi-Golezani *et al.,* 2019). Moreover, phosphorus is an essential macronutrient that has a variety of functions in the physiology and metabolism of plants. In groundnut, phosphorus deficit reduces photosynthetic activity, nitrogen uptake and yield (Siddique *et al.,* 2018). On the other hand, sufficient phosphorus availability can ease these limitations, encouraging active root growth and nutrient uptake, and eventually improving crop output (Huang *et al.,* 2018). Ganesamurthy *et al.* (2020) and Shanmugasundaram *et al.* (2015) has shown that phosphorus fertilisation and planting density work in concert to boost groundnut yield, nutrient assimilation and light interception. This study is to methodically examine the impact of various planting densities and phosphorus levels on groundnut quality and light interception in light of the body of existing knowledge. In this context, this paper presents a comprehensive examination of the influence of planting density and phosphorus levels on groundnut cultivation, shedding light on their combined effects on light interception and the nutritional quality of groundnut kernels.

## MATERIAL AND METHODS

The field experiment was conducted during *rabi*, 2019-20 at dryland farm of S. V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, which is geographically situated at 13.5°N latitude and 79.5°E longitude, with an altitude of 182.9 m above mean sea level, which falls under Southern Agro-climatic Zone of Andhra Pradesh and according to Trolls classification, it falls under Semi-Arid Tropics.

Rainfall amount of 25.6 mm was not sufficient to provide the required moisture for completion of crop cycle, irrigation was provided as and when required. Weekly mean bright sunshine hours day$^{-1}$ ranged from 4.6 to 9.7 hours day$^{-1}$, with an average of 7.8 hours day$^{-1}$ compared to decennial mean of 6.9 hours day$^{-1}$. Weather variables were within the cardinal range so as to enable the crop to reasonably express the effect of imposed treatments.

The experiment was laid out in a randomized block design with a factorial concept, with three replications. The treatments comprised of three plant densities *viz*., 22.5 cm x 10 cm ($D_1$), 20 cm x 7.5 cm ($D_2$) and 22.5 cm x 5.0 cm ($D_3$) and four phosphorus levels *viz*., 25.0 kg $P_2O_5$ ha$^{-1}$ ($P_1$), 37.5 kg $P_2O_5$ ha$^{-1}$ ($P_2$), 50.0 kg $P_2O_5$ ha$^{-1}$ ($P_3$) and 62.5 kg $P_2O_5$ ha$^{-1}$ ($P_4$). Groundnut was sown on 11$^{th}$ December 2019 and the variety tested was 'Dharani' which is a medium statured spanish bunch type, with yield potential of 2600 kg ha$^{-1}$ and 3400 kg ha$^{-1}$ during *kharif* and *rabi*, respectively, with an average oil content of 49 %. The recommended dose of fertilizer for groundnut crop was 30 - 50 - 50 N, $P_2O_5$ and $K_2O$ kg ha$^{-1}$. Recommended dose of nitrogen @ 30 kg ha$^{-1}$ was applied through urea in two splits at sowing and at 30 DAS. The recommended potassium @ 50 kg ha$^{-1}$ as muriate of potash was applied as basal dose at the time of sowing. Phosphorous was applied as basal at sowing as per the treatments through single super phosphate. Gypsum was applied @ 500 kg ha$^{-1}$ before flowering through furrow placement near the root zone.

Light interception for the randomly selected five plants from net plot area was recorded using quantum sensor at different heights of the plant, averaged and expressed in percentage.

The oil content in seed was determined by using Nuclear Magnetic Resonance Spectrophotometer as suggested by Tiwari *et al.* (1974) and the results were recorded from the digital display and expressed as percentage.

$$\text{Light Interception} = \frac{\text{Light intensity at canopy top - light intensity at canopy bottom}}{\text{light intensity at canopy top}} \times 100$$

The protein content of the seed was estimated by spectrophotometer as per the procedure laid down by Lowry *et al*. (1951) and expressed in percentage.

Panse and Sukhatme (1985) analysis of variance technique for randomised block design with factorial concept was followed in the statistical analysis of the data acquired on various parameters. At the five percent probability level, the F value was used to evaluate for statistical significance. At the five percent significance level, the critical difference for the major causes of variation was computed, and the findings were reported as significant or non-significant.

## RESULTS AND DISCUSSION

### Light interception

Significantly higher light interception was found with lower plant density (4.44 lakh ha$^{-1}$) at 25 DAS and harvest, followed by plant densities of 6.66 and 8.88 lakh ha$^{-1}$ which were comparable with each other (Table 1). At 50 DAS and 75 DAS of groundnut, the light interception at higher plant density of 8.88 lakh ha$^{-1}$ was found to be significantly superior over lower plant density (4.44 lakh ha$^{-1}$) and statistically at par with the interception at 6.66 lakh ha$^{-1}$. At 25 DAS penetration of light into deeper layers of plant canopy was higher in lower plant density due to sparse population, hence, higher light interception was recorded. But at higher plant densities, excessive plant population per unit area obstructed light interception reaching bottom layers of the plant canopy. But at 50 DAS and 75 DAS due to increase in vegetative plant frame and cumulated radiation interception among plants, light interception was superior in higher plant densities. At harvest lower plant density (mention the treatment) recorded higher light interception which might be due to increased leaf senescence and internal competition with increased plant population (Herbert, 1977). These findings are in proximity to Ayaz *et al.* (2004) and LinLi *et al.* (2008). At all the stages of crop growth, phosphorus levels did not exert any significant influence on light interception.

### Protein and Oil Content (%)

Protein content of groundnut was found to be non-significant due to the fact that protein content is more related to nitrogen which is an integral part of protein (Chaudhari *et al*., 2018). However, 6.66 lakh ha$^{-1}$ and phosphorus dose of 50 kg $P_2O_5$ ha$^{-1}$ recorded higher maximumcontent (Table 2). Oil content of groundnut was found to be non-significant.

This might be due to the fact that oil content is more of genetic character and it may not be altered agronomically within a season (Bihter *et al*., 2017). However, lower plant density of 4.44 lakh $ha^{-1}$ and higher phosphorus dose of 50 kg $P_2O_5$ $ha^{-1}$ recorded maximum oil content and was similar with the other treatments tested. These findings were in proximity with Mirvat *et al.* (2006), Subrahmaniyan *et al.* (2010).

## CONCLUSION

The planting density in this study (4.44 lakh $ha^{-1}$ at 25 DAS and at harvest; 6.66 lakh $ha^{-1}$ at 50 and 75 DAS) greatly affected light interception.However, phosphorus levels have no direct effect on light interception, but they may have an indirect effect by influencing dry matter production, which in turn affected LAI, which createed the space for light interception. Plant densities and P levels had little effect on the amount of protein or oil present. The findings should be further examined because phosphorus is necessary for nucleic acid synthesis *etc.* in plants and plant densities affect how much P is absorbed from the soil.

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**Table 1. Light interception (%) by groundnut canopy at different crop growth stages as nfluenced by plant densities and phosphorus levels**

| Treatments | 25 DAS | 50 DAS | 75 DAS | Harvest |
|---|---|---|---|---|
| **Plant densities (D)** | | | | |
| **$D_1$:** 4,44,444 (22.5 cm x 10 cm) | 48.8 | 70.4 | 72.6 | 43.7 |
| **$D_2$:** 6,66,666 (20 cm x 7.5 cm) | 41.7 | 80.1 | 79.1 | 39.1 |
| **$D_3$:** 8,88,888 (22.5 cm x 5 cm) | 38.8 | 80.5 | 79.8 | 37.8 |
| **SEm±** | 2.10 | 1.35 | 1.12 | 1.77 |
| **CD (P = 0.05)** | 6.1 | 3.9 | 3.3 | 3.6 |
| **Phosphorus levels (P)** | | | | |
| **$P_1$:** 25 kg $P_2O_5$ $ha^{-1}$ (50 % RDP) | 42.3 | 73.7 | 74.5 | 38.1 |
| **$P_2$:** 37.5 kg $P_2O_5$ $ha^{-1}$ (75 % RDP) | 41.5 | 76.2 | 77.0 | 38.1 |
| **$P_3$:** 50 kg $P_2O_5$ $ha^{-1}$ (100 % RDP) | 41.9 | 79.4 | 78.4 | 42.1 |
| **$P_4$:** 62.5 kg $P_2O_5$ $ha^{-1}$ (125 % RDP) | 46.8 | 78.5 | 78.8 | 40.2 |
| **SEm±** | 2.42 | 1.56 | 1.30 | 1.44 |
| **CD (P = 0.05)** | NS | NS | NS | NS |
| **Interaction (D x P)** | | | | |
| **SEm±** | 4.20 | 2.70 | 2.24 | 2.50 |
| **CD (P = 0.05)** | NS | NS | NS | NS |

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**Table 2. Quality parameters of groundnut kernel as influenced by plant densities and phosphorus levels**

| Treatments | Protein content (%) | Oil content (%) |
|---|---|---|
| **Plant densities (D)** | | |
| **$D_1$:** 4,44,444 (22.5 x 10 cm) | 26.3 | 46.8 |
| **$D_2$:** 6,66,666 (20 x 7.5 cm) | 26.5 | 46.8 |
| **$D_3$:** 8,88,888 (22.5 x 5 cm) | 26.3 | 46.7 |
| **SEm±** | 0.07 | 0.08 |
| **CD (P = 0.05)** | NS | NS |
| **Phosphorus levels (P)** | | |
| **$P_1$:** 25 kg $P_2O_5$ $ha^{-1}$ (50 % RDP) | 26.4 | 46.8 |
| **$P_2$:** 37.5 kg $P_2O_5$ $ha^{-1}$ (75 % RDP) | 26.3 | 46.7 |
| **$P_3$:** 50 kg $P_2O_5$ $ha^{-1}$ (100 % RDP) | 26.4 | 46.8 |
| **$P_4$:** 62.5 kg $P_2O_5$ $ha^{-1}$ (125 % RDP) | 26.5 | 46.7 |
| **SEm±** | 0.08 | 0.10 |
| **CD (P = 0.05)** | NS | NS |
| **Interaction (D x P)** | | |
| **SEm±** | 0.14 | 0.18 |
| **CD (P = 0.05)** | NS | NS |

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