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# Physiochemical Response of Groundnut (*Arachis hypogaea* L.) to Different Seasons, Genotypes and Planting Geometry

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**ABSTRACT**

*A field experiment was conducted at the Education and Research Farm, Department of Botany, College of Agriculture, Dapoli, to evaluate the effect of genotypes, seasons, and plant spacing on growth and yield of groundnut (Arachis hypogaea L.). Eleven genotypes from the Agricultural Research Station, Shirgaon, were tested in a split-plot design with three replications. Growth parameters (plant height, branches, leaves) and yield traits (pods per plant, 100-seed weight, pod yield) were recorded from five tagged plants. Total chlorophyll content, chlorophyll stability index, and membrane stability index increased up to 90 DAS and declined thereafter.*

***Keywords:*** *Chlorophyll stability index, Groundnut, spacing, genotypes.*

## INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an annual herb of the Fabaceae family, commonly referred to as a nut but botanically a seed. The plant has feathery leaves, yellow flowers, and underground legume fruits containing two to three seeds. Groundnut seeds are rich in oil, protein, and vitamin E, and are widely used as food, oil, and industrial raw material. The shells and haulms serve as fuel, animal feed, and fertilizer. The crop is cultivated throughout the tropics up to 1,000 m altitude and grows best in sandy loam, loamy, and well-drained black soils, requiring a minimum of 1,250 mm of well-distributed rainfall, while being sensitive to frost, drought, and waterlogging.

Rainfall and temperature are the most critical factors affecting groundnut productivity, with low and erratic rainfall limiting yields in semi-arid tropics. Summer cultivation enhances growth, flowering, and oil-rich kernel yield while reducing disease and pest incidence. Poor cultural practices, particularly wide spacing and inadequate weed management during early growth stages, also limit production.

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Adoption of high-yielding varieties, improved sowing methods, and modern cultivation techniques has increased productivity by over 50% compared to traditional practices (Natarajan et al., 2024).

## MATERIAL AND METHODS

The experiment was conducted at a site suitable for groundnut cultivation using eleven genotypes from the Agricultural Research Station, Shirgaon. A split–split plot design with three replications was used, with seasons (Kharif, Rabi) as main plots, genotypes ($G_1$–$G_{11}$) as sub-plots, and plant spacings (30 × 20, 30 × 15, 30 × 10 cm) as sub-sub plots. A uniform dose of 30 kg N, 40 kg $P_2O_5$, and 50 kg $K_2O$ ha$^{-1}$ was applied, with partial nitrogen top-dressing at 30 DAS and gypsum at 500 kg ha$^{-1}$ at 40 DAS. Data were analyzed using ANOVA as per Panse and Sukhatme (1985), and means were compared at 5% significance.

## RESULTS AND DISCUSSION

Data regarding the mean chlorophyll content of groundnut genotypes as influenced by the different treatments at different growth stages are presented in Table 1 and illustrated Fig 1. There was considerable variability amongst the treatment for chlorophyll content at various growth stages.

**Table1. Influenced of seasons and spacings on chlorophyll content (mg/g) of different groundnut genotypes at different growth stages (pooled)**

| Treatments | 30 DAS | 60 DAS | 90 DAS | At harvest |
|---|---|---|---|---|
| **Seasons** | | | | |
| **$S_1$ –Kharif** | 1.42 | 2.14 | 2.23 | 1.84 |
| **$S_2$ –Rabi** | 1.98 | 2.41 | 2.47 | 2.22 |
| **S.E±** | 0.017 | 0.015 | 0.010 | 0.021 |
| **C.D at 5%** | 0.102 | 0.093 | 0.063 | 0.129 |
| **Genotypes** | | | | |
| **$G_1$ –RTNG 14** | 1.78 | 2.41 | 2.51 | 2.18 |
| **$G_2$ –RTNG 53** | 1.71 | 2.40 | 2.52 | 2.17 |
| **$G_3$ –RTNG 27** | 1.84 | 2.48 | 2.59 | 2.25 |
| **$G_4$ –RHRG 1308** | 1.67 | 2.24 | 2.33 | 1.96 |
| **$G_5$ –RHRG 1435** | 1.62 | 2.12 | 2.20 | 1.89 |
| **$G_6$ –KDG 160** | 1.68 | 2.24 | 2.33 | 2.01 |
| **$G_7$ –KDG 187** | 1.64 | 2.20 | 2.21 | 1.91 |
| **$G_8$ –TKG Bold** | 1.72 | 2.27 | 2.34 | 2.03 |
| **$G_9$ –JL 1232** | 1.68 | 2.26 | 2.31 | 2.01 |
| **$G_{10}$ –K. Bhuratna** | 1.76 | 2.31 | 2.40 | 2.09 |
| **$G_{11}$ –K. Gaurav** | 1.62 | 2.07 | 2.13 | 1.81 |
| **S.E±** | 0.036 | 0.038 | 0.033 | 0.035 |
| **C.D at 5%** | 0.103 | 0.109 | 0.095 | 0.101 |
| **Spacings** | | | | |
| **$D_1$ -30X20 cm** | 1.70 | 2.36 | 2.46 | 2.11 |
| **$D_2$- 30X15 cm** | 1.70 | 2.28 | 2.36 | 2.04 |
| **$D_3$ -30X10 cm** | 1.68 | 2.18 | 2.23 | 1.94 |
| **S.E±** | 0.012 | 0.016 | 0.020 | 0.014 |
| **C.D at 5%** | NS | 0.046 | 0.055 | 0.040 |
| **Interaction effects** | | | | |
| **S X G** | SIG | SIG | SIG | SIG |
| **S X D** | SIG | NS | NS | NS |
| **G X D** | NS | NS | NS | NS |
| **S X G X D** | NS | NS | NS | NS |
| **General Mean** | 1.702 | 2.275 | 2.353 | 2.029 |

Chlorophyll and carotenoids are key pigments essential for photosynthesis, with chlorophyll a and b predominating in higher plants. The chlorophyll a/b ratio, typically 3:1, decreases during leaf senescence due to faster degradation of chlorophyll a (Thombre et al., 2014; & Madhusudhan & Sudhakar, 2018). In this study, chlorophyll content increased up to 90 DAS and declined towards harvest, likely due to changes in leaf area. Season S2 (Rabi) recorded the highest chlorophyll content (2.22 mg/g), 20.65% higher than Kharif, reflecting the influence of light intensity and sunshine duration. Among genotypes, G3 (RTNG-27) had the highest chlorophyll (2.25 mg/g), comparable to G1 (2.18 mg/g) and G2 (2.17 mg/g), while G11 (Konkan Gaurav) was lowest (1.81 mg/g), likely due to genetic differences. Wider spacing (D1: 30 × 20 cm) promoted higher chlorophyll (2.11 mg/g) compared to narrower spacing (D3: 30 × 10 cm, 1.94 mg/g), probably due to increased leaf number and thickness, enhancing resource availability (Meena et al., 2011; & Bhagavatha et al., 2016).

**Interaction effects**

The interaction between seasons and genotypes (SXG) was found significant at harvest.

**1. Interaction effects of Seasons and Genotypes:**

Perusal of the data presented in Table 1.1 revealed that, treatments $S_2G_3$ (2.47 mg/g) noted highest chlorophyll content which was at par with $S_2G_1$ (2.37 mg/g) and $S_2G_2$ (2.32 mg/g) over other treatments. However, the lowest chlorophyll content was recorded in treatments combinations $S_1G_{11}$ (1.61 mg/g).

**Table 1. Interaction effects of seasons and genotypes on chlorophyll content (mg/g) at harvest**

| Seasons | Genotypes | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | $G_1$ | $G_2$ | $G_3$ | $G_4$ | $G_5$ | $G_6$ | $G_7$ | $G_8$ | $G_9$ | $G_{10}$ | $G_{11}$ |
| $S_1$ | 1.99 | 2.02 | 2.04 | 1.72 | 1.66 | 1.80 | 1.76 | 1.88 | 1.84 | 1.91 | 1.61 |
| $S_2$ | 2.37 | 2.32 | 2.47 | 2.21 | 2.11 | 2.21 | 2.07 | 2.18 | 2.18 | 2.26 | 2.01 |
| **SEm±** | | **0.050** | | | | **C.D. at 5%** | | **0.143** | | | |

**Chlorophyll stability index (%):**

The total chlorophyll stability index (CSI) increased up to 90 DAS and declined thereafter, reflecting normal leaf senescence. Season S2 (Rabi) recorded the highest CSI (62.92%), 24.25% higher than S1 (Kharif, 50.64%), likely due to greater light intensity and photosynthetically active radiation. Among genotypes, G3 (RTNG-27) exhibited the highest CSI (62.36%), comparable to G1 (61.72%), while G11 (Konkan Gaurav) was lowest (50.74%), indicating genotypic variation. Wider spacing (D1: 30 × 20 cm) enhanced CSI (58.26%) compared to narrow spacing (D3: 30 × 10 cm, 55.23%), reflecting improved morpho-physiological performance under reduced plant density (Mondal et al., 2013).

**Table2. Influenced of seasons and spacings on chlorophyll stability index (%) of different groundnut genotypes at different growth stages (pooled)**

| Treatments | 30 DAS | 60 DAS | 90 DAS | At harvest |
|---|---|---|---|---|
| **Seasons** | | | | |
| **$S_1$ –Kharif** | 39.42 | 55.24 | 57.73 | 50.64 |
| **$S_2$ –Rabi** | 59.53 | 65.95 | 68.23 | 62.92 |
| **S.E±** | 0.24 | 0.29 | 0.10 | 0.21 |
| **C.D at 5%** | 1.44 | 1.75 | 0.60 | 1.30 |
| **Genotypes** | | | | |

| | | | | |
|---|---|---|---|---|
| **$G_1$ –RTNG 14** | 51.17 | 64.52 | 67.18 | 61.72 |
| **$G_2$ –RTNG 53** | 49.51 | 62.93 | 65.97 | 60.54 |
| **$G_3$ –RTNG 27** | 52.81 | 65.85 | 67.93 | 62.36 |
| **$G_4$ –RHRG 1308** | 48.68 | 62.31 | 64.71 | 57.54 |
| **$G_5$ –RHRG 1435** | 47.61 | 56.67 | 59.61 | 53.48 |
| **$G_6$ –KDG 160** | 48.59 | 59.92 | 62.92 | 55.84 |
| **$G_7$ –KDG 187** | 46.95 | 57.32 | 58.79 | 51.88 |
| **$G_8$ –TKG Bold** | 50.57 | 59.24 | 61.32 | 56.55 |
| **$G_9$ –JL 1232** | 50.37 | 60.52 | 61.91 | 55.12 |
| **$G_{10}$ –K. Bhuratna** | 50.99 | 61.46 | 64.05 | 58.81 |
| **$G_{11}$ –K. Gaurav** | 46.97 | 55.84 | 58.39 | 50.74 |
| **S.E±** | 0.71 | 0.57 | 0.31 | 0.36 |
| **C.D at 5%** | 2.02 | 1.63 | 0.88 | 1.02 |
| **Spacings** | | | | |
| **$D_1$ -30X20 cm** | 49.76 | 62.02 | 64.83 | 58.26 |
| **$D_2$- 30X15 cm** | 49.63 | 60.69 | 63.06 | 56.86 |
| **$D_3$ -30X10 cm** | 49.04 | 59.08 | 61.05 | 55.23 |
| **S.E±** | 0.31 | 0.31 | 0.19 | 0.18 |
| **C.D at 5%** | NS | 0.86 | 0.52 | 0.50 |
| **Interaction effects** | | | | |
| **S X G** | SIG | SIG | SIG | SIG |
| **S X D** | NS | NS | NS | NS |
| **G X D** | NS | NS | NS | NS |
| **S X G X D** | SIG | NS | NS | NS |
| **General Mean** | 49.476 | 60.558 | 62.980 | 56.780 |

**Interaction effects**

The interaction between seasons and genotypes (SXG) was found significant.

**1. Interaction Effects of Seasons and Genotypes (S × G)**

The interaction between seasons and genotypes significantly influenced the membrane stability index (MSI) at harvest. Among the combinations, the Kharif season with genotype RTNG-27 (S1G3) recorded the highest MSI, which was comparable to RTNG-14 (S1G1) and RTNG-53 (S1G2). These genotypes maintained superior membrane integrity under Kharif conditions, suggesting their better adaptation to the seasonal environment. In contrast, the Rabi season with genotype Konkan Gaurav (S2G11) showed the lowest MSI, indicating greater sensitivity of this genotype under Rabi conditions. This demonstrates that both seasonal factors and genotype characteristics interact to determine membrane stability in groundnut.

**2. Interaction Effects of Seasons and Spacings (S × D)**

Significant interactions were also observed between seasons and plant spacings. In Kharif, the wider spacing of 30 × 20 cm (D1) exhibited the highest MSI, whereas in Rabi, the narrowest spacing of 30 × 10 cm (D3) recorded the lowest MSI. The results indicate that wider spacing reduces competition for water and nutrients, which improves leaf water status and enhances membrane stability under varying seasonal conditions. These findings underscore the importance of optimizing plant density according to seasonal conditions to improve physiological resilience.

**3. Interaction Effects of Genotypes and Spacings (G × D)**

Genotype and spacing interactions significantly affected MSI. The combination of superior genotypes (RTNG-14 and RTNG-27) with wider spacing (D1) resulted in the highest MSI, reflecting better maintenance of membrane integrity under reduced intra-specific competition. Conversely, the sensitive genotype Konkan Gaurav at narrow spacing (D3) exhibited the lowest MSI, highlighting its susceptibility to stress under crowded conditions. This indicates that selecting appropriate genotype-spacing combinations is critical for enhancing physiological stability in groundnut.

**4. Interaction Effects of Seasons, Genotypes, and Spacings (S × G × D)**

The combined effect of seasons, genotypes, and spacing was highly significant. The highest MSI was observed in the Kharif season for genotype RTNG-27 grown at wider spacing (S1G3D1), demonstrating the synergistic influence of favourable seasonal conditions, superior genotype, and optimal plant density on membrane stability. In contrast, the Rabi season for Konkan Gaurav at narrow spacing (S2G11D3) showed the lowest MSI, indicating compounded stress effects. These results highlight that the integrated management of genotype selection, season, and plant spacing is crucial for enhancing drought tolerance and physiological efficiency in groundnut.

## CONCLUSION

The present study established that chlorophyll content, chlorophyll stability index, and membrane stability index in groundnut were significantly influenced by season, genotype, and plant spacing. The rabi season (S2) was more conducive for higher chlorophyll content and chlorophyll stability index, likely due to favourable radiation regimes, whereas membrane stability index was maximized during the kharif season (S1). Among the evaluated genotypes, RTNG-27 exhibited superior physiological performance for chlorophyll-related traits and was statistically at par with RTNG-14 and RTNG-53, while RTNG-14 recorded the highest membrane stability index. Konkan Gaurav consistently showed the lowest values across traits. Wider spacing (30 × 20 cm) significantly enhanced all physiological parameters compared to closer spacings, with the lowest values observed at (30 × 10 cm). These findings highlight the importance of genotype selection and optimum spacing in improving physiological stability and stress tolerance in groundnut cultivation.

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**Conflict of Interest:**

No conflict of interest exists.

**Author Contributions:**

All authors participated in critical revision and approved the final manuscript.

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