Impact of mid-season moisture stress on yield attributes and seed quality in groundnutgenotypes

ABSTRACT

A field experiment was conducted at Regional Agricultural Research Station, Tirupati, Acharya N.G.RangaAgriculturalUniversityduring*rabi*,2022and2023tostudytheimpactofmid-season moisturestress (40-80 DAS) on yield attributes and quality traits of groundnutgenotypes. The experiment was carried out in randomized block design 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 in threereplications.Amongthegroundnutgenotypesand check varieties testedfortheirtolerancetomoisture stress the genotypes, TCGS 2326, TCGS 1792, K9 and TCGS 2333 werefoundtowithstandmid-season moisturestressandmaintainedhighest100 kernel weight,shelling percentage, protein and oil content indicating tolerance tomoisture stress.

Key words: Mid-season moisture stress, 100 kernel weight, shelling percentage, protein content, oil content, Groundnut

1. INTRODUCTION

Groundnut is an important oilseed crop in the world and important legume cultivated mainly for its edible oil and protein. Groundnut is the largest source of edible oil and constitutes 50% of the total oilseeds production in India. Groundnut kernel contains high protein content (22-30 %) andedible oil (44-56 %). In India, groundnut is cultivated in an area of 57 lakh hawith annual production of 101.13 lakh tonnesand productivity of 1776.59 kg ha^{-1}. (Directorate of Economics and Statistics, 2021-2022). The major constraint in groundnutproduction are abiotic stresses among which, drought is one of the most significant abiotic stresses affects yieldand yield attributes. Mid-season moisture stress possesses serious impact on yield compared to early season and end-of season stress (Latha *et al.*, 2018). In India, as 70 % of groundnut is grown as rainfedcrop,it is subjected to intermittent soil moisture stress where yield attributes and quality of groundnut is reduced. To reduce yield lossand improve nutritional quality of groundnut under rainfed condition, it is essential to study the effect of soil moisture stress on protein and oil content and development of genotypes withstand moisture stress(Chaiyadee*et al.*, 2013).At present, there are only limited reports on effect of moisture stress on yield attributes and quality of groundnut kernels. Therefore, the objective of this research was to evaluate the effect of mid-season moisture stress on yield attributes such as 100 kernel weight, shelling percentage and quality traits *i.e.*,protein and oil content of groundnut genotypes with different levels of drought resistance.

2.MATERIAL AND METHODS

The field experiments were carried out at RARS, Tirupati, Acharya N.G Ranga Agricultural Universityduring *rabi*, 2022 and 2023. 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, India. The experiment was laid out in randomized block design with factorial concept with two main treatments and twelve sub treatments in three replications. Two main treatments include control and mid-season moisture stress imposed at 40-80 DAS and sub treatments include 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 maintaining 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 on yield attributes such as 100 kernel weight, shelling percentage and quality traits such as protein and oil content were recordedatharvestduringboth theyears.

2.1 100-kernel weight

The weight of randomly selected 100 kernels from each genotype of each replication was recorded as 100 kernel weight (KW) in grams using electronic sensitive balance.

2.2 Shelling percentage (%)

The shelling percentage of each genotype was recorded based on the weight of kernels recovered from the randomly drawn 100g of pods, using the following formula.

$$\text{Shelling \%} = \frac{\text{Weightofkernels}}{\text{Weightofpods}} \times 100$$

2.3 Protein and Oil content (%)

Protein and oil contentwere 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 protein and oil content.

Methodology:

A sample of 100 g of well matured dried kernels were used for protein and oil 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 protein and oil contentwas recorded.

2.4STATISTICALANALYSIS

The data were analyzed statistically by following analysis of variance technique for randomized block design with factorial concept outlined by Panse and Sukhatme (1985). 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

3.1 100 kernel weight (g)

The mean data pertaining to 100 kernel weightinfluenced bymid-moisture stress conditions was recorded at harvest in groundnut genotypes during *rabi*, 2022 and 2023 werepresented in the Table 1. Significant differences were observed among treatments, genotypes and non-significant interactions were observed among genotypes and treatments during both years.

During *rabi*, 2022 and 2023significant differences were observed among moisture stress treatments with highest 100 kernel weight under irrigated conditions (control) (40.72 and 41.03

g) compared to moisture stress (30.52 and 30.61 g) with 33.42and 34.04 % increase in 100 kernel weight over moisture stressmight be due to direct effect of photosynthetic traits in the accumulation of food to the seed (Alemu *et al.,* 2023).Similar findings with moisture stress treatments on 100 kernel weight in groundnut were reported by Latha *et al.* (2023).

During *rabi*,2022 significantly highest 100 kernel weight was recorded by TCGS 1792 (39.52 g) which wason par with TCGS 2333 (38.73 g), TCGS 2326 (38.10 g) and K9 (37.38 g). Lowest 100 kernel weight was recorded by TCGS 2024 (28.00 g) followed by TCGS 1785 (33.50 g). During *rabi*, 2023 TCGS 1792 recorded highest 100 kernel weight (40.27 g) which was at par with TCGS 2326 (39.41 g), TCGS 2333 (38.52 g), K9 (37.28 g) and TCGS 1789 (36.09 g). Whereas, TCGS 2024 (28.38 g) recorded lowest 100 kernel weight followed by TCGS 1785 (32.98 g). Results are in accordance with the reports of Thakur *et al.* (2013) who reported genotypic variation for 100 kernel weight in groundnut.

During *rabi*, 2022 and 2023 non-significant interactions were observed among genotypes and interactions. Similar results were reported by Alemu *et al.* (2023) in common bean.

3.2 Shelling percentage (%)

The mean data pertaining toshelling percentage of groundnut genotypes influenced by mid-seasonmoisture stress was presented in the Table 1.

During *rabi*, 2022 and 2023 significant differences were observed among the treatments with highest shelling percentage in control (72.14 and 70.93 %) compared to moisture stress (49.05 and 49.48 %) with increase in 47.07 and 43.35 % over moisture stress might be due to insufficient resources towardsdeveloping seeds which results in smaller, lighter kernels which contribute to a lower shelling percentage. The obtained results were also reported by Sunitha *et al.*(2015) who found significant differences among moisture stress treatments.

During *rabi*, 2022 significantly highest shelling percentage was recorded in TCGS 2326(70.14 %) which was on par with TCGS 1792 (70.05 %), TCGS 2333 (67.64 %) and K9 (67.35 %).Significantly lowest shelling percentage was recorded by TCGS 2024 (51.33 %) which was on par with TCGS 1785 (51.80 %), TCGS 1707 (54.24 %) and K6 (54.55 %). During *rabi*, 2023 significantly highest shelling percentage was recorded by TCGS 1792 (72.28 %) which was on par with TCGS 2326 (70.37 %) and K9 (67.63 %). Whereas, lowestshelling percentage was recorded by TCGS 1785 (47.85 %) which was on par with TCGS 2024 (50.42 %) and K6 (53.27 %). Similar results of genotypic differences for shelling percentage in groundnut were also reported by Thakur *et al.*(2013).

During *rabi*2022,under control condition, genotype TCGS 2333 recorded significantly highest shelling percentage (76.43 %) which was statistically on par with TCGS 2326 (7542 %), K9 (74.08 %) and TCGS 1789 (74.00 %). Lowest shelling percentage was recorded by TCGS 2024 (66.70 %). While remaining genotypes were statistically on par with each other. Under moisture stress condition, TCGS 1792 recorded significantly highest shelling percentage (67.99 %) which was on par with TCGS 2326 (64.85 %). Lowest shelling percentage was recorded by TCGS 1785 (32.04 %) which was on par with TCGS 2024 (35.97 %) and K6 (38.00 %). During *rabi* 2023, under control conditions significantly highest shelling percentage was recorded by TCGS 1792 (75.60 %) which was statistically on par with K9 (75.25 %), TCGS 2326 (75.00 %), TCGS 1784 (73.50 %), TCGS 2020 (72.95 %) and TCGS 2333 (71.85 %). Lowest shelling percentage was recorded by TCGS 1785 (61.85 %). Remaining genotypes were statistically on par with each other for shelling percentage. Under moisture stress conditions, TCGS 1792 recorded highest shelling percentage (68.95 %) which was on par with TCGS 2326 (65.75 %) and K9 (60.00 %). Lowest shelling percentage was recorded by TCGS 1785 (33.85 %) which was at par with TCGS 2024 (36.95 %), K6 (38.00 %) and TCGS 1707 (41.00 %).Such significant interactions for shelling percentage were also reported by Sunitha *et al*. (2015).

Table 1. Effect of mid-season moisture stress on yield attributes of groundnut genotypes

	100 kernel weight (g)						**Shelling percentage (%)**					
	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	40.56	30.71	35.64	40.42	30.79	35.61	67.90	40.58	54.24	70.90	41.00	55.95
TCGS 1784	40.46	30.14	35.30	39.12	30.00	34.56	72.54	42.46	57.50	73.50	44.99	59.25
TCGS 1785	37.00	30.00	33.50	37.52	28.45	32.98	71.56	32.04	51.80	61.85	33.85	47.85
TCGS 1789	40.60	31.07	35.83	41.53	30.64	36.09	74.00	48.54	61.27	71.00	48.12	59.56
TCGS 1792	43.74	35.31	39.52	44.85	35.69	40.27	72.10	67.99	70.05	75.60	68.95	72.28
TCGS 2019	41.79	30.76	36.28	41.00	30.86	35.93	71.52	52.75	62.14	70.89	59.10	65.00
TCGS 2020	40.00	30.20	35.10	40.59	31.00	35.80	72.29	45.98	59.14	72.95	46.25	59.60
TCGS 2024	35.00	21.00	28.00	36.25	20.52	28.38	66.70	35.97	51.33	63.88	36.95	50.42
TCGS 2326	43.00	33.20	38.10	45.29	33.52	39.41	75.42	64.85	70.14	75.00	65.75	70.37

TCGS 2333	45.14	32.32	38.73	43.99	33.05	38.52	76.43	58.85	67.64	71.85	50.75	61.30
K6	38.64	29.51	34.08	39.21	30.75	34.98	71.09	38.00	54.55	68.54	38.00	53.27
K9	42.74	32.02	37.38	42.57	32.00	37.28	74.08	60.63	67.35	75.25	60.00	67.63
Mean	**40.72**	**30.52**		**41.03**	**30.61**		**72.14**	**49.05**		**70.93**	**49.48**	
	T	**G**	**TXG**	**T**	**G**	**TXG**	**T**	**G**	**TXG**	**T**	**G**	**TXG**
SEm±	0.45	1.11	1.57	0.61	1.5	2.12	0.71	1.74	2.46	0.95	2.33	3.29
CD(P=0.05)	1.293	3.168	NS	1.745	4.275	NS	2.024	4.959	7.013	2.703	6.621	9.364
CV(%)	7.65			10.27			7.04			9.46		

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

3.3 Protein content (%)

The mean data pertaining to protein content in kernel of groundnut genotypes grown under mid-moisture stress conditions during *rabi*, 2022 and 2023 were presented in the Table 2. Non-significant differenceswere observed among treatments and interactions regarding protein content.Our results are in accordance with the findings of Musingo*et al.* (1989) who reported non-significant differences among moisture stress treatments and interactions in groundnut. Significant genotypic variability was observed among the genotypes for protein content during *rabi*, 2022 and 2023. During *rabi*, 2022 highest protein content was recorded in TCGS 1792 (25.67 %) which was on par with TCGS 2326 (25.63 %), TCGS 2333 (25.56 %) and K9 (25.25 %). Whereas, lowest protein content was recorded by TCGS 1784 (22.74 %) and remaining genotypes are statistically on par with each other. During *rabi*, 2023 significantly highest protein content was recorded by TCGS 2326 (26.59 %) which was statistically on par with TCGS 1792 (26.23 %), K9 (25.84 %), TCGS 2333 (25.35 %) and TCGS 2019 (24.97 %). Lowest protein content was recorded by TCGS 1785 (22.25 %), which was at par with TCGS 2024 (23.10 %), TCGS 1784 (23.23 %), K6 (23.26 %), TCGS 2020 (23.80 %), TCGS 1707 (23.95 %) and TCGS 1789 (24.32 %). Our results also concur with the published reports of Abadya*et al*. (2021) in groundnut.

3.4 Oil content (%)

The mean data pertaining to oil content of groundnut genotypes influenced by mid-moisture stress was recorded at harvest during *rabi*, 2022 and 2023 were presented in the Table 2. No significant differences were observed between treatments and genotype treatment interactions with regard to oil content. Our results agree with the published reports of Chaiyadee*et al.*

(2013) who reported non-significant difference between moisture stress treatments and interactions in groundnut. Significant difference in oil content was noticed among the genotypes during *rabi*, 2022 and 2023. During *rabi*, 2022 highest oil content was recorded by TCGS 1792 (51.67 %) which was at a par with TCGS 2326 (51.26 %), TCGS 2019 (51.02 %), K9 (50.70 %), TCGS 2333 (50.36 %) and TCGS 1789 (50.06 %). Lowest oil content was recorded by TCGS 2024 (44.39 %) which was on par with TCGS 1785 (45.96 %) and remaining genotypes were statistically on par with each other. During *rabi*, 2023 highest oil content was recorded by TCGS 1792 (52.10 %) which was on par TCGS 2326 (51.38 %), K9 (50.59 %), TCGS 2019 (50.43 %), TCGS 2333 (50.18 %) and TCGS 1789 (49.99 %). Whereas, lowest oil content content was recorded by TCGS 2024 (44.20 %) TCGS 1785 (45.48 %) and K6 (47.17 %). Remaining genotypes were statistically at par with each other. Our results agree with the published reports of Dwivedi *et al*. (1996) who reported significant variation among groundnut genotypes for oil content under moisture stress condition.

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

	Protein (%)						Oil (%)					
	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	24.63	23.82	24.23	24.00	23.90	23.95	49.11	47.91	48.51	48.51	48.25	48.38
TCGS 1784	22.43	23.05	22.74	23.51	22.95	23.23	47.25	48.91	48.08	48.08	48.52	48.30
TCGS 1785	23.69	23.04	23.37	22.50	22.00	22.25	46.79	45.12	45.96	45.96	45.00	45.48
TCGS 1789	24.87	23.51	24.19	24.95	23.69	24.32	49.50	50.62	50.06	48.24	51.74	49.99
TCGS 1792	26.26	25.07	25.67	25.62	26.85	26.23	51.25	52.08	51.67	51.67	52.54	52.10
TCGS 2019	25.14	23.85	24.49	25.42	24.52	24.97	49.71	52.34	51.02	49.00	51.85	50.43
TCGS 2020	24.77	23.43	24.10	24.60	23.00	23.80	48.19	47.91	48.05	47.00	48.00	47.50
TCGS 2024	23.20	22.82	23.01	23.29	22.90	23.10	44.78	44.01	44.39	44.39	44.00	44.20
TCGS 2326	25.56	25.70	25.63	26.22	26.95	26.59	50.27	52.25	51.26	50.02	52.75	51.38
TCGS 2333	25.82	25.30	25.56	26.14	24.57	25.35	50.00	50.72	50.36	50.36	50.00	50.18

K6	23.67	22.20	22.93	23.42	23.09	23.26	46.79	46.00	46.40	48.05	46.28	47.17
K9	25.51	25.00	25.25	25.68	26.00	25.84	50.39	51.00	50.70	50.63	50.54	50.59
Mean	**24.63**	**23.90**		**24.61**	**24.20**		**48.67**	**49.07**		**48.49**	**49.12**	
	T	**G**	**TXG**	**T**	**G**	**TXG**	**T**	**G**	**TXG**	**T**	**G**	**TXG**
SEm±	0.31	0.76	1.08	0.31	0.77	1.09	0.67	1.63	2.31	0.69	1.69	2.38
CD(P=0.05)	NS	2.166	NS	NS	2.193	NS	NS	4.651	NS	NS	4.8	NS
CV(%)	7.68			7.73			6.16			8.46		

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

4. CONCLUSION

Effect of mid-season moisture stress (40-80 DAS) was studied for variation in yield attributes and quality traits of groundnut genotypes for two years in two check varieties and tengroundnut genotypes. The genotypes and drought tolerant check variety TCGS 2326, TCGS 1792, K9 and TCGS 2333 recorded higher performance in terms of yield attributes and quality traits indicating its tolerance to mid-season moisture stress by maintaining highest kernel weight, shelling percentage and protein, oil content. Whereas, genotypes TCGS 2024, TCGS 1785 and check variety K6recorded lower yield attributes and quality traits indicating its susceptibility to moisture stress. The tolerant genotypes identifiedin the present study can be further evaluated for physiological and other yield traits under moisture stress conditions for confirming their tolerance.

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