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Channabasava
M.Sc. Scholar, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj, Uttar Pradesh, India

Rajesh Singh
Associate Professor, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Channabasava
M.Sc. Scholar, Department of Agronomy, Naini Agricultural institute, SHUATS, Prayagraj, Uttar Pradesh, India

Effect of spacing and irrigations on growth and yield of groundnut (*Arachis hypogaea* L)

Channabasava and Rajesh Singh

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Abstract
A field experiment was conducted during *Zaid* 2022 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The experiment was laid out in Randomized block design with ten treatments replicated thrice. The treatment combinations are mentioned as T_1 - 30 × 10 cm + 2 Irrigations (flowering stage, pod formation stage), T_2 - 30 × 10 cm + 3 Irrigations (seedling stage, flowering stage, pod formation stage), T_3 - 30 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage), T_4 - 35 × 10 cm + 2 Irrigations (flowering stage, pod formation stage), T_5 - 35 × 10 cm + 3 Irrigations (seedling stage, flowering stage, pod formation stage), T_6 - 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage), T_7 - 40 × 10 cm + 2 Irrigations (flowering stage, pod formation stage), T_8 - 40 × 10 cm + 3 Irrigations (seedling stage, flowering stage, pod formation stage), T_9 - 40 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage), T_{10} - control (RDF) - 25:50:75 NPK kg/ha The important findings of the experiment have been summarized and concluded here under the objectives taken. The application of 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) recorded significantly higher Plant height (68.84 cm), number of branches per plant (16.73), Number of nodules per plant (26.27), Plant dry weight (42.97 g/plant), Significantly maximum number of pods/plant (50.80), Seeds/pod (2.93) was obtained in the treatment of 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage).

Keywords: Groundnut, irrigation, spacing, yield

Introduction
The peanut (*Arachis hypogaea*), also known as the groundnut, goober (US), (Domonoske 2014) [1] pindar (US) or monkey nut (UK), is a legume crop grown mainly for its edible seeds. It is widely grown in the tropics and subtropics, being important to both small and large commercial producers. It is classified as both a grain legume and, due to its high oil content, an oil crop. World annual production of shelled peanuts was 44 million tonnes in 2016, led by China with 38% of the world total. Atypically among legume crop plants, peanut pods develop underground (geocarpy) rather than above ground. With this characteristic in mind, the botanist Carl Linnaeus gave peanuts the specific epithet *hypogaea*, which means "under the earth".
The peanut belongs to the botanical family *Fabaceae* (or *Leguminosae*), commonly known as the legume, bean, or pea family. Like most other legumes, peanuts harbor symbiotic nitrogen-fixing bacteria in root nodules. The capacity to fix nitrogen means peanuts require less nitrogen-containing fertilizer and improve soil fertility, making them valuable in crop rotations.
Peanuts are similar in taste and nutritional profile to tree nuts such as walnuts and almonds, and, as a culinary nut, are often served in similar ways in Western cuisines. The botanical a definition of a nut is "a fruit whose ovary wall becomes hard at maturity". Using this for the criterion, the peanut is not a nut. However, peanuts are usually categorized as nuts for the culinary purposes and in commom English more generally. Peanuts contain polyphenols and, polyunsaturated and monounsaturated fats, phytosterols and dietary fiber in amounts similar to several tree nuts. Peanut skins contain resveratrol which is under preliminary research for its potential effects in humans (Sales 2014) [9].

Soil moisture is the most common limiting factor for better yield in groundnut production. Timing of irrigation or rainfall has a significant effect on crop yield and quality. The yield can be increased substantially by irrigation. It has been found that the different levels of irrigation significantly influenced the growth parameters, yield components, yield and water use efficiency of groundnut (Jana *et al.* 1989) [2]. A good crop of groundnut with high pod yield can be raised with 11-12 irrigations (Reddy 1984) [7]. In India and its neighboring countries, mostly check basin method is used by the groundnut growers where irrigation is practiced.

Materials and Methods

The experiments on the effect of irrigation and spacing on the growth and yield attributes enhancement of groundnut were conducted at *Zaid* season of 2023-2024 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj which is located at 25^0 24 42 N latitude, 81^0 50 56 E longitude and 98 m altitude above the mean sea level. This region is located approximately 5 kilometers from Prayagraj city on the right bank of the Yamuna River beside Prayagraj Rewa Road. A composite soil sample was taken between 0 and 30 cm down. It was crushed, let to air dry, and its chemical and physical qualities examined. The soil reaction of the sandy clay loam was 7.6, the organic matter content was 0.69 (0.72%), the available nitrogen was 152.7 kg/ha, the phosphorus was 10.4 kg/ha, the potassium was 174.0 kg/ha, the sulfur content was 7.2 mg/kg, the zinc was 0.72 mg/kg, and the available B was 0.56 mg/kg. Groundnut (*Arachis hypogea. L*) variety K1812 were selected for sowing. Seeds were sown in line manually on 2023. Seeds were covered with the soil immediately after sowing. The spacing adopted was plant to plant 10 cm and row to row 30 cm according to the treatment details and the seeds were drilled at 3-4 cm depth. All the treatments were applied by balancing to the initial soil test values and crop requirements to justify the crop response to the supplied nutrients in both years.

Results and Discussion

Plant height: highest plant height (68.84 cm) was recorded with the application of 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage), whereas treatment 30 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) (67.54 cm) was found to be statistically at par with T_6, and minimum was reported in control (62.82 cm).

Number of branches per plant: At harvest there was significant difference among the treatments. However, highest number of branches (16.73) was recorded with the application of 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage), whereas treatment 30 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) (15.87) was found to be statistically at par with T_6, and minimum was reported in control (12.40).

Plant dry weight: significant difference among the treatments. However, maximum plant dry weight (42.97 g) was recorded with the application of 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage), whereas treatment 30 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) (42.51 g) was found to be statistically at par with T_6, and minimum was reported in control (35.79 g).

Number of nodules per plant: At harvest there was significant difference among the treatments. However, higher number of nodules (26.27) was recorded with the application of 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage), whereas treatment 30 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) (25.87) was found to be statistically at par with T_6, and minimum was reported in control (22.13).

Number of pods per plant: Significantly Maximum number of pods per plant (50.80) was recorded with the treatment of application of 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) over all the treatments, minimum was recorded in Control (RDF): 25:50:75 NPK kg/ha (40.00), and 30 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) (50.00) was statistically at par with T_6.

Number of kernels per pod: Significantly Maximum number of seeds per pod (2.93) was recorded with the treatment of application of 35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) over all the treatments, minimum was recorded in 30 × 10 cm + 2 Irrigations (flowering stage, pod formation stage) (1.20), and 30 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage) (2.87) was statistically at par with T_6.

Discussion

Sounda *et al*. (2006) [10] reported that maximum harvest index (30.46%) was obtained with I3 (3 irrigations applied at flowering, pegging, pod development stage) over I0 (rainfed) with TAG-24 variety of groundnut. Hosamani and Janawade (2007) [4] conducted experiment at College of Agriculture, Bheemarayanagudi and noted that maximum pod yield (1818 kg ha^{-1})was recorded maximum when irrigation scheduled at I1 (five irrigations at pre-flowering, flowering, pegging, pod formation and pod filling stage) over I2 (flowering, pod formation and pod filling stage) and I3 (fortnightly irrigations) on deep vertisols of Karnataka. Rahmianna *et al*. (2009) [8] stated that five times irrigations i.e., at planting and at 28DAS, 56 DAS, 76 DAS and 92 DAS respectively, during the crop period resulted in the same pod yield (1.76 t of dry pods ha^{-1}) as that of the four times irrigated crop (at planting and 28DAS, 56 DASand 76 DAS). Pawar *et al*. (2013) [5] conducted experiment at Mahatma Phule Krishi Vidyapeeth, Rahuri, on TAG-24 variety and stated that the plant height was found maximum when irrigation scheduled at 1.05 IW/CPE ratio followed by 1.20 IW/CPE ratio on clay loam soils of Maharashtra. Pervin *et al*. (2014) [6] conducted experiment during the rabi season (BARI Chinabadam-8 variety) and results revealed that the highest plant height was recorded when irrigation given at flowering, pod formation and seed filling stages and the lowest plant height (47.7 cm) was observed with irrigation at vegetative and pod formation stages on silty clay loam soils of Gazipur. Kumari and Reddy (2019) [3] and reported that dry matter partitioning to stem was significantly different among four moisture stress levels(30-50 DAS, 50-70 DAS, 70-90 DAS and moisture stress free)in which 'moisture stress free' treatment was deviating significantly from other three levels with the highest partitioning value of 2.438 irrespective of days after sowing and varieties. Among the varieties, Dharani and K-9 showed high value of partitioning than that of other three varieties.

Table 1: Effect of different irrigations and spacing yield attributes and yield of groundnut

S. No.	Treatments	Plant height	Number of branches per plant	Plant dry weight	Number of nodules per plant	Number of pods per plant	Number of seeds per pod
1.	30 × 10 cm + 2 Irrigations (flowering stage, pod formation stage)	64.32	14.13	36.86	22.27	43.20	1.20
2.	30 × 10 cm + 3 Irrigations (seedling stage, flowering stage, pod formation stage)	65.63	14.93	38.60	23.93	44.80	2.00
3.	30 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage)	67.54	15.87	42.51	25.87	50.00	2.87
4.	35 × 10 cm + 2 Irrigations (flowering stage, pod formation stage)	64.56	14.67	37.68	22.87	42.93	1.20
5.	35 × 10 cm + 3 Irrigations (seedling stage, flowering stage, pod formation stage)	66.24	15.60	38.82	24.60	45.93	2.00
6.	35 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage)	68.84	16.73	42.97	26.27	50.80	2.93
7.	40 × 10 cm + 2 Irrigations (flowering stage, pod formation stage)	63.47	13.47	36.64	22.00	40.93	1.20
8.	40 × 10 cm + 3 Irrigations (seedling stage, flowering stage, pod formation stage)	65.67	14.87	38.39	23.53	44.13	2.00
9.	40 × 10 cm + 4 Irrigations (seedling stage, vegetative stage, flowering stage, pod formation stage)	67.13	15.60	40.90	25.40	48.93	2.00
10.	Control (RDF): 25:50:75 NPK kg/ha	62.82	12.40	35.79	22.13	40.00	2.00
	F - Test	S	S	S	S	S	S
	SE m (±)	0.80	0.25	0.74	0.32	0.72	0.02
	CD (p=0.05)	2.39	0.75	2.22	0.95	2.16	0.08

Conclusion

In conclusion, the application of 35 × 10 cm spacing combined with four irrigations at crucial stages (seedling, vegetative, flowering, and pod formation) resulted in superior plant growth parameters compared to other treatments. This regimen consistently yielded the tallest plants, highest number of branches, greatest plant dry weight, most nodules per plant, highest number of pods per plant, and maximum number of kernels per pod. These findings align with previous studies indicating the significance of irrigation scheduling in maximizing groundnut yield. Our results contribute to the understanding of optimal irrigation strategies for enhancing groundnut productivity, emphasizing the importance of tailored irrigation schedules to specific growth stages. Further research could explore additional factors influencing groundnut growth and yield to refine cultivation practices and increase agricultural efficiency.

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