Original Research Article

ASSESSING GROUNDNUT (*Arachis hypogaea* L.) GENOTYPE YIELDS AND YIELD TRAITS WITH DIFFERENT PLANTING GEOMETRIES ON BROAD BED AND FURROWS

Abstract

A field study on "Assessing Groundnut (*Arachis hypogaea* L.) genotype yields and yield traits with different planting geometries on broad bed and furrows" was conducted during *rabi* season of 2022 in the experimental field at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, Telangana. The experiment was laid out in factorial randomised block design with three replications. Total 16 treatment combinations consisted of four planting geometries (P1) 30 × 10 cm, (P2) 15:15 × 10 cm, (P3) 20:20 × 10 cm, (P4) 25:25 × 10 cm and four varieties (V1) Girnar 4, (V2) Girnar 5, (V3) Avtar, (V4) K6. The important findings emerged from this investigation found that groundnut sown at the spacing of (P4) 25:25 × 10 cm recorded significantly higher number of pods plant^{-1} (33.0), kernels pod^{-1} (2.0), test weight (38.7 g), shelling percentage (67.1%), pod yield (1792 kg ha^{-1}) followed by (P3) 20:20 × 10 cm, (P4) 30 × 10 cm and (P4) 15:15 × 10 cm. The genotype V2 (Girnar 5) performed best in yield and yield contributing characteristics than other genotypes and it was on par with V1 (Girnar 4). Hence, our results concluded that (P4) 25:25 × 10 cm spacing, performing best with (V2) Girnar 5 and (V1) Girnar 4 varieties.

Key words: - Groundnut, planting geometries, varieties, yield, yield attributes

1. INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important oilseed crop and also plays a significant role in the Indian economy. It belongs to the Fabaceae (Leguminaceae) family and gets its namenclature from the Greek words "*Arachis*," meaning legume, and "*hypogaea*," meaning below ground, due to its underground pods. Groundnut kernels contain 40-50% oil, widely used in cooking and is rich in vitamins A, B and E. It is also valued as a rotation crop and as a legume, it aids in nitrogen fixation and improves soil health. Globally, groundnut is cultivated in over 100 countries on 29.5 million hectares, producing 48.7 million metric tonnes with an average yield of 1.6 metric tonnes ha^{-1} (FAOSTAT, 2019). Developing countries contribute significantly, accounting for 97% of the cultivation area and 94% of the production. India leads in groundnut cultivation, covering 55.71 lakh hectares and ranks second worldwide, with 102 lakh tonnes production in 2020-21 at a productivity rate of 1831 kg ha^{-1}. However, in the Telangana region, groundnut productivity lags at 837 kg ha^{-1} which is low compared to national productivity of 1816 kg ha^{-1} (Groundnut Outlook Report, 2020-21), necessitating improved agronomic practices to enhance productivity.

In Telangana, groundnut can be grown in *kharif*, *rabi* and *summer* seasons. *Rabi* is the preferred season for growing groundnut due to monsoon unpredictability and foliar diseases during *kharif*. Inadequate monsoon results in soil drought, prompting a shift to *rabi* cultivation under irrigation. *Rabi* groundnut benefits from ideal sunshine hours and high temperatures, yielding three times more than *kharif* (Gawas *et al.*, 2020).

Paired row planting involves arranging crop rows on both sides of a furrow by increasing ridge spacing, there by a common furrow is used for irrigation of two rows. This method is advantageous for many rainfed crops. Proper plant spacing enhances aeration, light penetration in the canopy and optimizing photosynthesis rates. Research under the All India Coordinated Research Project on Groundnut has shown that paired rows are more productive than the conventional single-row system. Broad bed furrows (BBF) improve soil conditions by reducing surface layer bulk density and soil strength. Since groundnut pods grow underground, loose and well-aerated seed beds are crucial for peg penetration and pod development. Studies at ICRISAT demonstrated increased groundnut yields with BBF (Vekariya *et al.,* 2015). Kamble *et al.* (2016) reported significant pod yield improvements with this technique. Trials across various locations also revealed that BBF planting resulted in significantly higher groundnut pod yields compared to conventional methods (Borde *et al.,* 2022).

Low groundnut production in India is attributed to rainfed cultivation in areas with erratic rainfall distribution. Lack of suitable rainfed varieties, coupled with diseases like rust, tikka and bud necrosis, hampering production. To boost yields, selecting the right variety, optimal spacing and fertilizer dosage is crucial. Groundnut yield primarily depends on variety and row spacing. Poor response to management practices often results from inadequate plant populations. Improved varieties and paired row planting are recommended agronomic practices to enhance groundnut productivity (Mandal *et al.*, 2019).

2. MATERIAL AND METHODS

The experiment was conducted during *rabi* season of 2022 in the field No. RP 7C Latitude: 17° 31' 48.00" N Longitude: 78° 16' 12.00" E, at ICRISAT, Hyderabad, Telangana, India. Soil samples were taken before sowing from 30 cm depth at random places in the experimental site to study the physico chemical properties of soil. The data of soil analysis revealed that the soil was sandy loam in texture with neutral (pH 7.89) in reaction and low in total nitrogen and available phosphorus and fairly rich in available potassium and.

The experiment was laid out with 2 × 4 factorial randomised block design with three replications on broad bed furrow. There were two factors, one factor includes four planting geometries, 30 cm × 10 cm (P1), 15:15 cm × 10 cm (P2), 20:20 cm × 10 cm (P3), 25:25 cm × 10 cm (P4) in paired row planting and second factor includes four varieties which were (V1) Girnar 4, (V2) Girnar 5, (V3) Avtar, (V4) K6. Girnar 4 (V1), Girnar 5 (V2), Avtar (V3) these three varieties are developed at International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and K6 (V4) developed at Agricultural Research Station (ARS), Anantapur. In case of planting geometries, the total plant population on a bed (furrow to furrow distance is 1.5 m and net planting bed area is 1.2 m) was same having four rows per bed whereas the spacing between two pairs in P2 is 60 cm, P3 is 50 cm and P4 is 40 cm (fig.1).

The field was ploughed up to 30 cm deep and a fine tilth was obtained by subsequent harrowing's. The experimental plots were laid out according to the plan after the preparatory cultivation. The field was prepared using a tractor-drawn ridger to create broad bed furrows of 1.2 m width and a 30 cm space between each broad bed furrow. The fertilizer dose of 20 kg nitrogen ha^{-1} was given in the form of urea and 40 kg ha^{-1}of phosphorous through single super phosphate and 50 kg ha^{-1} of potassium through muriate of potash. The fertilizer was applied along the marked lines 5 cm below the soil surface before sowing.

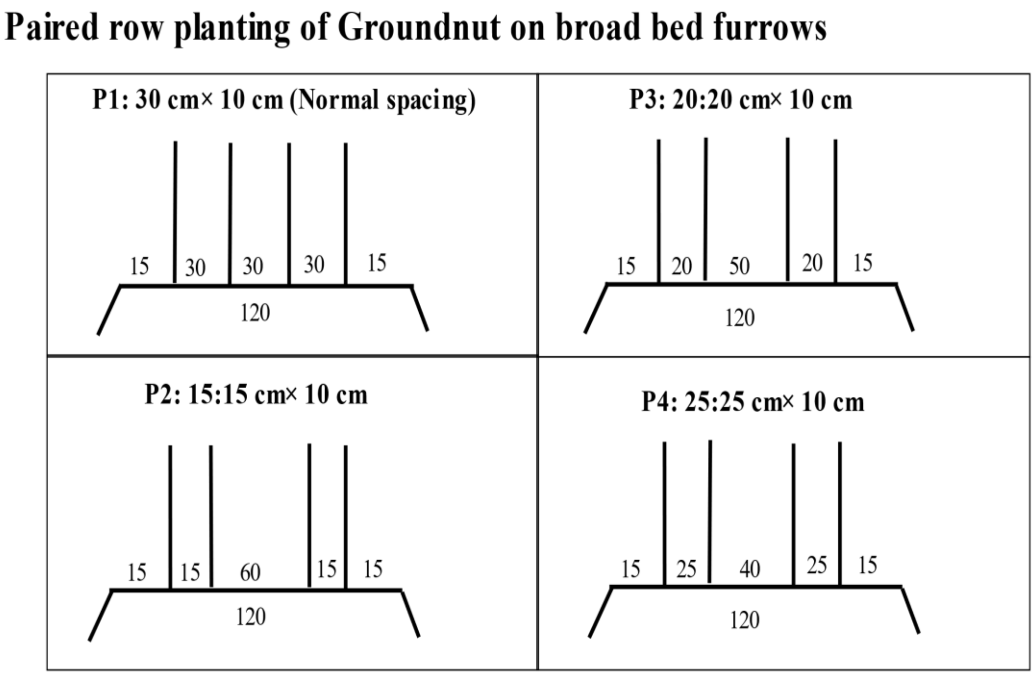

Fig. 1 Paired row planting of groundnut on broad bed furrows

3. RESULTS AND DISCUSSION

The important findings in the form of summarized data on yield and their attributes were analysed and the results were critically interpreted. The data presented in Table 1. and Figures 2 and 3, which indicate the, number of kernels pod^{-1}, test weight, shelling percentage, number of pods plant^{-1} and pod yield.

3.1 Number of pods plant^{-1}

Number of pods plant^{-1} had significantly influenced by planting geometry. Spacing of 25:25 x 10 cm (P4) resulted in the higher number of pods plant^{-1} (33.0) (fig.2) followed by 20:20 × 10 cm (P3) with 28.9 pods plant^{-1}. On the other hand, the wider spacing of 30 × 10 cm (P1) and the closer spacing of 15:15 × 10 cm (P2) had the lower number of pods plant^{-1} at 25.5 and 21.1 respectively. This trend is consistent with the findings of Santhosh Kumar *et al.* (2022), who observed that closer spacing (25 × 10 cm) resulted in higher pod numbers compared to wider spacing (30 × 10 cm). The higher number of pods at narrower spacings can be attributed to better resource utilization and competition among plants, favouring pod formation. Similarly, Reddy *et al.* (2022) reported that the application of specific nutrients and spacing combinations influenced pod production. These results collectively highlight the importance of optimizing plant geometry to maximize groundnut pod yield.

Varietal selection also significantly influenced the number of pods plant^{-1}. Girnar 5 (V2) demonstrated the higher pod count at 32.6 (fig.2) pods plant^{-1} and it was on par with Girnar 4 (V1) with 30.8 pods plant^{-1}. In contrast, variety K6 (V4) had the lower number of pods plant^{-1} at 19.8. These results align with the study by Oluwasemire *et al.* (2014), where different groundnut varieties exhibited varying pod production capacities. It's worth noting that these differences in varieties can be attributed to genetic traits and adaptability to specific environmental conditions. Furthermore, the influence of groundnut varieties on pod production was supported by studies such as Konlan *et al.* (2013), which demonstrated that different varieties can exhibit varying pod production capabilities. This emphasizes the significance of selecting suitable groundnut varieties tailored to local conditions for optimal yields.

3.2 Number of kernels pod^{-1}

The findings suggest that variations in plant geometries (spacings), varieties and their interactions did not lead to any statistically significant difference in the number of kernels pod^{-1} (table.1). This differs from the studies of Konlan *et al.* (2013) and Arif *et al.* (2016), where different groundnut varieties exhibited varying numbers of seeds pod^{-1}. In the study, all varieties performed uniformly in terms of kernel production.

3.3 Test weight (100 seed weight) (g)

All four planting geometries (P1 to P4) resulted in similar test weights, ranging from 38.6 to 38.8 g (table.1). This suggests that, under the conditions of this experiment, varying plant spacing did not influence the test weight of 100 seeds. This finding aligns with Ramesh and Praveen kumar (2007), who observed non-significant differences in 100-kernel weight among plant densities.

In contrast to plant geometry, groundnut varieties exhibited a significant impact on the test weight of 100 seeds. Girnar 5 (V2) and Girnar 4 (V1) demonstrated the higher test weights *i.e.*, 41.7 g and 41.3 g, respectively. On the other hand, varieties Avtar (V3) and K6 (V4) had lower test weights with 37.7 g and 34.1 g, respectively. This finding was consistent with the work of Bakal *et al.* (2020) who found significant differences in 100 seed weight between different groundnut varieties, highlighting the genetic variability in seed quality traits. Varietal differences in test weight were well-documented in the literature. Yilmaz *et al.*

(2022) observed that the weight of 100 seeds was affected primarily by the cultivar, not by the plant density. The higher test weight in certain varieties suggests that these varieties have a greater seed density, which is often associated with better seed quality, controlled by specific genes.

Test weight of 100 seeds did not show a significant difference on the interaction of plant geometry and varieties.

3.4 Shelling percentage (%)

The results noticed that there was no significant effect of plant geometry (spacing) on the shelling percentage (%). All four plant geometries (P1 to P4) resulted in similar shelling percentages, ranging from 66.7 to 67.1 (table.1). This suggests that, under the conditions of this experiment, varying plant spacing did not influence the shelling percentage.

In contrast to plant geometry, groundnut varieties had a significant impact on the shelling percentage. Girnar 5 (V2) and Girnar 4 (V1) demonstrated the higher shelling percentage at 69.2 and 69.0 (table.1), respectively. On the other hand, varieties Avtar (V3) and K6 (V4) had lower shelling percentage at 66.1 and 63.3, respectively. These findings are consistent with the results observed by Gawas *et al*. (2020), where plant geometry did not significantly affect shelling percentage. It suggests that groundnut shelling percentage may not be highly responsive to changes in plant geometry within the range of spacings tested in this study. These results suggest that varietal characteristics play a more significant role in shelling percentage compared to plant geometry under the conditions of the study.

The interaction between plant geometry and varieties did not show a significant impact on the shelling percentage.

3.5 Pod yield (kg ha^{-1})

Among the different plant geometries tested, the spacing of 25:25 × 10 cm (P4) resulted in the higher pod yield at 1792 kg ha^{-1} (fig.3) and this was followed by the 20:20 × 10 cm spacing (P3) with a pod yield of 1581 kg ha^{-1} with an increased yield of 58.4% and 39.8% over 15:15 × 10 cm spacing. On the other hand, the spacing of 15:15 × 10 cm (P2) had the lower pod yield at 1130 kg ha^{-1}. These findings are consistent with the results of previous studies, such as Chaudhari *et al.* (2018), who found that a specific plant spacing (22.5 × 10 cm) led to higher pod yields. It is evident that the choice of plant spacing can significantly impact pod yield, likely due to competition for resources and light among plants.

Groundnut varieties also exhibited a significant influence on pod yield. Among the varieties, Girnar 5 (V2) had the higher pod yield at 1759 kg ha^{-1} (fig.3) and it was on par with Girnar 4 (V1) at 1643 kg ha^{-1} with an increased yield of 30%, 21.5% over Avtar (V3) and 47.6%, 58.1% over K6 (V4) while Avtar (V3) and K6 (V4) had lower pod yields at 1352 kg ha^{-1} and 1113 kg ha^{-1}, respectively. These results were in accordance with the work of Priya *et al.* (2015) and Gawas *et al.* (2020), who both found significant varietal differences in pod yield. It is clear that certain groundnut varieties have a higher yield potential compared to others. This finding is in line with the observations of Jaiswal *et al.* (2017), who found variations in pod yield among different groundnut genotypes. The higher pod yield in certain varieties suggests that these varieties have genetic traits conducive to better pod production.

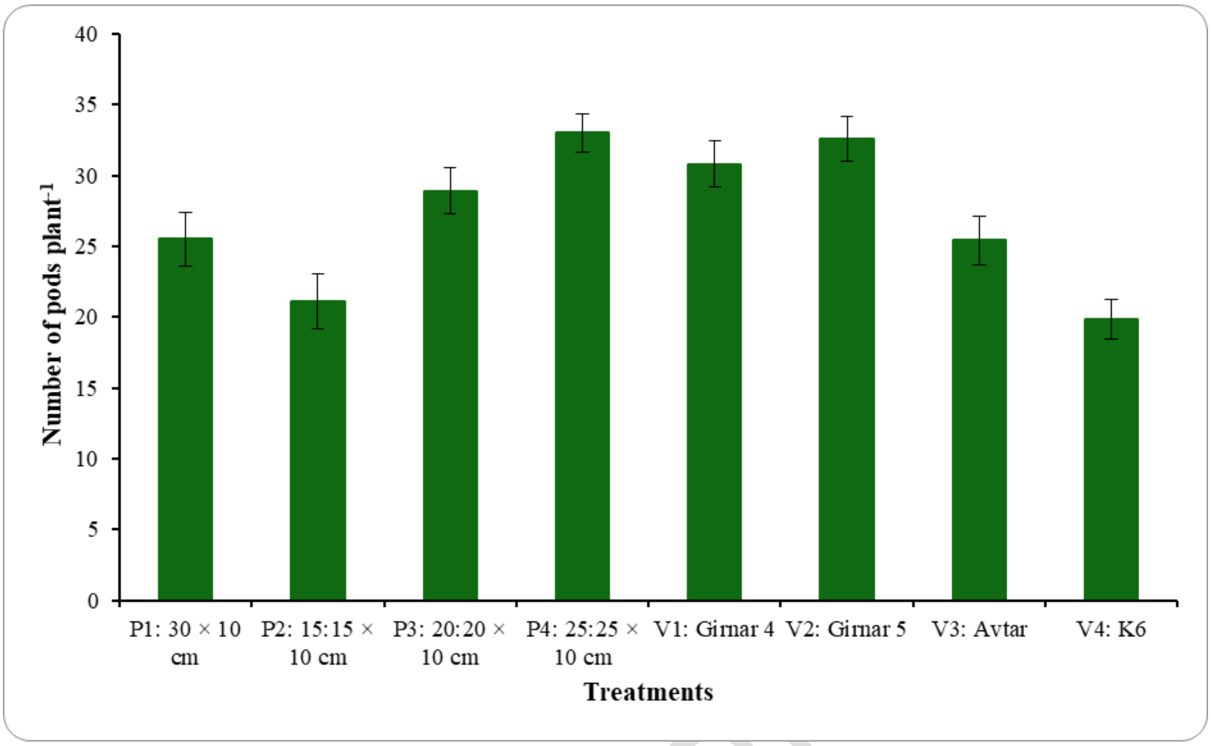

Fig. 2 Number of pods plant^{-1} as influenced by planting geometries and varieties on broad bed and furrows

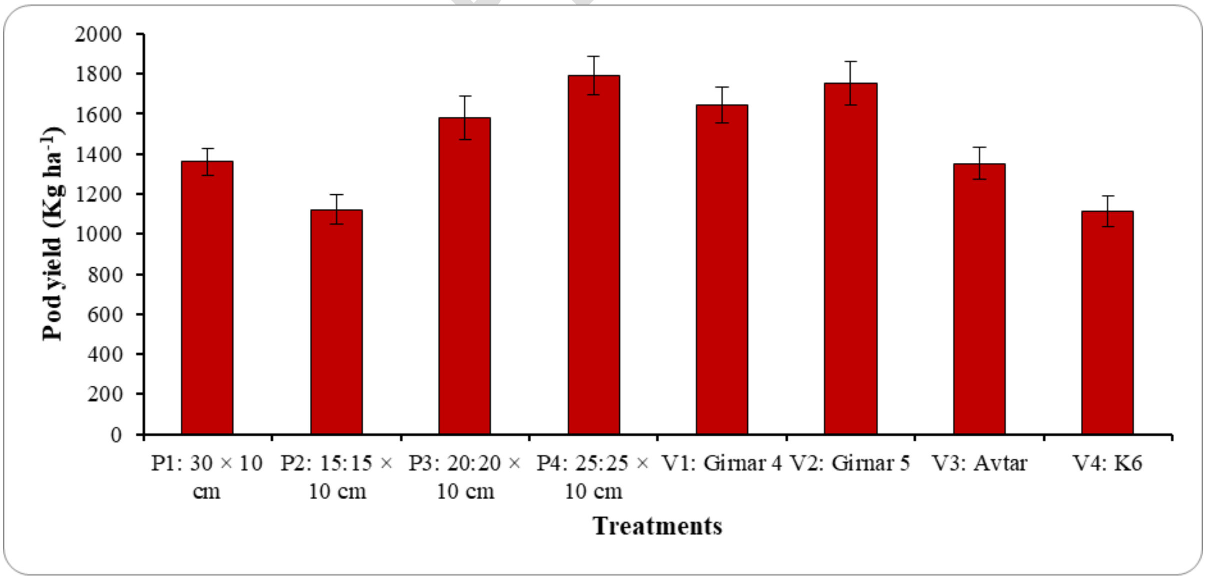

Fig. 3 Pod yield (kg ha^{-1}) as influenced by planting geometries and varieties on broad bed and furrows

Table 1. Yield traits and yield as influenced by planting geometries and varieties on broad bed and furrows

Treatments	Number of kernels pod^{-1}	Test weight (100 seed)	Shelling percentage (%)
Planting geometry (cm)			
P1: 30 × 10 cm	2.00	38.7	66.7
P2: 15:15 × 10 cm	2.00	38.8	66.9
P3: 20:20 × 10 cm	2.00	38.6	66.8
P4: 25:25 × 10 cm	2.00	38.7	67.1
S.Em ±	0.00	0.17	0.16
CD (P=0.05)	NS	NS	NS
Varieties			
V1: Girnar 4	2.00	41.7	69.0
V2: Girnar 5	2.00	41.3	69.2
V3: Avtar	2.00	37.7	66.1
V4: K6	2.00	34.1	63.3
S.Em ±	0.00	0.17	0.16
CD (P=0.05)	NS	0.50	0.474
Interaction P × V			
S.Em ±	0.00	0.35	0.32
CD (P=0.05)	NS	NS	NS

4. CONCLUSION

This paper presents results of a study on groundnut (*Arachis hypogaea* L.) genotype yields and yield traits with different planting geometries on broad bed and furrows for one season in the semi-arid region of India. Plant spacing of 25:25 × 10 cm resulted in a higher number of pods plant^{-1} and consequently led to a higher pod yield. While, extremely narrow spacing, as observed in 15:15 × 10 cm, negatively impact on pod yield. However, we did not observe any significant effects on the number of kernels pod^{-1}, test weight and shelling percentage due to varying plant geometries. Varietal selection emerged as a crucial factor, significantly affecting the number of pods plant^{-1}, test weight, shelling percentage and pod yield. Girnar 5 and Girnar 4 exhibited superior performance in terms of pod yield highlighting the importance of selecting suitable groundnut varieties tailored to local conditions.

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