

## Original Research Article

# **Exploring Pod seeded groundnut and its response to spacing and nutrient levels**

### **Abstract**

Groundnut is cultivated mainly by small and marginal farmers. Seed cost and sowing is stated to be the most expensive operation which combined is responsible for about 45% of the entire cost of groundnut cultivation. The seed cost is increased mainly by the operation of shelling, which raises it upto 3 times. The objective of this research was to test the viability of sowing groundnut with pods after proper seed treatment to reduce the shelling cost. Treatments include four spacing and three nutrient levels. It was sown in the spacing of 30 cm × 10 cm, 20 cm × 20 cm, 25 cm × 15 cm and 30 cm × 15 cm. The different nutrient levels followed were Soil test based recommendation approach, 100% Recommended dose of fertilizers (25:50:75 N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O kg ha<sup>-1</sup>) and 125% Recommended dose of fertilizers (31.25:62.5: 93.75 N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O kg ha<sup>-1</sup>). Groundnut response was evaluated based on dry matter production, number of pods per plant, hundred pod weight, pod yield, haulm yield, harvest index and B: C ratio. The combination of 30 cm × 15 cm spacing and 125% recommended dose of fertilizers (S<sub>4</sub>N<sub>3</sub>) documented the highest double pods per plant, hundred pod weight, highest pod yield of 3791 kg ha<sup>-1</sup> and benefit cost ratio of 2.89. The higher yield as well as higher benefit cost ratio indicates the practical feasibility and economic viability for adoption of pod seeded groundnut.

Key Words: Groundnut, Pod seeding, Spacing, Nutrient management.

### **Introduction**

Groundnut (*Arachis hypogaea* L.) also identified as peanut and 'king of oilseeds' is a vital oilseed, food and fodder legume crop belonging to family Fabaceae. It is the 13<sup>th</sup> most essential food crop in the world, 3<sup>rd</sup> chief basis for vegetable protein and 4<sup>th</sup> most significant source for edible oil. Groundnut production occupies a significant share in the Indian economy. India being the leader in groundnut production, holds the first position in both area and production around the world with an area of about 5.3 m ha and production of about 7.4 m tons.

Groundnut is cultivated in both irrigated and rainfed conditions. Nearly, around 80% of the groundnut production come from small and marginal farmers. Seed cost and sowing is stated to be the most expensive operation which combined is responsible for about 45% of the entire cost of groundnut cultivation (Byadgi et al., 2023; Narendra et al., 2023). The seed cost is increased mainly by the operation of shelling, which raises it upto 3 times. The shelling process also causes injuries and disturbance to seed through embryo fracture which reduces the germination capacity and the ability of seed to germinate at desired time to ensure an adequate level of plant population and initial growth. Hence groundnut shelling remains as a major problem in India (Gorane *et al.*, 2023).

Taking into account all these factors, the practise of pod seeding technology in groundnut can be exploited for increasing the productivity by reducing the input cost. Pod sowing is reported to be an important technology widely followed for groundnut cultivation in the areas of southern and northern China (Yu, 2004; Chen *et al.*, 2009; Chang and Zheng, 2013). Pod sowing enlists various advantages such as reduction of seed cost due to the omission of shelling process, lower seeding time, protection of kernels from birds and insects, storage for a longer time as pods without the loss of viability.

In order to advocate suitable package of practices for pod sown groundnut, spacing and nutrient levels have to be optimized to achieve the maximum yield (Veeramani and

Subrahmaniyan, 2011). The spacing that is followed for groundnuts sown as kernel can't be used for pod sowing as pod sowing results in the emergence of two plants from a hill owing to the presence of two kernels in a pod. This reason also stresses the importance of fixing the optimum nutrient level for pod sown groundnut as imbalanced use of fertilizers is reported to be an important reason for low yield of groundnut. Though many researchers have published their outcomes on the influence of spacing and effect of nutrient levels on groundnut sown as kernels, the research is yet to be done to evaluate the influence of pod sowing on the growth, yield characters and groundnut yield. This study aims to fill the gap by finding a suitable spacing and nutrient recommendation for pod seeded groundnut.

### **Materials and Methods**

Field research was conducted in 2019 at Agricultural College and Research Institute, Madurai, Tamil Nadu, India. Initially a preliminary lab experiment was conducted for identifying suitable seed treatment to ensure the germination. Based on the results of the preliminary experiment, for all the treatments, the unshelled groundnut was soaked in calcium oxychloride for 24 hours before sowing in the ratio of 1:2 (pods:solution). The experimental design followed was F-RBD. Treatments included spacing and nutrient levels. The unshelled groundnut was sown with the spacing of 30 cm × 10 cm, 20 cm × 20 cm, 25 cm × 15 cm and 30 cm × 15 cm. The different nutrient levels followed were Soil test based recommendation approach, 100% Recommended dose of fertilizers (25:50:75 N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O kg ha<sup>-1</sup>) and 125% Recommended dose of fertilizers (31.25 : 62.5 : 93.75 N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O kg ha<sup>-1</sup>). The groundnut variety used for sowing is VRI 2 with the total duration of 105 days. Groundnut was grown under irrigated condition. The fertilisers were given in the form of Urea, single super phosphate and muriate of potash. The total amount of nitrogen and potassium were split into three viz., 50% N & K<sub>2</sub>O as basal + 25 % N & K<sub>2</sub>O at 20 DAS and 25 % N & K<sub>2</sub>O at 45 DAS. Groundnut rich was sprayed to all plots invariably at the quantity

of 5.0 kg/ha at 35 DAS and 45 DAS. Gypsum @ 400 kg ha<sup>-1</sup> was supplied to each plot along the sides of plant rows and earthing up was done at 45 DAS. Pod sowing was immediately followed by first irrigation. Thereafter life irrigation was provided sufficiently on 3 DAS. Further irrigations for pod sown groundnut were provided based on need and requirement of crop with an interval of 7 to 10 days.

Treatments were arranged in a factorial randomised block design with spacing as the first factor and nutrient levels as the second factor. The treatments were replicated thrice. Groundnut biomass samples were collected after digging from a sample row from each plot and then dried in a forced air dryer at 65°C for one week. Plant weight, pod weight, and pod count data were collected from these samples. The pod sown crop was harvested while the older leaves dry, become yellow and fall. The appearance of black streaks on the inside wall of groundnut shell in majority of pods (more than 75 %) indicates maturity. Initially, the harvest was done in two border rows that was left on all four sides in every plot. Harvest in the net plot was done independently. In order to attain a constant weight, the pods were first hand stripped and then dried under sun. After sun drying, the pod yield was documented in kg ha<sup>-1</sup>. The haulm yield was also noted after stripping and was converted to kg ha<sup>-1</sup>.

The data pertained to the experiments were exposed to statistical analysis by Analysis of variance (ANOVA) method. Whenever the differences between the treatments were found to be significant, critical differences (CD) was worked out at five per cent probability level and the resulting values were provided.

## Results and Discussion

Treatments	DMP		Number of single seeded pods per plant	Number of double seeded pods per plant	Hundred pod weight
	(25 DAS)	(75 DAS)			

<b>S<sub>1</sub> N<sub>1</sub></b>	866	3356	2	7	80.7
<b>S<sub>1</sub>N<sub>2</sub></b>	894	3730	2	8	80.4
<b>S<sub>1</sub>N<sub>3</sub></b>	944	4460	3	10	81.7
<b>S<sub>2</sub>N<sub>1</sub></b>	815	3227	2	8	81.0
<b>S<sub>2</sub>N<sub>2</sub></b>	828	3557	3	11	84.1
<b>S<sub>2</sub>N<sub>3</sub></b>	894	3758	3	13	91.4
<b>S<sub>3</sub>N<sub>1</sub></b>	846	3242	2	8	80.8
<b>S<sub>3</sub>N<sub>2</sub></b>	867	3667	3	12	83.4
<b>S<sub>3</sub>N<sub>3</sub></b>	919	3712	3	14	94.0
<b>S<sub>4</sub>N<sub>1</sub></b>	807	3186	2	9	86.5
<b>S<sub>4</sub>N<sub>2</sub></b>	838	3265	3	13	93.0
<b>S<sub>4</sub>N<sub>3</sub></b>	895	3313	4	15	94.9
<b>SEd</b>	69.1	188.1	0.17	0.75	4.3
<b>CD (P=0.05)</b>	NS	390	0.35	1.56	NS
<p>S<sub>1</sub> : 30 cm × 10 cm N<sub>1</sub>:STCR(22.54: 26.68: 51.2 kg N P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O ha<sup>-1</sup>)</p> <p>S<sub>2</sub> : 20 cm × 20 cm N<sub>2</sub>:100% RDF (25: 50: 75 kg N P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O ha<sup>-1</sup>)</p> <p>S<sub>3</sub> : 25 cm × 15 cm N<sub>3</sub>:125% RDF (31.25: 62.5: 93.75 kg N P<sub>2</sub>O<sub>5</sub> K<sub>2</sub>O ha<sup>-1</sup>)</p> <p>S<sub>4</sub> : 30 cm × 15 cm</p>					

**Table 1. Effect of spacing and nutrient levels on Dry matter production, Number of single seeded pods, Number of double seeded pods and hundred pod weight of pod seeded groundnut**

Different spacing and nutrient levelshad no significant impact on the dry matter production of groundnut at 25 DAS. Dry matter production ranged from 815 to 919 kg ha<sup>-1</sup>. However, varied spacing and nutrient levels significantly affected dry matter production at 75 DAS. Adoption of closer spacing 30 cm × 10 cm (S<sub>1</sub>) with 125% RDF (N<sub>3</sub>)

registered significantly maximum dry matter  $4460 \text{ kg ha}^{-1}$  as compared to other treatments. There were no momentous differences in dry matter among the various spacing at 25 DAS probably because of fewer opposition for growth resources in pod sown groundnut. Dry matter unit area<sup>-1</sup> was greater with the spacing of  $30 \text{ cm} \times 10 \text{ cm}$  (S<sub>1</sub>). This may be owed to maximum plant density and increased photosynthesizing area on view of plant height and LAI coupled with adequate nutrient and water availability and absorption. Noticeable reduction of DMP was perceived in the wider spacing of  $30 \times 15 \text{ cm}$  (S<sub>4</sub>). Though the dry matter plant<sup>-1</sup> was improved under sparse spacing, it could not yield higher dry matter production unit area<sup>-1</sup> due to low plant population. Similar observation was also testified by Kathirvelan and Kalaiselvan (2006) that reduced plant population curtailed dry matter accumulation.

The combination  $30 \text{ cm} \times 15 \text{ cm}$  spacing and nutrient level of 125% recommended dose of fertilizers (S<sub>4</sub>N<sub>3</sub>) produced statistically superior number of single seeded pods plant<sup>-1</sup> (4) whereas the treatmental combinations of S<sub>1</sub>N<sub>3</sub>, S<sub>2</sub>N<sub>2</sub>, S<sub>2</sub>N<sub>3</sub>, S<sub>3</sub>N<sub>2</sub>, S<sub>3</sub>N<sub>3</sub> and S<sub>4</sub>N<sub>2</sub> registered three single seeded pods plant<sup>-1</sup> (3). Higher number of double seeded pods plant<sup>-1</sup> (15) were produced by the combination of  $30 \text{ cm} \times 15 \text{ cm}$  spacing and nutrient level of 125% recommended dose of fertilizers (S<sub>4</sub>N<sub>3</sub>). The favourable effect of less competition for space and growth resources in the wider spacing leads to better development of pods aiding the increase in the number of developed pods per plant. The reason for the lessening with closer spacing of  $30 \text{ cm} \times 10 \text{ cm}$  (S<sub>1</sub>) was because of the reduced availability of nutrients and solar energy for plants in closer spacing instigating competition among the plants. The inverse relation between the plant population and number of pods plant<sup>-1</sup> have also been confirmed by Meena *et al.* (2011).

Data on hundred pod weight revealed that spacing and nutrient levels had a

momentous influence on the hundred pod weight of groundnut. However, the interaction was non-significant. With regards to spacing treatment, 30 cm × 15 cm (S<sub>4</sub>) spacing registered statistically higher pod weight (91.5g) followed by S<sub>3</sub> (25 cm × 15 cm) and S<sub>2</sub> (20 cm × 20 cm). Among the three nutrient levels, application of 125% recommended dose of fertilizers (N<sub>3</sub>) produced noticeably higher hundred pod weight (90.5g) followed by N<sub>2</sub> (100% recommended dose of fertilizers). Under wider spacing, due to less competition there is enhanced translocation of photosynthates from vegetative parts to the reproductive parts and then to kernels leading to noticeable increase in hundred pod weight and hundred kernel weight. This is in conformity with the outcomes given by Soumya *et al.* (2011).

<b>Treatments</b>	<b>Pod yield (kg ha<sup>-1</sup>)</b>	<b>Haulm yield (kg ha<sup>-1</sup>)</b>	<b>Harvest Index</b>	<b>B : C ratio</b>
<b>S<sub>1</sub> N<sub>1</sub></b>	2594	4593	0.33	1.86
<b>S<sub>1</sub> N<sub>2</sub></b>	2762	5277	0.32	1.92
<b>S<sub>1</sub> N<sub>3</sub></b>	3137	5982	0.34	2.14
<b>S<sub>2</sub> N<sub>1</sub></b>	2943	4421	0.38	2.31
<b>S<sub>2</sub> N<sub>2</sub></b>	3051	4878	0.34	2.34
<b>S<sub>2</sub> N<sub>3</sub></b>	3226	5336	0.38	2.39
<b>S<sub>3</sub> N<sub>1</sub></b>	2844	4464	0.37	2.19
<b>S<sub>3</sub> N<sub>2</sub></b>	3121	5031	0.36	2.32
<b>S<sub>3</sub> N<sub>3</sub></b>	3272	5273	0.40	2.38
<b>S<sub>4</sub> N<sub>1</sub></b>	2810	4138	0.36	2.27
<b>S<sub>4</sub> N<sub>2</sub></b>	3339	4598	0.43	2.61
<b>S<sub>4</sub> N<sub>3</sub></b>	3791	4850	0.44	2.89

<b>SEd</b>	170	257	0.02	-
<b>CD (P=0.05)</b>	353	534	NS	-
S1 : 30 cm × 10 cm N <sub>1</sub> : STCR (22.54: 26.68: 51.2 kg N P <sub>2</sub> O <sub>5</sub> K <sub>2</sub> O ha <sup>-1</sup> ) S2 : 20 cm × 20 cm N <sub>2</sub> : 100% RDF (25: 50: 75 kg N P <sub>2</sub> O <sub>5</sub> K <sub>2</sub> O ha <sup>-1</sup> ) S3 : 25 cm × 15 cm N <sub>3</sub> : 125% RDF (31.25: 62.5: 93.75 kg N P <sub>2</sub> O <sub>5</sub> K <sub>2</sub> O ha <sup>-1</sup> ) S <sub>4</sub> : 30 cm × 15 cm				

**Table 2. Effect of spacing and nutrient levels on Pod yield, Haulm yield, Harvest index and B:C ratio of pod seeded groundnut**

A perusal of the pod yield of pod sown groundnut data revealed that the yield differences among the various spacing and nutrient levels attained the level of significance and the mean data are presented in Table 2. There was significant interaction among the spacing and nutrient levels on the pod yield of pod sown groundnut. The combination of 30 cm × 15 cm spacing and 125% recommended dose of fertilizers (S<sub>4</sub>N<sub>3</sub>) documented the highest pod yield of 3791 kg ha<sup>-1</sup>. Higher pod yield in wider spacing might be because of proficient exploitation of space and optimum availability of growth resources, which in turn have fashioned desirable environment for the plant to grow by producing optimum growth parameters and improved partitioning of assimilates to pods thereby achieving the maximum number of pods unit area<sup>-1</sup>. There was also increased rate of physiological process of groundnut and higher sink capacity with increase in nutrient level. The lowest pod yield was noted with the spacing of 30 cm × 10 cm and STCR approach (S<sub>1</sub>N<sub>1</sub>). It was 31.57% lower than the best treatment. Even though, it has greater plant population of 6,66,666 plants ha<sup>-1</sup>, more number of plants unit area<sup>-1</sup> lead to excessive competition among the plants which results in a drastic decline of the yield parameters and finally pod yield. This was in line with the outcomes of Lakshmi and

Reddy (2001) and Sternitzke et al. (2000). The higher plant population causes a struggle for utilizing the growth resources restricting the photosynthate partitioning thereby reducing the yield parameters and yield. Further, there is a poor source-sink relationship and the formation of late flowers has been suppressed in closer planting due to severe competition. This was in conformation with the results of Lanier et al. (2004) and Sorensen et al. (2005). The lower pod yield in STCR approach might be possibly because the STCR equation available for kernel sown groundnut was followed for pod sown groundnut where the yield and population was comparatively higher.

A significant increase in haulm yield was evidenced with increasing plant density of 6,66,666 plants ha<sup>-1</sup>. The higher haulm yield of pod sown groundnut was registered with the 30 cm × 10 cm (S<sub>1</sub>) spacing treatment. It shows a 14.2% increase over S<sub>4</sub>. The plant density determines the amount of sunlight intercepted in to the canopy and the higher plant population density speeds up canopy closure. The interception of photosynthetically active radiation (PAR) is increased which is needed for carbohydrate and higher biomass production in the plants.

Harvest index of groundnut was highly influenced by various spacing adopted. Amidst the treatments, spacing of 30 cm × 15 cm (S<sub>4</sub>) documented uppermost harvest index of 0.41. It was followed by the spacing of 25 cm × 15 cm (S<sub>3</sub>) and 20 cm × 20 cm (S<sub>2</sub>) which were on par with each other. Likewise, nutrient levels also had a substantial influence on the harvest index. Application of 125% recommended dose of fertilizers (N<sub>3</sub>) demonstrated higher harvest index (0.39). The interaction effect between spacing and nutrient levels was established to be non-significant.

The harvest index followed a decreasing trend with the increased plant population. Highest harvest index of 0.41 was documented when the pod sown groundnut are grown with the positioning of 30 cm × 15 cm (S<sub>4</sub>). This is possibly because of the lower haulm

yield and higher pod yield compared with other spacing which recorded higher plant population. The same views were opined by Meena et al. (2011). Arrangement of plants in 30 cm × 10 cm (S<sub>1</sub>) registered the least harvest index as it achieved higher biological yield unit area-1 and lower pod yield due to poor photosynthetic ability. The benefit cost ratio was also found to be highest (2.89) in the treatment combination of 30 cm × 15 cm spacing and the application of 125% recommended dose of fertilizers (S<sub>4</sub>N<sub>3</sub>) owing to low seed rate of 208 kg per hectare in the spacing of 30 × 15 cm (S<sub>4</sub>). The seed rate was 33.54% lesser than the spacing of 30 × 10 cm (S<sub>1</sub>).

### **Summary and Conclusion**

The objectives of this research were to determine if sowing the groundnut with pod has the viability to improve the yield and reduce the cost of cultivation. Groundnut growth as determined by dry matter production, number of pods per plant and hundred pod weight was found to be maximum in the combination of 30 cm × 15 cm spacing and 125% recommended dose of fertilizers (S<sub>4</sub>N<sub>3</sub>). Pod yield and B:C ratio data have clearly depicted the practical feasibility and economic viability for adoption of pod seeded



groundnut. There is a future scope to explore the pod seeded technology under rainfed condition also.

**Fig 1. Germination of two kernels from a single pod**

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