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Exploring Pod Seeded Groundnut and its Response to Spacing and Nutrient Levels

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Groundnut is cultivated mainly by small and marginal farmers. Seed cost and sowing are stated to be the most expensive operations which combined are 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 to 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 the soil-based recommendation approach, 100% Recommended dose of fertilizers (25: 50: 75 N, P_2O_5, K_2O kg ha^{-1}) and, 125% Recommended dose of fertilizers (31.25: 62.5: 93.75 N, P_2O_5, K_2O kg ha^{-1}). Groundnut response was evaluated based on dry matter production, number of pods per plant, hundred pod weight, pod

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yield, haulm yield, harvest index and B: C ratio. The combination of 30 cm × 15 cm spacing, and 125% recommended dose of fertilizers (S_4N_3) documented the highest double pods per plant, hundred pod weight, highest pod yield of 3791 kg ha^{-1} and benefit-cost ratio of 2.89. The higher yield as well as the higher benefit-cost ratio, indicates the practical feasibility and economic viability of adoption of pod-seeded groundnut.

Keywords: Groundnut; pod seeding; spacing; nutrient management.

1. INTRODUCTION

Groundnut (*Arachis hypogaea L.*) also identified as peanut and 'king of oilseeds' is a vital oilseed, food, and fodder legume crop belonging to the family Fabaceae. It is the 13th most essential food crop in the world, the 3rd chief basis for vegetable protein, and the 4th most significant source of edible oil. Groundnut production occupies a significant share of 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 groundnut production comes from small and marginal farmers. Seed cost and sowing are stated to be the most expensive operations which combined are 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 to 3 times. The shelling process also causes injuries and disturbance to the seed through embryo fracture which reduces the germination capacity and the ability of the seed to germinate at the desired time to ensure an adequate level of plant population and initial growth. Hence groundnut shelling remains a major problem in India [1].

Taking into account all these factors, the practice of pod seeding technology in groundnut can be exploited to increase 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 [2,3,4]. Pod sowing enlists various advantages such as reduction of seed cost due to the omission of the shelling process, lower seeding time, protection of kernels from birds and insects, and storage for a longer time as pods without the loss of viability.

To advocate a suitable package of practices for pod-sown groundnut, spacing, and nutrient levels have to be optimized to achieve the maximum yield [5]. 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 the low yield of groundnut. Though many researchers have published their outcomes on the influence of spacing and the effect of nutrient levels on groundnut sown as kernels, the research is yet to be done to evaluate the influence of pod sowing on growth, yield characters and groundnut yield. This study aims to fill the gap by finding a suitable spacing and nutrient recommendation for pod-seeded groundnuts.

2. MATERIALS AND METHODS

Field research was conducted in 2019 at the Agricultural College and Research Institute, Madurai, Tamil Nadu, India. Initially, a preliminary lab experiment was conducted to identify suitable seed treatment to ensure 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 soil was sandy clay loam and taxonomically known as *Typic udic hapustalf* which had a bulk density of 1.26 mg cc-1. The nutrient status was found to be low (205 kg ha^{-1}), medium (16 kg ha^{-1}) and medium (191 kg ha^{-1}) with respect to available nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O). During the cropping period, the maximum and minimum temperature fluctuated from 43 to 25˚C and 22.5 to 14.5˚C, respectively. The total rainfall obtained during the cropping period was 2.6 mm in 1 rainy day. 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 the soil-based recommendation approach, 100% Recommended dose of fertilizers (25: 50: 75 N, P_2O_5, K_2O kg ha^{-1}) and 125% Recommended dose of fertilizers (31.25: 62.5: 93.75 N, P_2O_5, K_2O kg ha^{-1}). The groundnut variety used for sowing is VRI 2 with a total duration of 105 days. Groundnut was grown under irrigated conditions. 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_2O as basal + 25 % N & K_2O at 20 DAS and 25 % N & K_2O 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^{-1} 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 the need and requirement of the 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 65ºC 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 dried, became yellow, and Fell. The appearance of black streaks on the inside wall of groundnut shells in the majority of pods (more than 75%) indicates maturity. Initially, the harvest was done in two border rows that were left on all four sides of every plot. Harvest in the net plot was done independently. To attain a constant weight, the pods were first hand stripped and then dried under the sun. After sun drying, the pod yield was documented in kg ha^{-1}. The haulm yield was also noted after stripping and was converted to kg ha^{-1}.

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

3. RESULTS AND DISCUSSION

Different spacing and nutrient levels had no significant impact on the dry matter production of groundnut at 25 DAS. Dry matter production ranged from 815 to 919 kg ha^{-1}. However, varied spacing and nutrient levels significantly affected dry matter production at 75 DAS. Adoption of closer spacing 30 cm × 10 cm (S1) with 125% RDF (N_3) registered a significant maximum dry matter 4460 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 view of opposition for growth resources in pod sown groundnut. Dry matter unit $area^{-1}$ was greater with the spacing of 30 cm × 10 cm (S1). This may be owed to maximum plant density and increased photosynthesizing area on the view of plant height and LAI coupled with adequate nutrient and water availability and absorption. Closer spacing have resulted in the production of higher number of leaves and thereby contributing superior dry matter production [6]. A noticeable reduction of DMP was perceived in the wider spacing of 30 × 15 cm (S4). Though the dry matter $plant^{-1}$ was improved under sparse spacing, it could not yield higher dry matter production unit $area^{-1}$ due to low plant population. A similar observation was also testified that reduced plant population and curtailed dry matter accumulation [7].

The combination of 30 cm × 15 cm spacing and nutrient level of 125% recommended dose of fertilizers (S4N3) produced a statistically superior four number of single-seeded pods $plant^{-1}$ whereas the treatment combinations of S1N3, S2N2, S2N3, S3N2, S3N3 and, S4N2 registered three single seeded pods $plant^{-1}$. A higher value of 15 number of double-seeded pods $plant^{-1}$ were produced by the combination of 30 cm × 15 cm spacing and a nutrient level of 125% recommended dose of fertilizers (S4N3). The favorable 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 cm × 10 cm (S1) 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 the number of pods $plant^{-1}$ has also been confirmed [8].

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

Treatments	DMP		Number of single seeded pods per plant	Number of double seeded pods per plant	Hundred pod weight
	(25 DAS)	(75 DAS)			
S_1N_1	866	3356	2	7	80.7
S_1N_2	894	3730	2	8	80.4
S_1N_3	944	4460	3	10	81.7
S_2N_1	815	3227	2	8	81.0
S_2N_2	828	3557	3	11	84.1
S_2N_3	894	3758	3	13	91.4
S_3N_1	846	3242	2	8	80.8
S_3N_2	867	3667	3	12	83.4
S_3N_3	919	3712	3	14	94.0
S_4N_1	807	3186	2	9	86.5
S_4N_2	838	3265	3	13	93.0
S_4N_3	895	3313	4	15	94.9
SEd	69.1	188.1	0.17	0.75	4.3
CD (P=0.05)	NS	390	0.35	1.56	NS

S1 : 30 cm × 10 cm N1 : STCR (22.54: 26.68: 51.2 kg N P2O5 K2O ha^{-1})
S2 : 20 cm × 20 cm N2 : 100% RDF (25: 50: 75 kg N P2O5 K2O ha^{-1})
S3 : 25 cm × 15 cm N3 : 125% RDF (31.25: 62.5: 93.75 kg N P2O5 K2O ha^{-1})
S4 : 30 cm × 15 cm

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 (S4) spacing registered statistically higher pod weight (91.5 g) followed by S3 (25 cm × 15 cm) and S2 (20 cm × 20 cm). Among the three nutrient levels, the application of a 125% recommended dose of fertilizers (N3) produced noticeably higher hundred pod weight (90.5 g) followed by N2 (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 a noticeable increase in hundred pod weight and hundred kernel weight. This conform with the outcomes of other researches [9].

A perusal of the pod yield of pod sown groundnut data revealed that the yield differences among the various spacing and nutrient levels attained a 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 (S4N3) documented the highest pod yield of 3791 kg ha^{-1}. 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 a 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 $area^{-1}$. There was also an increased rate of physiological process of groundnut and higher sink capacity with an increase in nutrient level. The lowest pod yield was noted with the spacing of 30 cm × 10 cm and STCR approach ($S1N_1$). It was 31.57% lower than the best treatment. Even though it has a greater plant population of 6, 66,666 plants ha^{-1}, more plants unit $area^{-1}$ leads 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 other researchers [10,11]. The higher plant population causes a struggle to utilize the growth resources restricting the photosynthetic partitioning and 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 [12,13,14]. The lower pod yield in the STCR approach might be possible because the STCR equation available for kernel-sown groundnut was followed for pod-sown groundnut where the yield and population were comparatively higher.

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

Treatments	Pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})	Harvest Index	B : C ratio
S_1N_1	2594	4593	0.33	1.86
S_1N_2	2762	5277	0.32	1.92
S_1N_3	3137	5982	0.34	2.14
S_2N_1	2943	4421	0.38	2.31
S_2N_2	3051	4878	0.34	2.34
S_2N_3	3226	5336	0.38	2.39
S_3N_1	2844	4464	0.37	2.19
S_3N_2	3121	5031	0.36	2.32
S_3N_3	3272	5273	0.40	2.38
S_4N_1	2810	4138	0.36	2.27
S_4N_2	3339	4598	0.43	2.61
S_4N_3	3791	4850	0.44	2.89
SEd	170	257	0.02	-
CD (P=0.05)	353	534	NS	-

S1 : 30 cm × 10 cm N1 : STCR (22.54: 26.68: 51.2 kg N P2O5 K2O ha^{-1})
S2 : 20 cm × 20 cm N2 : 100% RDF (25: 50: 75 kg N P2O5 K2O ha^{-1})
S3 : 25 cm × 15 cm N3 : 125% RDF (31.25: 62.5: 93.75 kg N P2O5 K2O ha^{-1})
S4 : 30 cm × 15 cm

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

A significant increase in haulm yield was evidenced by increasing plant density of 6, 66,666 plants ha^{-1}. The higher haulm yield of pod sown groundnut was registered with the 30 cm × 10 cm (S_1) spacing treatment. It shows a 14.2% increase over S_4. The plant density determines the amount of sunlight intercepted into the canopy. With the increased population, the interception of photosynthetically active radiation (PAR) is increased which is needed for carbohydrate and higher biomass production in the plants [15]. Similarly, advanced haulm yield was registered with the application of 125% recommended dose of fertilizers (N3) in case of pod sown groundnut. It shows a 15.7% increase over the STCR approach. It can be drawn back to the higher LAI and DMP with increased level of fertilizers.

The harvest index of groundnut was highly influenced by various spacing adopted. Amid the treatments, spacing of 30 cm × 15 cm (S4) documented uppermost harvest index of 0.41. It was followed by the spacing of 25 cm × 15 cm (S3) and 20 cm × 20 cm (S2) which were on par with each other. This is possibly because of the lower haulm yield and higher pod yield compared with other spacing which recorded higher plant population [7]. Likewise, nutrient levels also had a substantial influence on the harvest index. Application of 125% recommended dose of fertilizers (N3) demonstrated a higher harvest index (0.39). Applying sufficient nutrients play a significant role in improving the productivity of the crop which in turn improves the harvest index. The interaction effect between spacing and nutrient levels was established to be non-significant [16].

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 (S4N3) owing to a low seed rate of 208 kg per hectare in the spacing of 30 × 15 cm (S4). The seed rate was 33.54% less than the spacing of 30 × 10 cm (S1). Seed being the most expensive input, higher benefit cost ratio was noted with lower seed rate [17,18,19].

4. 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 (S4N3). Pod yield and B: C ratio data have depicted the practical feasibility and economic viability of the adoption of pod-seeded groundnut. There is a future scope to explore the pod-seeded technology under rainfed conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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