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Effect of sowing date and variety on morphological growth traits of rainfed groundnut

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Abstract

A research study was undertaken in the College Farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana Agriculture University during *kharif*, 2024 to evaluate the effect of sowing windows and varieties on growth of groundnut (*Arachis hypogaea* L.). The experimental plot was laid out in Split Plot design with three dates of sowing (second fortnight of June, first fortnight of July and second fortnight of July) and five groundnut varieties (TG 37-A, KDG 128, TAG 24, TCGS 1694 and K6). The data analysis revealed that the crop sown on July I fortnight attained physiological maturity early than the other sowing windows. Days to seedling emergence did not significantly differ between the varieties. K6 achieved physiological maturity in a shorter period among the other varieties under study. The analysis of the data indicated that the crop sown in the June II fortnight had significantly higher plant height, leaf area, and leaf area index at physiological maturity compared to the other two sowing windows. Additionally, it was noted that KDG 128 had the statistically highest leaf area and leaf area index, while K6 had the tallest plants among the varieties studied at physiological maturity. LAD (Leaf Area Duration) values across the three growth phases were unaffected by sowing dates. Among the varieties, TG 37-A and KDG 128 (93 days) recorded significantly higher LAD than TAG 24, TCGS 1694, and K6. During pod formation to maturity, LAD of KDG 128 (132.8 days) was on par with TG 37-A (129.3days) and both exceeded the remaining varieties.

Keywords: Groundnut, plant height, leaf area, leaf area index, leaf area duration, varieties

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the world's most important oilseed crops, often referred to as the "king of vegetable oilseeds," "poor man's cashew nut" and "wonder nut" (Biswas and Bhattacharjee, 2019) ^[2]. The genus *Arachis* comprises over 70 wild species, but only *A. hypogaea* L. has been domesticated and is widely cultivated (Prasad *et al.*, 2010) ^[3]. It is grown mainly between latitudes 40°N and 40°S, with a growth period of 90–115 days for sequential branching types and 120–140 days for alternate branching types. The crop thrives best at temperatures of 22–28°C, while yields may decline when temperatures fall below 18°C or rise above 33°C (FAO database).

In India, groundnut covers an area of 4.71 million ha with 10.18 million tonnes production and 2163 kg ha⁻¹ productivity. In Telangana, *kharif* area is 10 thousand ha with 28 thousand tonnes of production and 2832 kg ha⁻¹ productivity while total area is 92 thousand ha with 225 thousand tonnes production and 2450 kg ha⁻¹ productivity. (Indiastat, 2023-24). In India, its yield is majorly influenced by rainfall patterns, making it vulnerable to monsoon fluctuations and drought, with climate change further intensifying these challenges through unpredictable weather (Mukhtar *et al.*, 2013) ^[4]. Consequently, productivity remains unstable. In Telangana, groundnut holds significant importance as an oilseed crop, primarily grown on red sandy loams and alfisols in districts such as Mahabubnagar, Nagarkurnool, Wanaparthy, Nalgonda, and Rangareddy. Despite its significance, the average yield remains limited to about 1.5–2.0 t ha⁻¹, constrained by erratic rainfall, low soil fertility, pest infestations and limited use of advanced farming practices (ICRISAT, 2023).

Although many high-yielding groundnut varieties have been developed, their performance often

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varies with climatic conditions. Evaluating these varieties under local environments is essential, as temperature, rainfall and humidity play a crucial role in determining yield potential and disease tolerance (Soumya, 2011) [8]. Groundnut pod yield has been shown to follow a curvilinear trend in relation to rainfall and soil moisture availability (Bhatia *et al.*, 2009) [6] making weather parameters as one of the major factors to be considered for groundnut production in Telangana. In Telangana, a baseline survey revealed that 98% of farmers rely on informal seed sources, with inadequate access to quality seed being a major constraint to improving yields and farm income (Charyulu *et al.*, 2023) [7]. Research further indicates that, in many semi-arid regions, groundnut can deliver higher net returns and benefit–cost ratios than alternative crops under favorable conditions (Nayak *et al.*, 2021 and Kamble *et al.*, 2023) [5, 9]. Enhancing productivity during the *kharif* season in Telangana will require the adoption of improved varieties along with optimized sowing schedules.

Materials and Methods

The present investigation was conducted during the *kharif*, 2024 at the College Farm, College of Agriculture, Rajendranagar, Professor Jayashankar Telangana Agricultural University, Hyderabad (Telangana, India). The geographical location of the experimental site was 17° 19' 21" N latitude, 78° 24' 36" E longitude, with an elevation of 548 m above mean sea level. The experimental site is positioned in Telangana's Southern Telangana agro-climatic zone, falling under Troll's climate classification as a semi-arid tropic (SAT).

According to the soil analysis results the soil was considered slightly alkaline in reaction and had a loamy texture. It was found to have a medium level of available phosphorus, a high level of available potassium, and a low level of organic carbon and available nitrogen.

The research was conducted to study the impact of three sowing windows and five varieties. The three sowing dates under consideration were June II fortnight (June 20th), July I fortnight (July 5th) and July II fortnight (July 20th) and the varieties under study were TG37-A, KDG 128, TAG 24, TCGS 1694 and K6. The trial was conducted in Split-plot design with three replications, considering sowing dates as main plots and varieties as sub plots. Sowing was done accordingly and all the agronomic practices were followed as per the recommendation. Observations recorded from the investigation included days to emergence of seedling, days to attain physiological maturity, plant height (cm), leaf area (cm²), leaf area index and leaf area duration at four phenological stages *i.e.*, first flower bud appearance, 50% flowering, pod formation stage and physiological maturity.

Results and Discussion

Effect of sowing dates

Days to emergence of the seedling

Days to emergence of groundnut seedlings was significantly influenced by the dates of sowing as reported in Table 1. The crop sown on 20th June 2024 (D₁) recorded the least number of days to emergence (9.4 days) while crop sown on 5th July 2024 (D₂) recorded 9.7 days and 20th July 2024 (D₃) sown crop required the maximum time for emergence (10.6 days) and was significantly higher than D₁. The delay in emergence observed in D₃ could be attributed to lower bright sunshine hours (29th Standard meteorological week) during late sowing, which might have affected seed germination and vigor. These results are

consistent with previous findings that early sowing provides favorable conditions for rapid emergence by Caliskan *et al.* (2008) [10].

Days to physiological maturity

Sowing dates variably affected growth parameters at different phenological stages as tabulated in Table 1. Dates of sowing did not significantly affect days to physiological maturity where D₂ (5th July) matured fastest at 98.5 days, D₁ (20th June) required 101.2 days and D₃ (20th July) 104.9 days. These results were similar to findings of Kanade *et al.* (2015) [11].

Plant height

The results regarding plant height as mentioned in Table 2 conclude that, at the first flower bud stage was not significantly influenced by the dates of sowing. Although statistically non-significant, the tallest plants were recorded in 5th July sowing with a mean height of 16.05 cm, followed by 20th June sowing (15.21 cm) and 20th July sowing (15.07 cm). At the 50% flowering stage, dates of sowing did not significantly influence plant height. The highest mean plant height was recorded under D₃ with 23.39 cm, followed by D₂ (22.50 cm) and D₁ (21.27 cm). Similar findings were also reported by Gowda *et al.* (2017), who observed that delayed sowing enhanced stem elongation but did not translate to higher yields. At the pod formation stage, the effect of dates of sowing on plant height was found to be significant. The plants sown on 20th June (D₁) attained a significantly greater height (35.39 cm) compared to those sown on 20th July (D₃, 32.43 cm), while D₂ (5th July) was statistically on par with both. At physiological maturity, plant height was significantly influenced by sowing dates. The tallest plants were recorded in D₁ (41.77 cm), which was significantly superior to D₂ (35.91 cm) and statistically on par with D₃ (40.56 cm). The comparatively shorter plant height in the crop sown in July can be attributed to lower temperatures whereas the crop sown in June II fortnight has been exposed to comparatively higher temperatures that might have led to the rapid growth of the plants. These results are in line with the findings of Kamble *et al.* (2023) [9]. The findings were according to Reddy *et al.* (2014) [12] and Yadavrao *et al.* (2023) [13].

Leaf area

According to the statistical analysis of data related to leaf area as in Table 3, at 1st flower bud appearance leaf area was found to be highest in D₁ with a mean value of 126.51 cm², followed by D₂ with 123.89 cm² and D₃ with 115.68 cm². Although D₁ recorded the highest leaf area, the differences among sowing dates were not statistically significant. A similar trend was observed at the 50% flowering stage with 418 cm² in D₁ sown crop 408.36 cm² in D₂ sown crop and 413.69 cm² in D₃ sown crop, where no significant difference was observed. During pod formation, leaf area remained statistically non-significant, indicating that sowing date had no significant effect on leaf area during this critical reproductive stage. However, the numerical values were in a decreasing trend with 1490.66 cm² in D₁ followed by 1487.15 cm² in D₂ and 1481.42 cm² in D₃. At physiological maturity, a non-significant variation among sowing dates was recorded. These outcomes resonate with previous empirical results by Purna Chandana *et al.* (2025).

Leaf area index

The data encapsulated in Table 4, concludes that the sowing dates did not significantly influence LAI at any of the growth

stages observed namely, first flower bud appearance, 50% flowering, pod formation and physiological maturity stages. However, numerically, D₁ (20th June 2024) recorded the highest LAI at the early stages, i.e., 0.42 at first flower bud appearance and 1.40 at 50% flowering. This was followed closely by D₂ (5th July 2024) and D₃ (20th July 2024). During the pod formation stage, all three sowing dates exhibited comparable LAI values (4.94–4.97), indicating that plants across sowing dates developed a sufficient canopy during this key reproductive phase. At physiological maturity, D₂ showed slightly higher LAI (4.11) compared to D₁ and D₃. Similar observations were recorded by Baliarsingh and Mahapatra (2015)^[14].

Leaf area duration

The LAD values across the three growth phases (1st flower bud appearance to 50% flowering, 50% flowering to pod formation and pod formation to physiological maturity) did not differ significantly with sowing dates as per Table 5. However, D₃ (20th July 2024) sown crop recorded the highest LAD of 126.9 days during pod formation to maturity, compared to 111.0 for D₁ (20th June sown crop) and 100.3 for D₂ (5th July sown crop). Though not statistically divergent, the elevated LAD for late sowing (D₃) may be attributed to cooler post-anthesis temperatures that delay senescence and extend leaf photosynthetic duration, resulting in prolonged green canopy retention. (Kingra and Kaur., 2012)^[1].

Effect of varieties

Day to emergence of seedling

According to the data in Table 1, the difference in days to emergence among the varieties were not statistically significant, though slight numerical variations were observed. TG 37-A and TAG 24 emerged in 9.5 days, KDG 128 in 9.7 days, TCGS 1694 in 10.5 days and K6 in 10.3 days. These variations are likely attributable to inherent varietal traits.

Days to physiological maturity

Varieties showed significant differences in days to attain maturity (Table 1). TAG 24 (90.8 days) and K6 (88.0 days) were earliest to mature while KDG 128 (110.5 days) and TCGS 1694 (110.6 days) took the longest time. This variation confirms that genetic differences primarily govern crop duration.

Plant height

A significant difference among varieties regarding plant height was observed at the 1st flower bud appearance stage. Among the five tested varieties, K6 (V₅) recorded the highest plant height (17.74 cm) followed by TCGS 1694 (17.20 cm), whereas the shortest plants were observed in TAG 24 (13.04 cm). The difference in the plant height among different varieties can be attributed to the genetic differences among the varieties (Wang *et al.*, 2021)^[21]. At the 50% flowering stage, varietal differences remained significant. The tallest plants were recorded in K6 (23.93 cm), followed by TCGS 1694 (22.99 cm) and TAG 24 (21.22 cm). The shortest height was observed in TG 37-A (21.70 cm). During pod formation, the differences among varieties became more pronounced and statistically highly significant K6 (49.73 cm) exhibited an exceptionally high plant height, which was significantly superior to all other varieties. This was followed by TCGS 1694 (33.69 cm), TG 37 A (29.21 cm) and KDG 128 (28.94 cm). The lowest height at this stage was found in TAG 24 (27.34 cm). At the physiological maturity stage, a significant variation was recorded among the varieties. K6 showed significantly maximum plant height of 52.79 cm

followed by TCGS 1694 (37.64 cm), KDG 128 (36.50 cm) and TG37 A (6.46 cm). TAG 24 continued to show the lowest plant height (33.69 cm), indicating its dwarf nature. The consistent superiority of K6 throughout the growth stages may be attributed to its higher photosynthetic activity and better partitioning of assimilates towards vegetative organs. Similar results were registered by Swetha Sree *et al.* (2020)^[15]. The data for those arranged in Table 2.

Leaf area

The data of effect of sowing dates and varieties on leaf area has been presented in Table 3. TAG 37-A (134.55 cm²) and KDG 128 (132.33 cm²) recorded significantly higher leaf area compared to TAG 24 (120.78 cm²), K6 (116.22 cm²) and TCGS 1694 (106.27 cm²) at the 1st flower bud appearance stage. TG37-A exhibited the highest leaf area (439.10 cm²), significantly superior than K6 (400.80 cm²) and TCGS 1694 (389.73 cm²) and significantly on par to TAG 24 (419.50 cm²) and KDG 128 (418.73 cm²) during the 50% flowering stage. The marked increase in leaf area can be linked to accelerated cell division and expansion, coupled with vigorous vegetative growth supported by favorable weather conditions such as optimal temperature, adequate rainfall and sufficient light during the growth period. These outcomes resonate with previous empirical results by Banik *et al.* (2009)^[17].

Although the differences at the pod formation stage were not statistically significant, the recorded leaf area values were TAG 24 (1521.80 cm²), TCGS 1694 (1517.84 cm²), TG 37-A (1481.81 cm²), K6 (1457.93 cm²) and KDG 128 (1452.66 cm²). These values reflect the genetic capacity of the varieties to optimize source area during this crucial reproductive stage. Similar observations were reported by Mohite *et al.* (2017)^[16] and Ragavalli *et al.* (2019)^[18].

TG 37A (1257.19 cm²) and TAG 24 (1242.15 cm²) exhibited substantially larger leaf areas at physiological maturity than TAG 24 (1150.99 cm²). These findings were consistent with the findings reported by Vaishnavi.

Leaf area index

The effect of sowing dates and five varieties is presented in Table 4. Groundnut leaf area index was significantly impacted by the types in the first stage of flower bud appearance. The variety TG 37A (0.45) had a much greater leaf area index than the other types, TAG 24 (0.40) and K-6 (0.39) (0.42), and was in line to KDG 128 (0.44). TCGS-1694 had the significantly lowest leaf area index (0.33).

At 50% flowering stage, there was significant effect of varieties on leaf area index of groundnut. Significantly higher leaf area index was recorded in the variety TG 37A (1.46) than the varieties KDG 128 (1.40) which was on par with TAG 24 (1.40) and significantly higher than K6 (1.34) and TCGS 1694 (1.30). At pod formation stage there was no significant effect of varieties on the leaf area index of the groundnut.

Similarly, at physiological maturity stage higher leaf area index was reported in TG 37A (4.19) variety which was on par to TAG 24 (4.14) and significantly higher than KDG 128 (4.00), K6 (3.95) and TCGS 1694 (3.90).

The observed varietal differences can be linked to genetic diversity in canopy architecture, leaf retention capacity, and growth period. According to Deshmukh *et al.* (2020)^[19], KDG 128 is characterized by its ability to sustain a higher leaf area index under rainfed and terminal stress conditions, whereas TG 37-A is noted for its pronounced early growth vigor.

Leaf area duration

The observations on LAD as influenced by dates of sowing and varieties are presented in Table 5. Varietal differences had a statistically significant influence on LAD during the interval from 50% flowering to pod formation. TG 37-A (V₁) and KDG 128 (V₂) recorded LAD values of 93 days while TAG 24(60.1 days), TCGS 1694(84.8 days) and K6(46.2 days). In the period from pod formation to physiological maturity, KDG 128 (132.8) was significantly higher than TAG 24, TCGS 1694, and K6, and

comparable to TG 37-A (129.3). Both of these varieties also outperformed those with lower LAD. These trends may be associated with differences in canopy persistence, leaf senescence rate, and photosynthetic capacity. Varieties such as TG 37-A and KDG 128 tend to retain green leaf area for a longer duration during seed filling, thereby supporting greater assimilate production and improved yield potential (Meena *et al.*, 2015) ^[20]. The sowing date × variety interaction remained non-significant at all stages.

Table 1: Effect of different dates of sowing and varieties on phenology of groundnut

Treatment	Phenology				
	Emergence stage	1 st Flower bud appearance stage	50% flowering stage	Pod formation stage	Physiological maturity stage
Main factor: Dates of Sowing					
D1- 20 th June 2024	9.4	30.1	53.1	80.6	101.2
D2- 5 th July 2024	9.7	29.7	52.6	80.3	98.5
D3- 20 th July 2024	10.6	28.5	52.5	80	104.9
S.Em ±	0.2	0.4	0.7	0.6	1.2
CD (p=0.05)	0.9	NS	NS	NS	4.6
Sub factor: Varieties					
V1- TG 37-A	9.5	29.3	51.4	80.5	107.8
V2- KDG 128	9.7	29.5	51.6	80.6	110.5
V3- TAG 24	9.5	30.2	53.7	80.3	90.8
V4- TCGS 1694	10.5	29.4	53.3	79.8	110.6
V5- K6	10.3	28.8	53.6	80.4	88.0
S.Em ±	0.4	0.5	0.7	0.8	1.7
CD (P=0.05)	NS	NS	NS	NS	4.9
Interaction (Factor (D) at same level of V)					
S.Em ±	0.6	0.9	1.3	1.4	2.9
CD (P=0.05)	NS	NS	NS	NS	NS
Interaction (Factor(V) at same level of D)					
S.Em ±	0.6	0.9	1.3	1.4	2.8
CD (P=0.05)	NS	NS	NS	NS	NS

Table 2: Plant height (cm) of groundnut varieties at different growth stages as influenced by sowing dates

Treatment	Plant height (cm)			
	1 st Flower bud appearance stage	50% flowering Stage	Pod formation stage	Physiological maturity stage
Main factor: Dates of Sowing				
D1- 20 th June 2024	15.21	21.27	35.39	41.77
D2- 5 th July 2024	16.05	22.50	33.53	35.91
D3- 20 th July 2024	15.07	23.39	32.43	40.56
S.Em ±	0.3	0.66	0.47	0.62
CD (P=0.05)	NS	NS	1.83	2.45
Sub factor: Varieties				
V1- TG 37-A	13.35	21.70	29.21	36.46
V2- KDG 128	15.89	22.10	28.94	36.50
V3- TAG 24	13.04	21.22	27.34	33.69
V4- TCGS 1694	17.20	22.99	33.69	37.64
V5- K6	17.74	23.93	49.73	52.79
S.Em ±	0.39	0.57	1.39	1.70
CD (P=0.05)	1.13	1.66	4.06	4.97
Interaction (Factor (D) at same level of V)				
S.Em ±	0.67	0.98	2.41	2.95
CD (P=0.05)	NS	NS	NS	NS
Interaction (Factor(V) at same level of D)				
S.Em ±	0.67	1.10	2.21	2.71
CD (P=0.05)	NS	NS	NS	NS

Table 3: Leaf area per plant (cm²) of groundnut varieties at different growth stages as influenced by sowing dates

Treatment	Leaf area (cm ²)			
	1st Flower bud appearance stage	50% flowering Stage	Pod formation stage	Physiological maturity stage
Main factor: Dates of Sowing				
D1- 20 th June 2024	126.51	418.71	1490.66	1231.89
D2- 5 th July 2024	123.89	408.36	1487.15	1201.52
D3- 20 th July 2024	115.68	413.69	1481.42	1200.08
S.Em ±	2.24	8.71	31.25	16.97
CD (P=0.05)	NS	NS	NS	NS
Sub factor: Varieties				
V1- TG 37-A	134.55	439.10	1521.80	1257.19
V2- KDG 128	132.33	418.73	1481.81	1199.44
V3- TAG 24	120.78	419.57	1517.84	1242.15
V4- TCGS 1694	106.27	389.73	1452.66	1170.58
V5- K6	116.22	400.80	1457.93	1186.45
S.Em ±	3.21	10.99	38.93	21.13
CD (P=0.05)	9.37	32.06	NS	61.67
Interaction (Factor (D)at same level of V)				
S.Em ±	5.56	19.03	67.43	36.60
CD (P=0.05)	NS	NS	NS	NS
Interaction (Factor(V)at same level of D)				
S.Em ±	5.45	19.12	67.93	36.87
CD (P=0.05)	NS	NS	NS	NS

Table 4: Leaf area index of groundnut varieties at different growth stages as influenced by sowing dates

Treatment	1 st flower bud appearance stage	50% flowering stage	Pod formation stage	Physiological maturity stage
Main factor: Dates of Sowing (D)				
D1- 20 th June 2024	0.42	1.40	4.97	4.11
D2- 5 th July 2024	0.41	1.36	4.96	4.01
D3- 20 th July 2024	0.39	1.38	4.94	4.00
S.Em ±	0.01	0.03	0.10	0.06
CD (P=0.05)	NS	NS	NS	NS
Sub factor: Varieties				
V1- TG 37-A	0.45	1.46	5.07	4.19
V2- KDG 128	0.44	1.40	4.94	4.00
V3- TAG 24	0.40	1.40	5.06	4.14
V4- TCGS 1694	0.35	1.30	4.84	3.90
V5- K6	0.39	1.34	4.86	3.95
S.Em ±	0.01	0.04	0.13	0.07
CD (P=0.05)	0.03	0.11	NS	0.21
Interaction (Factor (D)at same level of V)				
S.Em ±	0.02	0.06	0.22	0.12
CD (P=0.05)	NS	NS	NS	NS
Interaction (Factor(V)at same level of D)				
S.Em ±	0.02	0.06	0.23	0.12
CD (P=0.05)	NS	NS	NS	NS

Table 5: Leaf area duration of groundnut varieties at different growth stages as influenced by sowing dates

Treatment	1 st flower bud appearance to 50% flowering	50% flowering to pod formation	Pod formation to physiological maturity
Dates of Sowing			
D1- 20 th June 2024	20.8	75.5	111.0
D2- 5 th July 2024	20.2	74.9	100.3
D3- 20 th July 2024	21.2	76.0	126.9
S.Em ±	0.8	4.2	5.7
CD (P=0.05)	NS	NS	NS
Varieties			
V1- TG 37-A	21.11	93.3	129.3
V2- KDG 128	20.2	93.0	132.8
V3- TAG 24	21.1	60.1	86.1
V4- TCGS 1694	19.9	84.8	130.0
V5- K6	21.4	46.2	85.4
S.Em ±	0.9	4.5	9.3
CD (P=0.05)	NS	13.1	27.1
Interaction (Factor (D)at same level of V)			
S.Em ±	1.5	7.8	16.1
CD (P=0.05)	NS	NS	NS
Interaction (Factor(V)at same level of D)			
S.Em ±	1.6	8.1	15.5
CD (P=0.05)	NS	NS	NS

Conclusion

In groundnut, plant height was not significantly influenced by sowing dates at the first flower bud and 50% flowering stages, but the effect became significant during pod formation and physiological maturity. Across varieties, significant differences in plant height were recorded at all growth stages, with K6 attaining the greatest height at physiological maturity, surpassing TCGS 1694, KDG 128, TAG 24 and TG 37A. Sowing dates did not significantly impact leaf area, leaf area index (LAI) and leaf area duration (LAD). However, varietal differences were evident for leaf area. TG 37-A exhibited a significantly larger leaf area than TCGS 1694 and K6, while being comparable to TAG 24 and KDG 128. At physiological maturity, TG 37A also recorded a significantly higher LAI than TCGS 1694 and K6, but was statistically similar to KDG 128 and TAG 24. For LAD, KDG 128 recorded significantly higher values than TAG 24 and K6, while remaining at par with TCGS 1694 and TG 37-A.

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