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Effect of Mid-Season Moisture Stress on Fatty Acid Composition of Groundnut (*Arachis hypogaea* L.) Genotypes

K. Vishnu Priya [a*], P. Latha [b++], S. Ratna Kumari [c#], P. Ratna Kumar [d++] and A. Srividhya [e†]

[a] *Department of Crop Physiology, Agricultural College, Bapatla, Acharya N.G Ranga Agricultural University, Bapatla-522101, Andhra Pradesh, India.*
[b] *Department of Crop Physiology, ANGRAU, RARS, Tirupati-517502, India.*
[c] *Department of Crop Physiology, Agricultural College, ANGRAU, Bapatla- 522101, India.*
[d] *Department of Plant Physiology, IIOR, Hyderabad-500030, India.*
[e] *Department of Genetics and Plant Breeding, ANGRAU, RARS, Tirupati-517502, India.*

Authors' contributions

This work was carried out in collaboration among all authors. Authors PL, SRK, PRK and AS designed the experiment. Author KVP carried out experiment work. Author PL drafted the manuscript and all authors revised it. All authors read and approved the final manuscript.

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[++] *Principal scientist;*
[#] *Professor;*
[†] *Senior scientist;*
**Corresponding author: E-mail: vishnukotamalagi@gmail.com;*

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ABSTRACT

A field experiment was conducted at Regional Agricultural Research Station, Tirupati, Acharya N.G. Ranga Agricultural University during *rabi*, 2022 and 2023 to study the effect of mid-season moisture stress on fatty acid composition of groundnut genotypes. The experiment was carried out in randomized block design (RBD) with factorial concept with two main treatments *i.e.,* control and mid-season moisture stress (40-80 DAS) and 12 sub treatments *i.e.,* two check varieties and ten contrasting groundnut genotypes sown in three replications. The study revealed that during *rabi,* 2022 and 2023 the genotype, TCGS 2326 recorded highest palmitic acid (12.67 and 12.99%) which was on par with K9 (11.96%) and TCGS 1792 (12.56%) during 2022 and 2023. Whereas, lowest palmitic acid was recorded by TCGS 2024 (9.51 and 10.00%). During *rabi,* 2022 highest stearic acid was recorded by TCGS 1792 (3.19%) which was at par with TCGS 2326 (3.14%) and during 2023, TCGS 2326 (3.34%) recorded highest stearic acid which was on par with TCGS 1792 (3.16%) whereas, lowest stearic acid was recorded by TCGS 2024 (2.47%) and TCGS 1785 (2.47%) during 2022 and 2023. Highest oleic acid was recorded by TCGS 1792 (53.02 and 52.67%) which was on par with TCGS 2333 (52.63 and 41.80%) and lowest oleic acid was recorded by TCGS 1785 (40.05 and 40.01%). Highest linoleic acid was recorded by TCGS 2024 (37.89%) and K6 (37.12%) whereas, lowest linoleic acid composition was recorded by TCGS 1792 (20.17%) and TCGS 2326 (20.13%) during 2022 and 2023.

Keywords: Mid-season moisture stress; fatty acid composition; palmitic acid; stearic acid; oleic acid; linoleic acid; groundnut; randomized block design.

1. INTRODUCTION

Groundnut is an important oilseed crop in the world and cultivated mainly for its edible oil, protein and fatty acids. Groundnut kernel contains high protein content (22-30%), edible oil (44-56%) and fatty acids among which oleic acid, linoleic acid and palmitic acid constitutes for 90 % of the total fatty acid composition in groundnut [1]. Oleic acid and linoleic acid ratio (O/L) determine the durability and quality of groundnut [2,3]. High-oleic groundnut has longer shelf-life and better flavor quality than low-oleic groundnut. Groundnut kernel also consists of minor fatty acids such as stearic acid, arachidic acid, eicosenoic acid, behenic acid, lignoceric acid and gadoleic acid constitutes for 1 and 3% of the total fatty acid composition [4].

In India, as 70% of groundnut is grown as *rainfed* crop, it is subjected to intermittent soil moisture stress where yield and quality of groundnut is reduced. To improve the nutritional quality of groundnut under rainfed condition, it is essential to study the effect of soil moisture stress on composition of fatty acids [5].

There are only limited reports on effect of drought on quality of groundnut kernels. Therefore, the objective of this research was to evaluate the effect of mid-season moisture stress on fatty acid composition of groundnut genotypes with different levels of drought resistance.

2. MATERIALS AND METHODS

The experiment was carried out during *rabi*, 2022 and 2023 at Regional Agricultural Research Station, Tirupati, Acharya N.G Ranga Agricultural University. The experimental site is geographically located at 13.5^0 N latitude and 79.5^0 E longitude and at an altitude of 182.9 m above the mean sea level (MSL) in the Southern Agro-Climatic zone of Andhra Pradesh, Tirupati district, India. The experiment was laid out in randomized block design with factorial concept with two main treatments and twelve sub treatments in three replications. Main treatments include control and mid-season moisture stress (40-80 DAS) and sub treatments *i.e.,* two check varieties *i.e.,* K6 (drought susceptible) and K9 (drought tolerant) and ten contrasting groundnut genotypes procured from Dept. of Genetics and Plant Breeding, RARS, Tirupati. Control treatment was maintained by providing irrigation while, mid-season moisture stress treatment was imposed by growing plants in rainout shelters by withholding irrigation from 40-80 DAS. On the completion of stress period, irrigation was provided to both control and rainout shelters. Observations of fatty acids such as palmitic acid, stearic acid, oleic acid and linoleic acid were recorded at harvest during both the years.

2.1 Estimation of Fatty Acids

Four fatty acids *i.e.,* palmitic acid, stearic acid, oleic acid and linoleic acid were estimated after harvest in both and control and stress samples using near infrared reflectance spectroscopy *i.e.,* NIRS (FOSS DZ 2500, Denmark).

Importance: Near infrared reflectance spectroscopy (NIRS) is a more rapid non-destructive technique for screening of large population of seed for analysis of desirable changes in the fatty acid composition [6,7].

Methodology: A sample of 100 g of well matured dried kernels were used for fatty acids estimation in near infrared spectroscopy *i.e.,* NIRS (FOSS DZ 2500, Denmark) using ISI scan Nova software. Seed sample was loaded in a round cup which was filled up sufficiently to allow good absorption of the incident light and percentage of fatty acids was recorded.

2.2 Statistical Analysis

The data were analyzed statistically by following analysis of variance technique for randomized block design with factorial concept outlined by Panse and Sukhatme [8]. The statistical hypothesis of equalities of treatment means was tested by F- test at 1 to 5% per cent level of significance.

3. RESULTS AND DISCUSSION

3.1 Palmitic Acid (%)

The mean data pertaining to palmitic acid composition was recorded at harvest in kernel of groundnut genotypes grown under mid-moisture stress conditions during *rabi*, 2022 and 2023 were presented in the Table 1 and Fig. 1. During *rabi*, 2022 significant differences were observed among moisture stress treatments with highest palmitic acid under irrigated conditions (control) (11.16%) compared to moisture stress (10.61%) with 5.18 % increase in palmitic acid over stress. Our results are in agreement with Boydack et al. [9] and Aydinsakir et al. [10] who reported significant differences among water deficit treatments for palmitic acid in groundnut. During *rabi,* 2023 non-significant differences were observed among moisture stress treatments. Results are in accordance with the reports of Dwivedi et al. [11]. During *rabi*, 2022 among the genotypes tested, TCGS 2326 recorded significantly highest palmitic acid (12.67%) which was on par with K9 (11.96%), TCGS 1792 (11.87%) and TCGS 2333 (11.83%). Whereas, lowest palmitic acid was recorded by TCGS 2024 (9.51%) which was on par with TCGS 1785 (9.62%), K6 (9.84%) and TCGS 1784 (10.03%). During *rabi*, *2023* significant differences were observed among the genotypes with highest palmitic acid composition in TCGS 2326 (12.99%) which was statistically at par with TCGS 1792 (12.56%), K9 (12.11%), TCGS 2019 (11.75%) and TCGS 2333 (11.71%). While lowest palmitic acid was recorded in TCGS 2024 (10.00%) which was on par with TCGS 1785 (10.10%), K6 (10.15%), TCGS 1784 (10.19%), TCGS 1707 (10.58%) and TCGS 2020 (10.65%). Similar genotypic variability for palmitic acid were reported by Hashim et al. [12], Silva et al. [13], Akcura *et al*. [14] in groundnut and Ghaffar et al. [15] in sunflower and Joshan et al. [16] in safflower. No significant interactions were found among moisture stress treatments and genotypes with regard to palmitic acid during *rabi,* 2022 and 2023. Similar results of non-significant interactions were reported by Young et al. [17], Abadya et al. [4] in groundnut. Non-significant interactions was also reported by Ghaffar et al. [15] in sunflower.

3.2 Stearic Acid

The mean data regarding stearic acid of groundnut genotypes influenced by mid-season moisture stress was presented in the Table 1 and Fig. 2. During *rabi,* 2022 and 2023 non-significant differences were observed among the moisture stress treatments with respect to stearic acid. The obtained results are in agreement with the findings of Petcu et al. [18] and Ghaffar et al. [15] in sunflower and who found non-significant differences among moisture stress treatments. During *rabi*, 2022 significantly highest stearic acid was recorded in TCGS 1792 (3.19%) which was on par with TCGS 2326 (3.14%), TCGS 2333 (3.04%), K9 (3.01%), TCGS 2019 (2.94%) and TCGS 1789 (2.90%). Significantly lowest stearic acid composition was recorded by TCGS 2024 (2.47%) which was on par with TCGS 1784 (2.52%), TCGS 1785 (2.61%), K6 (2.62%) and TCGS 2020 (2.78%). During *rabi*, 2023 significantly highest stearic acid was recorded by TCGS 2326 (3.34%) which was on par with TCGS 1792 (3.16%), K9 (3.14%), TCGS 2333 (3.11%), TCGS 2019 and TCGS 1789 (3.04%). Whereas, lower stearic acid was recorded by TCGS 1785 (2.47%) which was on par with TCGS 2024 (2.56%) and K6 (2.73%). Similar results of genotypic differences for stearic acid were reported by Dwivedi et al. [11] Silva et al. [13] in groundnut and Joshan et al. [16] in safflower. During *rabi*, 2022 and 2023 non-significant interactions were observed between

Table 1. Effect of mid-season moisture stress on quality parameters of groundnut genotypes

	Palmitic acid (%)						Stearic acid					
	2021-22			2022-23			2021-22			2022-23		
Genotypes	**T_0**	**T_1**	**Mean**	**T_0**	**T_1**	**Mean**	**T_0**	**T_1**	**Mean**	**T_0**	**T_1**	**Mean**
TCGS 1707	10.77	10.01	10.39	10.76	10.40	10.58	2.86	2.75	2.81	2.75	2.92	2.83
TCGS 1784	10.20	9.85	10.03	10.26	10.12	10.19	2.63	2.40	2.52	2.80	2.90	2.85
TCGS 1785	10.16	9.08	9.62	10.15	10.05	10.10	2.51	2.71	2.61	2.56	2.38	2.47
TCGS 1789	11.27	11.15	11.21	11.27	11.33	11.30	2.99	2.82	2.90	3.00	3.08	3.04
TCGS 1792	11.75	12.00	11.87	12.90	12.22	12.56	3.12	3.25	3.19	3.18	3.14	3.16
TCGS 2019	11.53	11.00	11.27	11.74	11.75	11.75	2.95	2.93	2.94	3.08	3.01	3.04
TCGS 2020	10.48	10.34	10.41	10.47	10.82	10.65	2.76	2.80	2.78	2.93	2.93	2.93
TCGS 2024	10.02	9.00	9.51	10.01	10.00	10.00	2.54	2.40	2.47	2.40	2.72	2.56
TCGS 2326	12.90	12.43	12.67	12.90	13.09	12.99	3.10	3.18	3.14	3.25	3.42	3.34
TCGS 2333	12.40	11.26	11.83	11.53	11.88	11.71	3.08	3.00	3.04	3.17	3.06	3.11
K6	10.27	9.42	9.84	10.20	10.10	10.15	2.68	2.56	2.62	2.71	2.75	2.73
K9	12.18	11.75	11.96	12.17	12.05	12.11	3.10	2.91	3.01	3.13	3.15	3.14
Mean	**11.16**	**10.61**		**11.20**	**11.15**		**2.86**	**2.81**		**2.91**	**2.95**	
	T	**G**	**TXG**	**T**	**G**	**TXG**	**T**	**G**	**TXG**	**T**	**G**	**TXG**
SEm±	0.12	0.3	0.43	0.18	0.44	0.63	0.04	0.11	0.15	0.05	0.12	0.17
CD (P=0.05)	0.353	0.865	NS	NS	1.267	NS	NS	0.306	NS	NS	0.336	NS
CV (%)	6.84			9.75			9.28			9.86		

T_0: Control, T_1: Mid-season moisture stress (40-80 DAS)

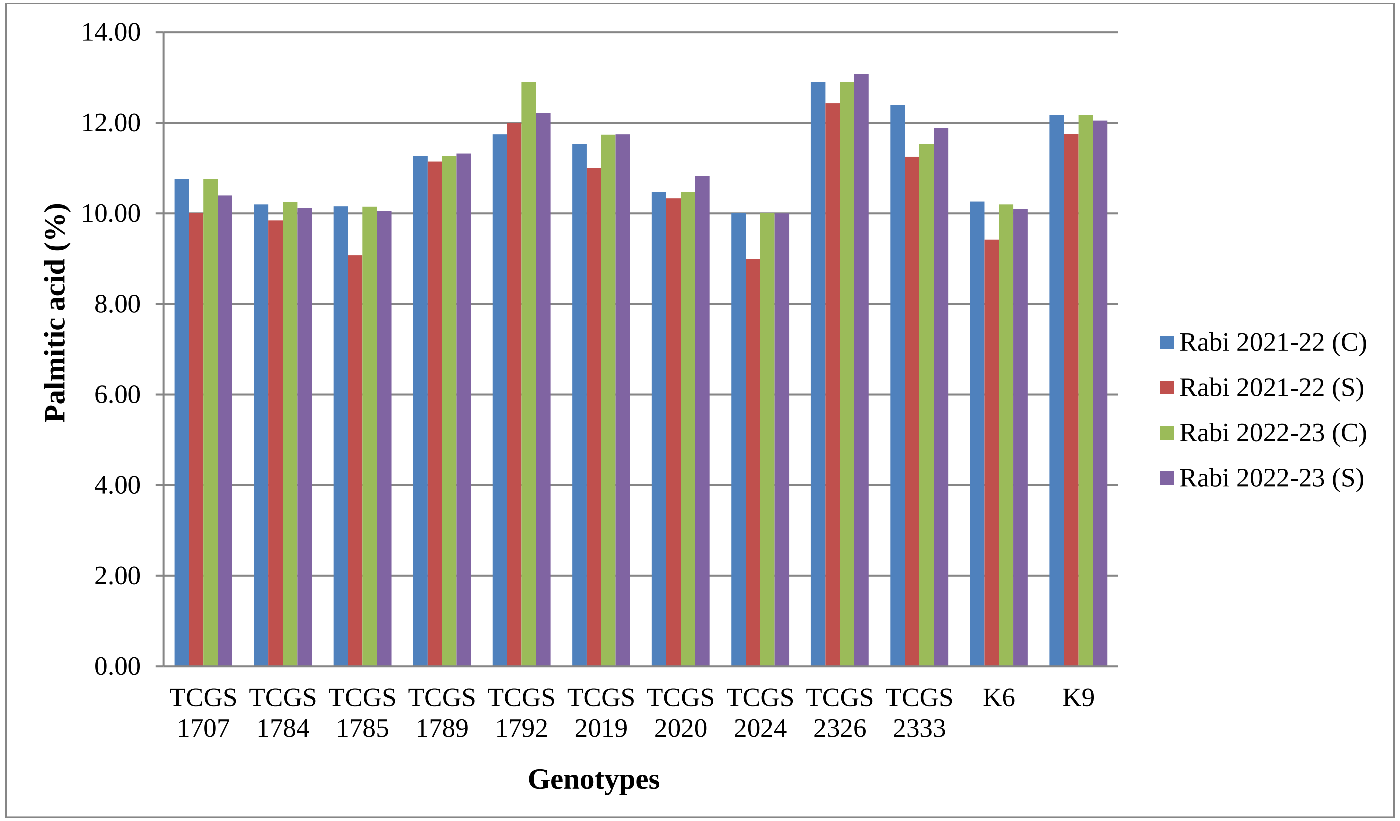

Fig. 1. Effect of mid-season moisture stress on palmitic acid (%) of groundnut genotypes

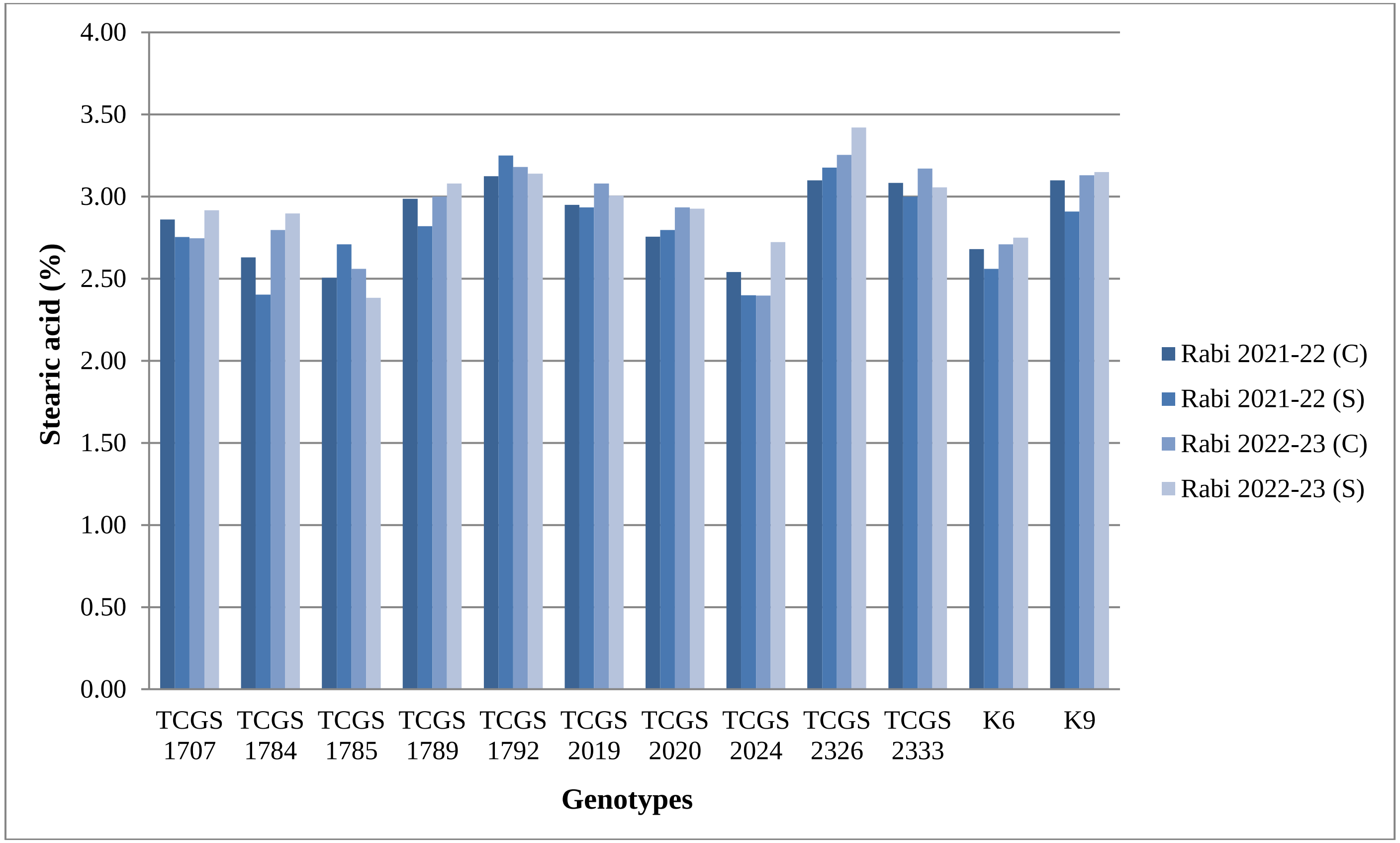

Fig. 2. Effect of mid-season moisture stress on stearic acid (%) of groundnut genotypes

Table 2. Effect of mid-season moisture stress on quality parameters of groundnut genotypes

	Oleic acid (%)						Linoleic acid (%)					
	2021-22			2022-23			2021-22			2022-23		
Genotypes	**T_0**	**T_1**	**Mean**	**T_0**	**T_1**	**Mean**	**T_0**	**T_1**	**Mean**	**T_0**	**T_1**	**Mean**
TCGS 1707	45.65	42.52	44.08	46.11	43.22	44.67	27.30	27.09	27.19	27.33	26.25	26.79
TCGS 1784	38.68	44.92	41.80	44.09	44.21	44.15	26.88	28.88	27.88	27.52	30.68	29.10
TCGS 1785	39.25	40.85	40.05	39.14	40.88	40.01	29.30	30.54	29.92	29.05	31.00	30.03
TCGS 1789	47.25	48.00	47.63	46.29	47.21	46.75	25.89	26.35	26.12	26.24	27.21	26.73
TCGS 1792	52.75	53.29	53.02	52.40	52.95	52.67	20.73	19.62	20.17	21.99	20.79	21.39
TCGS 2019	46.04	46.50	46.27	46.12	46.01	46.06	26.56	26.40	26.48	26.00	26.12	26.06
TCGS 2020	45.37	45.00	45.19	45.01	45.09	45.05	27.13	30.36	28.75	27.02	27.00	27.01
TCGS 2024	40.09	41.85	40.97	43.59	40.00	41.80	35.37	40.41	37.89	28.00	33.00	30.50
TCGS 2326	48.47	51.28	49.88	47.66	50.85	49.25	19.82	28.66	24.24	20.52	19.75	20.13
TCGS 2333	53.25	52.00	52.63	51.23	49.21	50.22	23.84	20.63	22.23	19.90	20.63	20.26
K6	43.64	43.02	43.33	44.36	41.85	43.10	28.06	32.65	30.35	33.25	41.00	37.12
K9	50.18	50.21	50.19	47.55	49.57	48.56	21.89	25.70	23.80	23.84	25.69	24.77
Mean	**45.88**	**46.62**		**46.13**	**45.92**		**26.06**	**28.11**		**25.89**	**27.43**	
	T	**G**	**TXG**	**T**	**G**	**TXG**	**T**	**G**	**TXG**	**T**	**G**	**TXG**
SEm±	0.66	1.62	2.29	0.68	1.67	2.36	0.39	0.94	1.34	0.44	1.08	1.53
CD (P=0.05)	NS	4.609	NS	NS	4.478	NS	1.097	2.688	3.801	1.26	3.086	NS
CV (%)	8.57			8.88			8.54			9.96		

T_0: Control, T_1: Mid-season moisture stress (40-80 DAS)

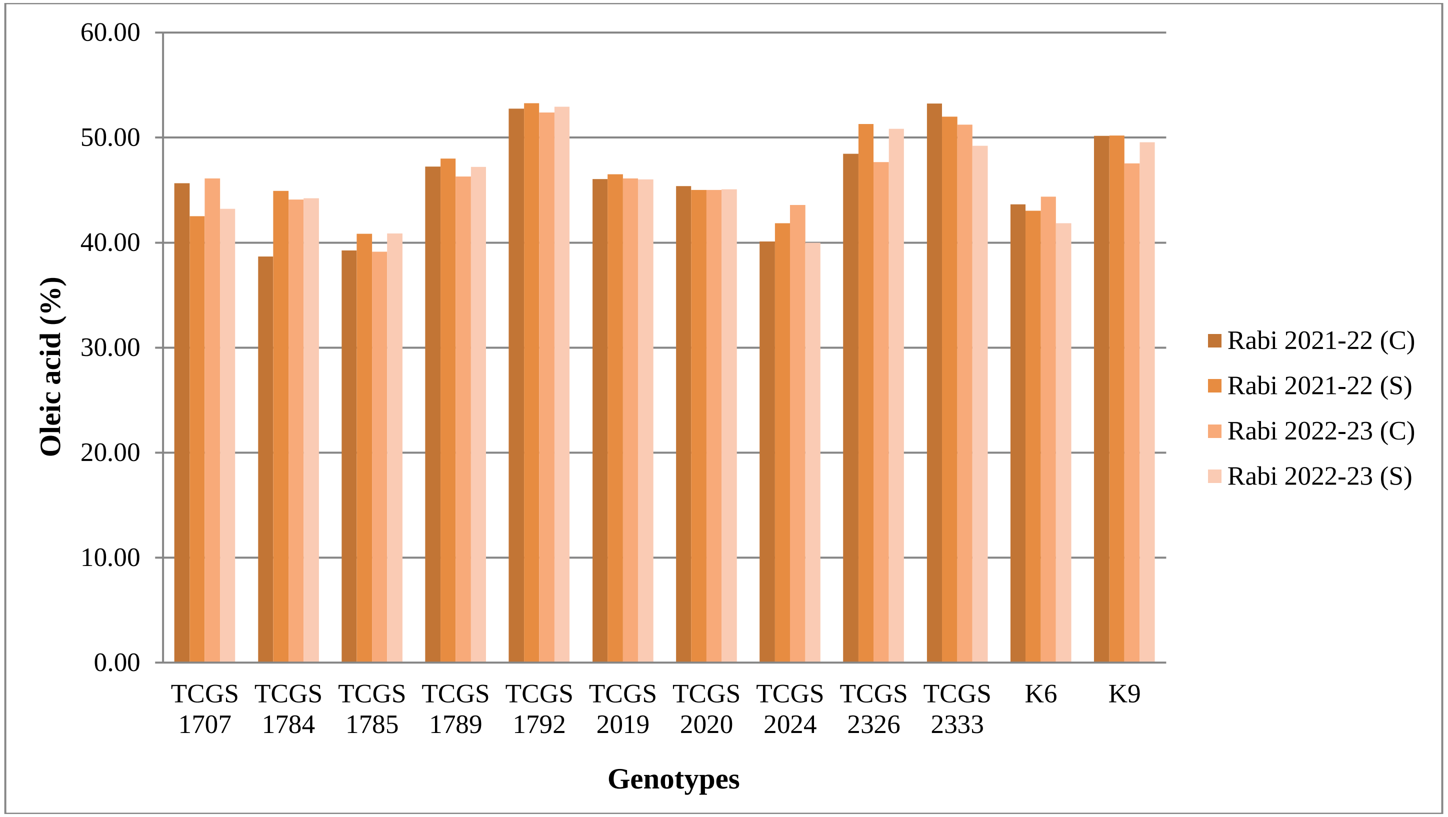

Fig. 3. Effect of mid-season moisture stress on oleic acid (%) of groundnut genotypes

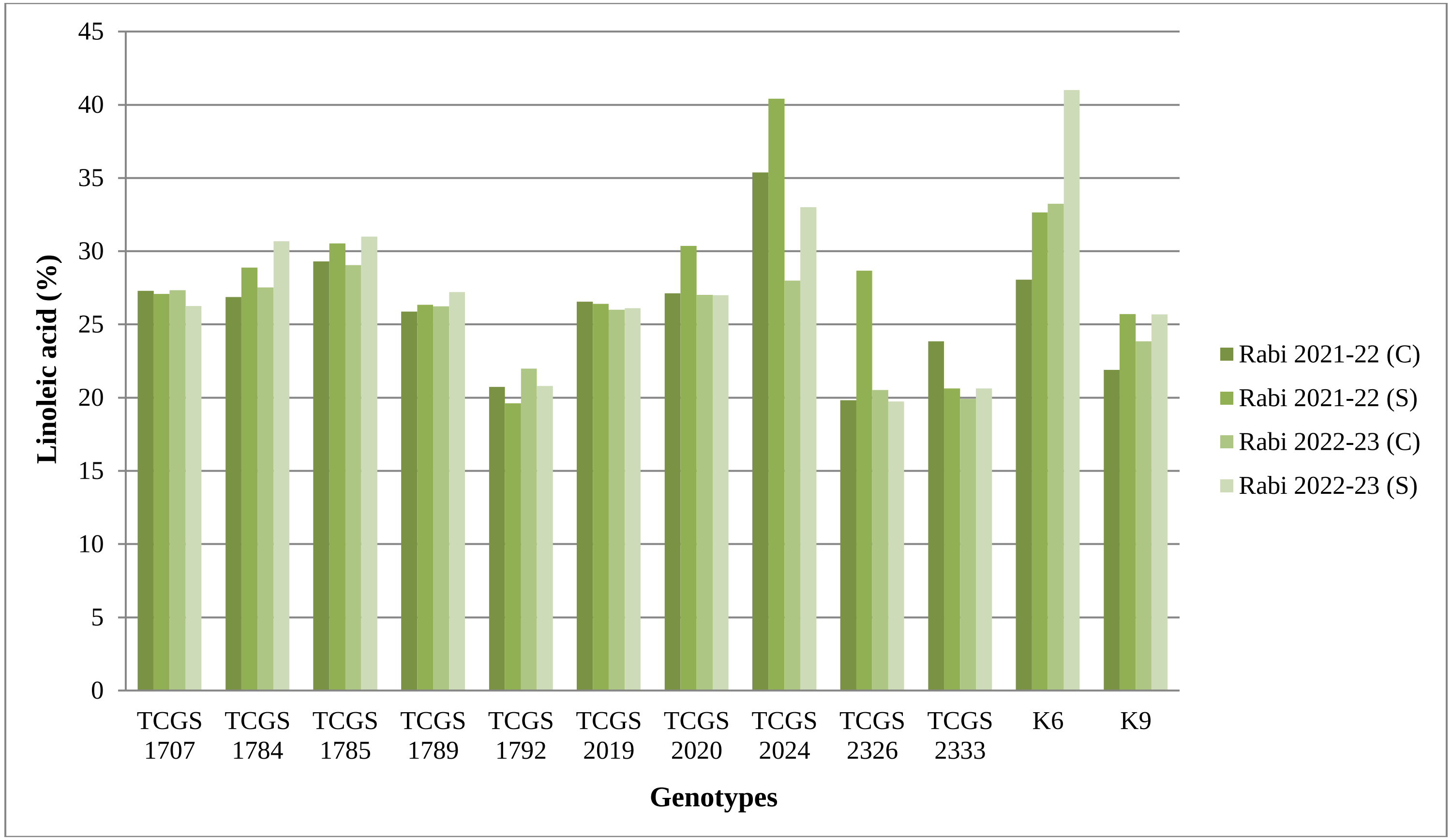

Fig. 4. Effect of mid-season moisture stress on linoleic acid (%) of groundnut genotypes

treatments and genotypes for stearic acid. Similar non-significant interactions were reported by Hashim et al. [12] in groundnut and Ghaffar et al. [15] in sunflower.

3.3 Oleic Acid

Data pertaining to oleic acid composition in groundnut genotypes influenced by mid-season moisture stress were presented in Table 2 and Fig. 3. During *rabi*, 2022 and 2023 non-significant differences were observed among treatments with regard to oleic acid composition. Our results were in contrary with those obtained by Chakraborty et al. [1]. During *rabi*, 2022 among the genotypes, TCGS 1792 significantly recorded highest composition of oleic acid (53.02%) which was on par with TCGS 2333 (52.63%), K9 (50.19%) and TCGS 2326 (49.88%). Lowest oleic acid composition was observed in TCGS 1785 (40.05%) which was on par with TCGS 2024 (40.97%), TCGS 1784 (41.80%), K6 (43.33%) and TCGS 1707 (44.08%). During *rabi,* 2023 significantly highest oleic acid was recorded by TCGS 1792 (52.67%) which was on par with TCGS 2333 (50.22%), TCGS 2326 (49.25%) and K9 (48.56%). Whereas, lowest oleic acid was recorded by TCGS 1785 (40.01%) which was statistically on par with TCGS 2024 (41.80%), K6 (43.10%), TCGS 1784 (44.15%) and TCGS 1707 (44.67%). Our results also concur with the published reports of Young et al. [17], Misra and Nautiyal [19], Silva et al. [12] and Akcura et al. [14]. Interaction between treatments and genotypes was non-significant for oleic acid during *rabi*, 2022 and 2023. Similar, non-significant interactions were reported by Abadya et al. [4] in groundnut and Ghaffar et al. [15] in sunflower.

3.4 Linoleic Acid

Mean data pertaining to linoleic acid of groundnut genotypes grown under mid-season moisture stress was presented in Table 2 and Fig. 4. During *rabi,* 2022 and 2023 moisture stress treatment recorded significantly highest linoleic acid (28.11% and 27.43%) compared to irrigated condition (control) (26.06% and 25.89%). Moisture stress treatment recorded 7.29% and 5.61% increase in linoleic acid compared to control condition. Similar results of significant differences were observed under drought stress by Hashim et al. [12], Boydack et al. [9] Aydinsakir et al. [10] and Akcura et al. [14] in groundnut. During *rabi,* 2022 among the genotypes tested, highest linoleic acid was recorded by TCGS 2024 (37.89%) followed by K6 (30.35%) and TCGS 1785 (29.92%). Whereas, lowest linoleic acid composition was recorded by TCGS 1792 (20.17 %) which was statistically on par with TCGS 2333 (22.23%), followed by and K9 (23.80%). During *rabi,* 2023 highest linoleic acid composition was recorded by K6 (37.12%) followed by TCGS 2024 (30.50%). While lowest linoleic acid composition was recorded in TCGS 2326 (20.13%) which was at par with TCGS 2333 (20.26) and TCGS 1792 (21.39%). Similar results were reported by Misra and Nautiyal [19], Silva et al. [13], Akcura et al. [14] in groundnut and Joshan et al. [16] in safflower. During *rabi,* 2022 under control condition, highest linoleic acid was recorded by TCGS 2024 (35.37%) followed by TCGS 1785 (29.30%) and lowest linoleic acid was recorded by TCGS 2326 (19.82%) which was on par with TCGS 1792 (20.73%) and K9 (21.89%) and significantly highest linoleic acid was observed in TCGS 2024 (40.41 %) followed by K6 (32.65%) and lowest linoleic acid was recorded by TCGS 1792 (19.62%) which was statistically on par with TCGS 2333 (20.63%). Our results also concur with the published reports by Hashim et al. [12], Silva et al. [13] and Akcura et al. [14] in groundnut. During *rabi,* 2023 non-significant interactions were found among treatments and genotypes. Obtained results are in contrary with the reports of Hashim et al. [12] in groundnut.

4. CONCLUSION

Variation in fatty acid composition of groundnut genotypes was assessed over 2 years in two check varieties and ten groundnut genotypes grown under mid-season moisture stress condition (40-80 DAS). The genotypes TCGS 2326, TCGS 1792, K9 and TCGS 2333 recorded higher palmitic acid, stearic acid, oleic acid and lower linoleic acid indicating its tolerance to mid-season moisture stress by maintaining better composition of fatty acids. Whereas, genotypes TCGS 2024, TCGS 1785, TCGS 1784 and TCGS 1707 recorded poor kernel quality performance in terms of fatty acids composition indicating its susceptibility to drought stress. The tolerant genotypes identified in the present study can be further evaluated for other kernel quality traits along with physiological and yield traits under moisture stress conditions for confirming their tolerance.

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DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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