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Effect of sowing time on varieties of summer groundnut

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Abstract
A field experiment was conducted during the summer season of the year 2022 at regional research station farm, Anand Agricultural University, Anand, Gujarat, India to study the effect of sowing time on varieties of summer groundnut. The soil having sandy loam or *Goradu* type of texture with adequate drainage profile. The experiment was laid out in split plot design with four replications and nine treatment combinations, where main plot consisted of three different sowing time: S_1: Second fortnight of January; S_2: First fortnight of February; S_3: Second fortnight of February and the sub-plot consisted of three different groundnut varieties: TAG 24, TG 37A and GG 34. The study assessed plant population, growth parameters: plant height (cm), Dry weight of root nodules (mg/plant), Plant dry biomass (g/plant) and Days to maturity with yield attributes and yield: pods per plant, seed index (g) and shelling (%) and pod and haulm yield. Quality parameters also recorded as oil and protein content. Sowing on Second fortnight of February resulted in higher plant height, dry weight of root nodules and plant dry biomass. Crop sown at second fortnight of January recorded more days to maturity and the highest pods per plant. It also led to higher pod yield as well as haulm yield. Among the varieties, GG 34 was observed the highest plant height, plant dry biomass, days to maturity, pods per plant and shelling. Variety GG 34 produced the highest pod yield as well as haulm yield. Sowing on second fortnight of January and selecting GG 34 can increase yield and net return in summer groundnut cultivation, providing valuable insights for farmers and researches.

Keywords: Summer groundnut, sowing time, TAG 24, TG 37A, GG 34

1. Introduction
Groundnut is an important oilseed crop of tropical and subtropical areas and now being cultivated on about 25 million hectares of land in about 100 countries in the world under different agro-climatic regions where rainfall during the growing season exceeds 500 mm. Groundnut is major oilseed crop in India and it plays a significant role in bridging the vegetable oil deficit within the country. Groundnut is available throughout the year and grown mostly under rainfed conditions. Groundnut is known as “King of Oilseeds”. Groundnut kernels are consumed directly as raw, roasted, fried or boiled and also used in culinary preparations like peanut butter, peanut milk, peanut flour etc. Groundnut oil is edible oil containing Oleic acids and Linoleic acids (Sardana and Kandhola, 2007) [7]. Groundnut cake used as feed to cattle as well as manure as it contains 7-8% of nitrogen, 1.5% of phosphorus and 1.2% of potassium and its haulms are used as cattle feed. Groundnut is not only an important oilseed crop of India but also an important agricultural export commodity. India occupies first position in terms of area and second in production. China is the largest producer as well as consumer of groundnut in the world with 166.24 lakh tonnes followed by India 68.57 lakh tonnes. India exports groundnut to more than 75 countries. India had exported 638.582 million tonnes of groundnut to the world for the worth of Rs 5381.61 crores per 727.35 USD Millions during the year 2020-21. Among all groundnut growing states of India, Gujarat has the highest area and production with low productivity per hectare as compared to Tamil Nadu. In Gujarat, groundnut area under *kharif* and summer is about 21.01 and 0.61 lakh ha with the production of 39.91 and 1.42 lakh tonnes, respectively while productivity of 1899 kg/ha in *kharif* and 2327 kg/ha in summer (Anon., 2021). Groundnut is mainly grown as a rainfed crop during *kharif* season, but also grown in the summer season, wherever the irrigation facilities are available. Because of decreasing per capita availability of land due to increase in population and urbanization, there is no more land under cultivation and hence it is necessary to employ low-cost technologies for improving groundnut

yield through natural resource management. The sowing time plays an important role among various agronomic factors, which influencing the yield of groundnut. Normal sowing has longer growth duration which consequently provides an opportunity to accumulate more biomass as compared to late sowing, hence manifested in higher economic and biological yields. It is required to monitor the microclimatic element. Yield with different dates of sowing can be related to the effect of photothermal quotient. Change in the optimum temperature during its vegetative or reproductive growth adversely affect the initiation and duration in different phenophases and finally yield of crop (Vinu *et al.*, 2020) [9]. Among different agronomic practices proper time of sowing is a most important factor and it is a non-cash input, about which the information is to be find out for obtaining maximum yield. Some newly developed varieties of groundnut especially bunch type varieties give good response in summer season. Sometime farmers faced problems regarding early monsoon at the time of harvesting, So, timely sowing is necessary for particular variety in case of summer season. Keeping this in mind, the research topic is taken "effect of sowing time on varieties of summer groundnut". This research paper will provide valuable insights into the interaction between sowing time and variety selection, contributing to the development of effective strategies for maximizing productivity and meeting the increasing global demand for this vital crop.

2. Materials and Methods

The field experiment was laid out in plot E-5 at the RRS farm, regional research station, Anand Agricultural University, Anand, Gujarat, India (22.31° N latitude and 72.57° E and 45.1 mm above the mean sea-level) during the summer seasons 2022. This centre is located in the Middle Gujarat Agro-Climatic Zone (AES-III) of Gujarat. The experimental field has an even topography with a gentle slope having good drainage. The soil samples were taken randomly from experimental plot to a depth of 0-15. The soil was sandy loam in texture, medium in organic carbon (0.39%), medium in available phosphorus (31.78 kg/ha) and available potash (349.56 kg/ha) with average nitrogen (224 kg/ha). Its pH was slightly alkaline (7.20) and low in soluble salts. The experimental design followed a split plot design with three different sowing time as the main plot treatments and three summer groundnut varieties as the sub-plot treatment with 4 replications. The treatments consisted of 3 sowing time (S_1: Second fortnight of January; S_2: First fortnight of February; S_3: Second fortnight of February) and 3 varieties. *viz*., V_1: TAG 24; V_2: TG 37A and V_3: GG 34. Recommended dose of nitrogen, phosphorus and potassium (N: P_2O_5: K_2O @ 25:50:00 kg/ha) was applied through urea and SSP. Entire dose of Nitrogen and phosphorus were applied to all the plots as basal dose in furrow prior to sowing. The seed were treated with fungicide Vitavex powder (Carboxin 37.5% + Thiram 37.5% WS) @ 3 g/kg of seed mixed properly with some amount of water, then allowed to dry in shade for 10 hours before sowing. The seeds of groundnut varieties were sown manually in previously opened furrows at the distance of 30 cm between the rows @ 120 kg/ha. Fertilizers were placed below the seeds before sowing. After sowing seeds were covered with a thin layer of soil to avoid damage by birds in all the treatments. The first irrigation was given just after sowing and remaining irrigations were given as and when required by the crop. Oxyfluorfen 23.5 EC @ 15.3 ml / 10 liter of water was sprayed as pre-emergence for weed control 24 hrs. after sowing. The left-over weed was controlled by one hand weeding at 30 DAS was carried out during the course of investigation. Neither serious disease nor pests were observed in the crop during the course of investigation, but in order to prevent infestation of leaf spot, collar rot and tikka disease, application of vitavex powder (carboxin 37.5% + thiram 37.5% WS) (fungicide) just before the sowing as seed treatment and Mancozeb 63% + Carbendazim 12% WP as drenching @ 10 g/ 10 liter of water at 30 DAS. To reduce the infestation of sucking pest and lepidopteran pest spraying of profenophos 50% EC @ 20 ml in 10 liter of water and quinalphos 25% EC @ 20 ml in 10 liter of water, respectively. Harvesting of crop was done at physiological maturity stage. Plant stand at 20 DAS and at harvest from each plot one meter row length selected and counted. Growth and yield attributing characters *viz*., plant height (cm) at 30, 60, 90 DAS and at harvesting, dry weight of root nodules/plant at 45 DAS, plant dry biomass (g/plant), days to maturity, pods per plant, shelling (%) and seed index (g) were recorded. Pod and haulm yield were recorded at harvesting of the crop. The net profit was worked out by deducting the total cost of cultivation from gross realization for each treatment and recorded accordingly. Benefit: cost ratio (BCR) is the ratio of gross realization to the total cost of cultivation was calculated by using the following formula.

$$\text{BCR} = \frac{\text{Gross realization (₹/ha)}}{\text{Total cost of cultivation (₹/ha)}}$$

2.1 Statistical Analysis

The statistical analysis of the data generated during the course of investigation was carried out by using statistical method appropriate split-plot design concept for field experiment and data analysis by computer system at the computer centre, Department of Statistics, BACA, AAU, Anand, Gujarat as per the procedure described by Cochran and Cox (1967) [3]. The variances of different sources of variation in ANOVA were tested by 'F-test' and compared with the value of Table-F at 5% level of significance. To explain the treatment effect, summary tables along with Sem ± and CD at 5% are given in chapter 'experimental results' and their co-efficient of variance are given in the appendices at the end.

3. Results and Discussion

Various factors related to crop production played a crucial role in increasing groundnut production per unit area. Among these factors, the sowing time and the selection of suitable varieties were particularly important in maximizing production. The objective of the experiment was to find out the effect of sowing time and suitable varieties on growth, yield attributes and yield of summer groundnut. To achieve the aforementioned objectives, the results and discussion of various parameters are presented below:

3.1 Effect of sowing time

3.1.1 Plant population

Plant population (per meter row length) of summer groundnut at 20 DAS and at harvest were found to be non-significant as influenced by different sowing time. It might be due to favourable weather condition during the germination period and also soil condition was good. It is reveals from the data that the plant stand of all the treatments was uniform and variations obtained in results were due to treatment effects and not due to the effect of plant stand.

Table 1: Plant population and growth parameters of summer groundnut as influenced by sowing time and varieties (2022)

Treatment	Plant population (per m row length)		Plant height (cm)				Dry wt. of root nodules (mg/plant) at 45 DAS	Plant dry biomass (g/plant) at 45 DAS	Days to maturity
	At 20 DAS	At harvest	At 30 DAS	At 60 DAS	At 90 DAS	At harvest			
Main plot : Sowing time (S)									
S_1 : Second fortnight of January	11.75	10.33	7.58	26.42	46.36	58.80	44.17	6.89	117.00
S_2 : First fortnight of February	11.33	11.17	8.67	32.56	48.25	62.36	44.09	7.24	110.00
S_3 : Second fortnight of February	11.50	10.42	9.69	33.53	50.14	63.85	45.04	8.02	109.00
SEm ±	0.34	0.33	0.24	0.93	1.05	1.15	0.72	0.17	1.97
CD at 5%	NS	NS	0.82	3.20	NS	NS	NS	0.58	6.80
CV (%)	10.19	10.74	9.45	10.41	7.57	6.43	5.62	7.82	6.08
Sub plot : Varieties (V)									
V_1 : TAG 24	11.92	10.75	8.08	29.64	46.08	60.08	44.24	6.44	107.00
V_2 : TG 37 A	11.58	10.42	8.83	29.33	46.17	59.26	45.28	6.95	101.00
V_3 : GG 34	11.08	10.75	9.03	33.53	52.50	65.67	43.78	8.76	128.00
SEm ±	0.29	0.27	0.18	0.71	0.85	1.05	0.75	0.14	1.67
CD at 5%	NS	NS	0.54	2.10	2.51	3.11	NS	0.41	4.97
Interaction (S×V)									
SEm ±	0.50	0.47	0.31	1.22	1.46	1.81	1.29	0.24	2.90
CD at 5%	NS	NS	NS	NS	NS	NS	NS	0.71	NS
CV (%)	8.71	8.91	7.27	7.93	6.07	5.88	5.82	6.45	5.17

3.1.2 Growth parameters

Plant height (cm) at 30, 60, 90 DAS and at harvest was significantly higher when crop sown on second fortnight of January. The data revealed that significantly higher plant height at 30 and 60 DAS were observed when groundnut was sown on second fortnight of February (S_3) (9.69 cm and 33.53 cm), respectively. Treatment S_2 (First fortnight of February) was found at par with second fortnight of February (S_3) at 60 DAS plant height. Plant height at 90 DAS and at harvest found to be non-significant due to different sowing time (Table 1). It is evident from the plant height at 30, 60, 90 DAS and at harvest were increased significantly when delayed crop sowing. Whereas, in early sown crop having low temperature during the early stage resulted in significantly lower plant height (Jangilwad *et al.,* 2015) [4]. Dry weight of root nodules at 45 DAS was found to be non-significant as influenced by sowing time (Table 1). Significantly the highest plant dry biomass at 45 DAS (8.02 g/plant) was reported in treatment S_3 (Second fortnight of February). While lowest plant dry biomass at 45 DAS (6.89 g/plant) was found in treatment S_1 (Second fortnight of January) which was at par with treatment S_2 (First fortnight of February). Plant dry biomass increase with delayed sown crop due to congenial environmental conditions (Kamble *et al.,* 2023) [5]. Significantly the highest number of days to maturity (117 days) was observed when crop was sown at Second fortnight of January (S_1). Delay sown groundnut at Second fortnight of February (S_3) taken minimum days (109 days) for the maturity. Early sown crop required more number of days as compared to late sown groundnut which is similar to finding of Birajdar *et al.,* 2020 [2].

3.1.3 Yield attributes

Significantly the highest number of pods per plant (21.22 pods) were recorded when crop sown at second fortnight of January (S_1). Whereas, significantly the lowest number of pods per plant (16.29 pods) were observed when crop was sown at Second fortnight of February (S_3). Number of pods were decreased with late sowing which was similar to finding of Sai *et al.,* 2022 [6]. Delayed sowing increases the plant biomass (vegetative growth) which is affect inversely on pod per plant (reproductive growth). Sowing time had non-significant effect on shelling (%) as well as on seed index (g).

3.1.4 Yield

It was revealed from the data that sowing time had significant effect on pod yield of summer groundnut. Treatment S_1 (Second fortnight of January) reported significantly the highest pod yield (3382 kg/ha). While crop sown at second fortnight of February (S_3) showed significantly lowest pod yield (2355 kg/ha). Shendage *et al.,* 2018 [8] reported similar finding that of pod yield increased with sowing of groundnut on early in January month in summer growing season as compared to late sown crop. It was observed from the experiment, sowing time had a significant effect on haulm yield (kg/ha). Significantly the highest haulm yield (6438 kg/ha) were recorded when groundnut sown at second fortnight of January (S_1), which was at par with treatment S_2 (first fortnight of February) with 6214 kg/ha haulm yield. This might be due to the proper distribution of moisture during critical growth period of the crop and long day conditions exposed the crop to better sunlight for longer duration which produces more photosynthates for growth and development of the plant during early sown conditions (Sai *et al.,* 2022) [6].

3.1.5 Quality parameters

It was observed from the experiment that, sowing time had non-significant effect on oil content and protein content in groundnut crop in summer season.

3.2 Effect of varieties

3.2.1 Plant population

Plant population (per meter row length) of summer groundnut at 20 DAS and at harvest were found to be non-significant as influenced by varieties.

3.2.2 Growth parameters

Significantly higher plant height (9.03 cm, 33.53 cm, 52.50 cm and 65.67 cm) was recorded by variety GG 34 (V_3). Variety TG 37A (V_2) is significantly at par with variety V_3 (GG 34) at 30 DAS. The variation in plant height of groundnut varieties measured during different stage of groundnut might be due to the genetic characteristics of individual varieties. Dry weight of root nodules at 45 DAS was observed to be non-significant as influenced by varieties of groundnut. The data reveled that, variety GG 34 (V_3) produced significantly the highest plant dry biomass weight (8.76 g/plant) and TAG 34 (V_1) resulted the

lowest plant dry biomass (6.44 g/plant). Different varieties were shown significant influence on days to maturity of summer groundnut. Variety GG 34 (V_3) taken significantly the maximum days for maturity (128 days) and variety TG 37A (V_2) taken minimum days for maturity (101 days).

Table 2: Yield attributes and yield of summer groundnut as influenced by sowing time and varieties (2022)

Treatment	Yield attributes			Yield	
	Pod per plant	Shelling (%)	Seed index (g)	Pod yield (kg/ha)	Haulm yield (kg/ha)
Main plot : Sowing time (S)					
S_1 : Second fortnight of January	21.22	70.08	45.00	3382	6438
S_2 : First fortnight of February	18.80	69.83	46.43	2938	6214
S_3 : Second fortnight of February	16.29	70.44	44.69	2355	5665
SEm ±	0.52	1.27	0.77	103	132
CD at 5%	1.79	NS	NS	357	457
CV (%)	9.56	6.27	5.90	12.38	7.49
Sub plot : Varieties (V)					
V_1 : TAG 24	18.33	69.57	44.67	2812	5924
V_2 : TG 37 A	17.61	70.88	43.85	2717	5978
V_3 : GG 34	20.37	69.89	47.60	3145	6415
SEm ±	0.33	1.14	0.56	97	110
CD at 5%	0.98	NS	1.65	290	326
Interaction (S×V)					
SEm ±	0.57	1.98	0.96	169	190
CD at 5%	NS	NS	NS	NS	NS
CV (%)	6.07	5.65	4.24	11.68	6.23

3.2.3 Yield attributes

Variety GG 34 (V_3) reported significantly the highest number of pods per plant (20.37 pods) and the lowest number of pods per plant (17.61 pods) were observed in variety TG 37A (V_2). It was observed that effect of different varieties of summer groundnut was found to be non-significant on shelling (%). The seed index of summer groundnut crop was found significant by different varieties. Variety GG 34 (V_3) recorded significantly the higher seed index value (47.60 g). While variety TG 37A (V_2) showed significantly the lowest seed index value (43.85 g).

3.2.4 Yield

Different varieties of summer groundnut showed significant result. Variety GG 34 (V_3) was produced significantly the maximum pod yield (3145 kg/ha) and V_2 (Variety TG 37A) showed the lowest pod yield (2717 kg/ha). This might be due to GG 34 having superior genetic makeup as compare to other two varieties of this experiment. Haulm yield was found to be significant in case of varieties of summer groundnut. Variety V_3 (GG 34) produced significantly the highest haulm yield (6415 kg/ha). Whereas, V_1 (variety TAG 24) showed the lowest haulm yield (5924 kg/ha), comparatively. This is because of V_3 having more dense plant canopy and more number of branches as compare to variety TAG 24 and TG 37A.

3.2.5 Quality parameters

Oil (%) of groundnut seed was found to be significantly affected by varieties of groundnut. Variety V_1 (GG 34) reported significantly the highest oil (%) (50.90%) in kernels. Whereas, variety TAG 24 (V_1) recorded less oil content (47.46%) as compared to others significantly. This might be due to GG 34 having great genes to produce more biochemical properties. The protein (%) in kernel showed non- significant effect on varieties of groundnut.

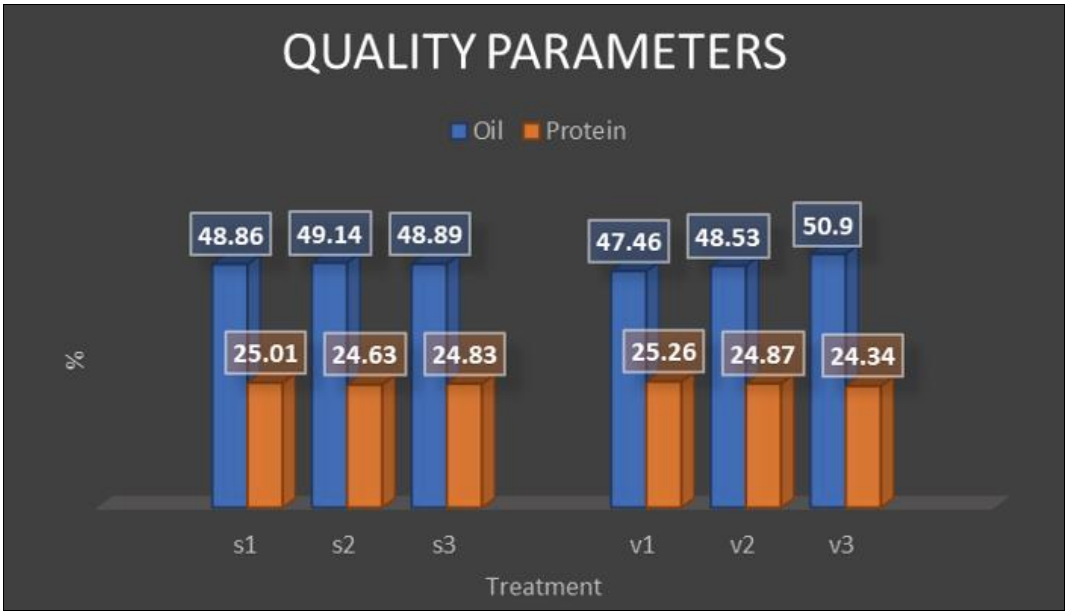

Fig 1: Quality parameters of summer groundnut influenced by sowing time and varieties (2022)

3.3 Interaction Effect

The interaction effect between sowing time and varieties (S x V) on plant dry biomass found to be significant. The combination of variety GG 34 (V_3) which was sown at Second fortnight of February (S_3) revealed significantly the highest plant dry biomass at 45 DAS (9.92 g/plant). Whereas, the lowest plant dry biomass at 45 DAS was found in treatment combination S_1V_1 (S_1: Second fortnight of January and V_1: TAG 24) with 5.78 g/plant weight. No significant interactions were observed between sowing times and varieties in all other parameters.

Table 2: Interaction effect plant dry biomass (g/plant) at 45 DAS of summer groundnut as influenced by sowing time and varieties (2022)

S x V	V_1 : TAG 24	V_2 : TG 37 A	V_3 : GG 34
S_1 : Second fortnight of January	5.78	6.95	7.94
S_2 : First fortnight of February	6.15	7.15	8.41
S_3 : Second fortnight of February	7.38	6.74	9.92
SEm±	0.24		
CD (0.05)	0.71		

3.4 Economics

The data presented in Table 4.8 shows that treatment S_1 (Sowing at second fortnight of January) recorded maximum gross and net return of ₹ 215633/ha and ₹ 153243/ha with BCR 3.46 followed by treatment S_2 (Sowing at First fortnight of February) recorded gross and net return of ₹ 188877/ha and ₹ 126487/ha with BCR 3.03. variety V_3 (GG 34) realized maximum gross and net income of ₹ 201593/ha and ₹ 139203/ha, respectively with BCR 3.23 followed by variety TAG 24 (V_1) with gross and net realization of ₹ 180718/ha and ₹ 118328/ha with BCR 2.90. Whereas, treatment V_2 gave gross and net return of ₹ 175248/ha and ₹ 112858/ha, respectively with BCR 2.81. among the different treatment combination S_1V_3 (Variety GG 34 sown on Second fortnight of January) secured maximum gross as well as net return of ₹ 231226/ha and ₹ 1688366/ha, respectively along with BCR of 3.71. Treatment combination S_3V_2 (Variety TG 37A sown on Second fortnight of February) found minimum in gross and net return of ₹ 135880/ha and ₹ 73490/ha, respectively along with 2.18 BCR.

4. Conclusion

In light of the results obtained from this investigation, following conclusions are emerged out. Treatment combination i.e. sowing on second fortnight of January with GG 34 variety found more remunerative over other varieties and sowing time.

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6. Competing interests

The authors declare that there is no conflict of interest related to this article.

7. Author's Contributions

D. B. Patoliya: Conceptualization, Methodology, data collection, Analysis, Writing, editing.
G. L. Kadam: Conceptualization, discussion, Review and editing, Supervision.
V. B. Mor: Conceptualization, discussion, Review and editing, Supervision.
A. S. Bhanvadia: Conceptualization, discussion, Review and editing, Supervision.
M. B. Viradiya: Review and Supervision.

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