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Yield and Quality of Groundnut (*Arachis hypogaea* L.) as Affected by Planting Geometry and Number of Plants Per Hill

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Abstract: An experiment was conducted to find out the effect of planting geometry and number of plants hill^{-1} on the yield and quality of groundnut seeds. The experiment consisted of two planting geometry, viz., square planting (22.4 x 22.4 cm^2) and rectangular planting (30.0 x 16.7 cm^2) and three levels of number of plants hill^{-1} viz., one, two and three plants hill^{-1}. Results showed that planting geometry affected the yield and yield components significantly. Rectangular planting gave significantly higher yield than did square planting system. But square-planting system gave significantly higher percentage of both protein and oil in seed. Two plants hill^{-1} gave significantly higher yield than that of one plant and three plants hill^{-1}. Protein content was significantly affected due to the number of plants hill^{-1} where two plants hill^{-1} gave the maximum result (25.58%) which was insignificantly followed by that of three plants hill^{-1} while oil content remained unaffected. The crops planted in rectangular system (30 x 16.7cm^2) with two plants hill^{-1} showed maximum pod yield (2.49 t ha^{-1}). Both protein (26.05%) and oil (50.06%) content was found higher with the crops of square planting system with two plants hill^{-1}. Therefore, the crops planted in rectangular system (30 x 16.7 cm^2) with two plants hill^{-1} emerged out as the promising practice for the improvement of yield in groundnut.

Key words: Groundnut, hill, planting geometry, quality, yield

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the most important oleaginous crops. It occupies the fourth place in the world among the oilseed crops in respect to both area and production next to soybean, sunflower and cotton (Weiss, 1983). Its kernel is rich in protein (25 to 30%) and edible oil (48 to 50%) as against in other oilseed crops grown in Bangladesh (Khaleque, 1986). Being a legume crop, groundnut enriches soil by fixing nitrogen without draining the non-renewable energies and without upsetting the agro-ecological balance (Reddy and Kaul, 1986). Thus, its intensive as well as extensive cultivation might save a huge amount of foreign currency which is spent for importing about two-third of the edible oil consumed in Bangladesh (Hossain and Haque, 1994). Since, groundnut is a less photosensitive crop, it can be grown round the year and help supplement the edible oil, food and fodder shortage in Bangladesh.

Yield of a crop is a function of genotype and environment. Environment includes management and climatic factors. Cultural practices have been considered to be the most important management factors that affect the yield and quality of a crop. Among the cultural practices, many authors have emphasized on the importance of planting geometry with optimum number of plants hill^{-1}. Kalra *et al.* (1984) recorded the highest pod yield of 3.6 t ha^{-1} at the spacing of 30 x 15cm^2 in rectangular planting system. Thorat *et al.* (1986) found significantly more dry pods with the spacing of 30 x 15 than 45 x15 and 30 x 30cm^2 spacing. Alam *et al.* (1992) reported that the variety Acc-12 produced significantly highest pod yield of 2.80 t ha^{-1} with the spacing of 30 x 15cm^2 in rectangular planting system.

Number of plant hill^{-1} plays a notable role in groundnut production. Saini *et al.* (1971) found that yield increased with the increase in number of seeds hill^{-1} (from 1 to 3 seeds hill^{-1}) at all spacing of 30 x 15, 22.5 x 22.5, 30 x 30, 37.5 x 37.5 or 45 x 45 cm^2. Thomsan *et al.* (1985) found the highest yield (285 kg rai^{-1}, 1 rai = 0.11ha) at the spacing of 30 x 20 cm^2 with 2 plants hill^{-1}. Evidences also indicate that higher intra-row distance increases both oil and protein content in groundnut seeds (Kumar and Venkatachari, 1971; Bhan and Misra, 1971). However, Agasimani *et al.* (1989) recorded the highest oil content in groundnut seeds with the spacing of 20 x 5 cm^2 with one plant hill^{-1}.

All the above evidences indicated that planting geometry and number of plants hill^{-1} are two important yield and quality determinant factors among the cultural practices. However, information in this aspect is scanty, which became the way of perpetuating its large-scale cultivation especially in perspective to Bangladesh condition. Therefore, this study was designed to determine appropriate planting geometry and optimum number of plant hill^{-1} for higher yield and better quality seeds of groundnut crop.

Materials and Methods

The research work was conducted at the Agronomy Field Laboratory, Bangladesh Agricultural University, Mymensingh, during the period from December 1995 to May 1996. The experimental site usually remains above the flood level. Soil type of the experimental land is sandy loam in texture with pH ranging from 5.5 to 6.0. Its chemical composition shows 0.7% total N, 0.62% organic carbon, 12 ppm available P, 0.23 meq/100g exchangeable K and 14 ppm available S. The treatments included two planting geometry viz., square planting (22.4 x 22.4cm^2) and rectangular planting (30 x 16.7cm^2) and three levels of number of plants hill^{-1} viz., 1 plant, 2 plants and 3 plants hill^{-1}. The experiment was laid out in a factorial design adopting randomized complete block. Each unit plot size was 4.0 X 2.4m^2.

The plots were fertilized with urea, triple super phosphate, muriate of potash, gypsum and zinc oxide @ 70, 160, 85, 110 and 5 kg ha^{-1}, respectively as recommended by Bangladesh Agricultural Research Institute (1990). The groundnut variety "Jhinga badam" (Acc-12) was used as the study material. Seeds were sown on 26 December 1995, maintaining plant spacing as par treatments. Crop management practices, such as, gap filling, weeding, thinning, irrigation and mulching were accomplished as par requirements. Crops were harvested at maturity with field duration of 150 days. Analysis of variances were worked out to find the statistical significance of the treatments on yield and yield attributes. The differences in treatment means in question of significance were adjudged by the Duncan's new multiple range test (Gomez and Gomez, 1984). Protein and oil content of shelled nuts were determined through chemical analysis by micro kjeldhal method and Soxhlet analytical method, respectively (Hamilton and Simpson, 1967).

Results and Discussion

Planting geometry greatly affected pod yield of groundnut. The treatment of rectangular planting system produced significantly

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Table 1: Effect of planting geometry and No. of plants hill^{-1} on the yield and quality of groundnut

Parameters	Plant height (cm)	Primary branches hill^{-1} (No.)	Mature pods hill^{-1} (No.)	One-seeded hill^{-1} (No.)	Two-seeded pods hill^{-1} (No.)	Three-seeded pods hill^{-1} (No.)	Four-seeded pods hill^{-1} (No.)	Wt. of 100 pods(g)	Wt. of 100 seeds(g)	Dry haulm yield (t ha^{-1})	Shelling percentage	Pod yield (t ha^{-1})	Protein (%)	Oil (%)
Planting geometry														
Square Planting	80.99a	10.57a	16.77b	1.85a	5.08b	8.32b	1.52b	124.66b	38.12b	6.23b	70.46b	2.11b	25.70a	49.70a
Rectangular Planting	76.62b	10.48a	18.53a	1.93a	5.66a	9.14a	1.80a	125.86a	38.53a	6.32a	71.66a	2.26a	25.16b	49.32b
Number of plant hill^{-1}														
1	75.30c	6.77c	14.56c	1.46c	3.86c	7.52c	1.72a	123.57b	37.03b	5.62c	70.06c	2.12b	25.23b	49.45a
2	78.20b	10.77b	20.11a	2.29a	6.29a	9.86a	1.67ab	127.87a	40.38a	6.21b	71.87a	2.39a	25.58a	49.62a
3	82.92a	14.05a	18.30b	1.92b	5.96b	8.82b	1.60b	124.36b	37.13b	7.00a	71.26b	2.06c	25.48ab	49.46a

Table 2: Interaction of planting geometry and number of plants hill^{-1} on the yield and quality of groundnut

Planting geometry	No. of plants hill^{-1}	Plant height (cm)	Primary branches hill^{-1} (No.)	Mature pods hill^{-1} (No.)	One-seeded hill^{-1} (No.)	Two-seeded pods hill^{-1} (No.)	Three-seeded pods hill^{-1} (No.)	Four-seeded pods	Wt. of 100 pods(g)	Wt. of 100 seeds(g)	Dry haulm yield (t ha^{-1})	Shelling percentage	Pod yield (t ha^{-1})	Protein (%)	Oil (%)
Square x planting	1	77.94c	6.24e	14.22d	1.69c	3.77d	7.36e	1.40c	124.86b	37.03c	5.28f	69.28d	1.99e	25.11b	49.20b
	2	81.44b	10.77c	18.81b	2.13b	5.69c	9.36b	1.63bc	125.30b	39.25a	6.09d	71.18bc	2.28b	26.05a	50.06a
	3	83.69a	14.71a	17.29c	1.73c	5.77c	8.26c	1.53c	123.84c	38.09b	7.33a	70.94c	2.07d	25.93a	49.84a
Ratangular planting	1	72.65e	7.30d	14.89d	1.23d	3.96d	7.67d	2.03a	122.27d	36.93c	5.96e	70.84c	2.24c	25.34b	49.70a
	2	74.95d	10.76c	21.40a	2.44a	6.89a	10.37a	1.70b	130.43a	40.51a	6.33c	72.55a	2.49a	25.11b	49.17b
	3	82.25b	13.39b	19.30b	2.12b	6.14b	9.38b	1.66bc	124.87b	38.16b	6.67b	71.59b	2.05d	25.03b	49.08b

Figures in a column having dissimilar letters are significantly different at 5% level.

higher pod yield of 2.26 t ha^{-1} in comparison to that of square planting system (2.11 t ha^{-1}). Among the pod yield attributes, number of pods hill^{-1}, number of mature pods hill^{-1}, number of one-seeded, two-seeded, three-seeded and four-seeded pods hill^{-1}, and weight of 100 pods certainly contributed directly to pod yield. All the yield attributes were associated best with the treatment of rectangular planting system, which immensely helped increase pod yields.

All the pod yield attributes showed higher dimension with rectangular planting system. Perhaps, the crops planted following rectangular system utilized better interception of sunlight, air circulation, soil nutrient and moisture, which helped accomplish photosynthetic activity better, supplied adequately to the sink, thus yield components were attributed to the higher magnitude. Similar opinion was expressed by Hossain *et al.* (1999) in case of jute seed. Plant height and number of branches hill^{-1}, although, did not directly contribute to pod yield, but their higher dimension might help increase yield of dry haulm, which have high fuel potential to the groundnut growers.

The planting system significantly influenced the protein and oil content of groundnut seeds (Table 1). In both the cases, the square planting system advantageously influenced these quality factors. Square planting system probably favoured some physiological processes of groundnut crops, which resulted in the increase of both protein and oil content of seeds.

Pod yield of groundnut was significantly influenced due to number of plants hill^{-1} (Table 1). The treatment of two plants hill^{-1} gave the maximum pod yield (2.39 t ha^{-1}) compared to those of one plant hill^{-1} (2.12 t ha^{-1}) and three plants hill^{-1} (2.06 t ha^{-1}) and differences in each case was statistically significantly. All the yield contributing characters of groundnut such as number of mature pods hill^{-1}, weight of 100 pods, weight of 100 seeds and shelling percentage showed higher dimension with the treatment of two plants hill^{-1} which directly helped increase pod yield.

The number of plants hill^{-1} also significantly influenced the protein content of groundnut seeds. Two plants hill^{-1} gave the highest percentage of seed protein (25.58%), which was statistically identical to that of three plants hill^{-1}. Protein content of seed was the lowest with one plant hill^{-1} (Table 1). Oil content of seeds, however, remained unaffected due to number of plants hill^{-1}. Still the crops of two plants hill^{-1} gave numerically higher percentage of oil content compared to that of others. Saini *et al.* (1971) did not find any differences in oil content of groundnut seeds grown with different row spacing and number of plants hill^{-1}. Nandania *et al.* (1992) also reported that row spacing did not affect the oil content of groundnut seeds.

The interaction effect of planting geometry and number of plants hill^{-1} significantly affected the pod yield of groundnut (Table 2). The interaction between rectangular planting system and two plants hill^{-1} registered the highest pod yield and it was followed significantly by that of rectangular planting with one plant hill^{-1} and square planting with two plants hill^{-1}. The pod yields ranging intermediate level were received when groundnut crops were planted with increased number of plants hill^{-1} irrespective to planting geometry. The increased number of plants hill^{-1} (3 plants hill^{-1}) irrespective to planting geometry reduced the magnitude of all the yield component. So, increased number of plants hill^{-1} could not compensate the yield loss of lower dimension of component characters. But the combination of rectangular planting system with two plants hill^{-1} showed higher dimension of almost all of the yield components which directly contributed higher pod yield of groundnut. Similar results were reported by Cheema *et al.* (1985) when groundnut seeds were sown at rectangular system with a spacing of 45 x 15cm^2.

Protein content of groundnut seeds was affected significantly by the interaction effect of planting geometry and number of plants hill^{-1} (Table 2). Protein percentage was found higher with the seeds of two plants hill^{-1} (26.05%) in square planting system which was closely followed by that of three plants hill^{-1} in same planting system (25.93%). Both these results were significantly higher than the protein content of seeds of other treatment combinations which, although, varied, among themselves, but not significantly.

Oil content of groundnut seeds was also statistically significant due to the interaction between planting geometry and number of plants hill^{-1}. Higher percentage of oil (50.06) was obtained due to the resultant effect of square planting and two plants hill^{-1} which was closely followed by that of three plants hill^{-1} in same planting system and one plant hill^{-1} in rectangular system, respectively (Table 2). These three results were significantly higher than the oil content of seeds of rest of the treatment combinations, which did not vary significantly among themselves. Two plants hill^{-1} planted in square system availed the beneficial effect of uniform space, soil moisture, better light interception and air circulation, which resulted not only a considerable yield but also higher percentage of protein and oil. Biridar *et al.* (1988) found the similar result.

From the above results it may be concluded that planting geometry and number of plants hill^{-1} can increase pod yields and improve quality of groundnut seeds, but the optimal result depends on careful manipulation and optimization of planting system and number of plants hill^{-1}. From the findings of the experiment it can be concluded that groundnut crops should preferably be planted in rectangular planting system (30.0 x 16.7cm^2) with two plants hill^{-1} in order to obtain higher pod yield and better quality seeds.

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