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# Groundnut mother plant exposure to moisture stress and effect of their interaction on germination and seedling growth traits

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### Abstract

Seed germination and seedling growth can be affected by various environmental conditions experienced by the mother plant. However, information about how the maternal environment affects seed quality is scare. This study aimed to investigate the effects of moisture stressed mother plant on the seed germination and seedling growth. Ten groundnut genotypes were grown in open field conditions during the summer months and were exposed to three moisture stress regimes then the harvested seed from the mother plants were collected and tested in laboratory for germination and seedling growth traits in laboratory using FCRD and FRBD design. Results indicated that seeds harvested from the mother plants exposed to regular irrigation (control) germinated and seedling growth traits were better than seeds harvested from the mother plants that were exposed to moisture stress at peg formation and moisture stress at peg and pod formation. Germination and seedling vigour traits of moisture stressed seed of the moisture stressed seed. The difference in germination and seedling growth traits of seeds might be due to the epigenetic memory inherited from the mother plants.

**Keywords:** Groundnut, moisture stress, germination, seedling growth, radicle length, plumule length, vigor index I

### Introduction

Groundnut (*Arachis hypogea* L.) is an important food legume and oilseed crop belongs to the botanical family Fabaceae also called as Leguminoseae. It is an economically important food legume containing 44-56% oil and 22-30% protein on a dry seed basis. Groundnut (is a major cash crop in the semi-arid tropics, where it is mostly grown under rain fed conditions. This is characterized by intermittent and occasionally by prolonged drought stresses. This affects one or more critical phenol phases of growth resulting in poor yield of groundnut.

Drought (water deficits) stress is the prime abiotic constraints, under the current and climate change scenario in future. Any further increase in the occurrence, and extremity of these stress, would severely reduce the crop productivity and food security, globally. Drought is deleterious for plant growth, yield and mineral nutrition (Garg *et al*. 2004) [8] and is one of the largest limiting factors in agriculture (Reddy *et al*., 2004; Yu and Setter, 2003) [16, 23]. Drought stress affects various physiological processes and is deleterious for growth, development and economic yield of crop (Garg *et al*., 2004; Talebi *et al*., 2013) [8, 20]. Water stress not only adverse effects the pod yield but also quality of seed (Ruker *et al*., 1995) [17]. High quality seeds are essential for successful plant establishment. It is well known that the mother plant greatly influences seed traits, such as seed size, germination rate, and viability (Donohue, 2009, Geshnizjani, *et al*. 2019) [7, 10]. The pattern of seed germination varies according to seed source, parental nutrition, seed maturity and environmental condition during seed development (Chaisurisri *et al*., 1992) [4]. However, information about the effects of the maternal environment on the seed and seedling vigor of ornamental plants under abiotic stresses remains scarce. Hence the study was aimed to study the germination and seedling growth of the groundnut mother plants exposed to moisture stress.

### Materials and Methods

Plant material: Ten groundnut genotypes were received from AICRP on summer groundnut M.P.K.V Rahuri. The genotypes namely Phule-6021, Phule Unnati, Phule Bharati, TPG-41, RHRG-1149, RHRG-1103, RHRG-1134, RHRG-1142, RHRG-1186 and RHRG-6110 were included as genetic material in this study.

The experiment was conducted during summer 2018 at AICRP on summer groundnut, M.P.K.V Rahuri in a factorial randomized block design (FRBD) with three replications and two factors i.e. groundnut genotypes and moisture stress. Ten genotypes i.e $G_1$ (Phule-6021),

$G_2$ (Phule Unnati), $G_3$ (Phule Bharati), $G_4$ (TPG-41), $G_5$ (RHRG-1149), $G_6$ (RHRG-1103), $G_7$ (RHRG-1134), $G_8$ (RHRG-1142), $G_9$ (RHRG-1186) and $G_{10}$ (RHRG-6110) and three moisture regimes *viz* $T_1$(control -irrigation as per recommendation), $T_2$ (Stress at peg formation- irrigation was ceased eight days before peg formation stage and after the peg formation stage stress was released and irrigation was provided) and $T_3$ (Stress at peg and pod formation- Irrigation was ceased eight days before the peg formation stage and pod formation stage after the peg formation and pod formation stage stress was released and irrigation was provided). The seeds of the ten genotypes were sown with spacing of 30 X 10 cm. The crop was grown by adopting recommended package of practices. The harvested seeds of all of the three treatments were collected and dried. The experiment was carried out in laboratory by using Factorial Completely Randomized Block Design (FCRD) on harvested seeds from the mother plants which were subjected to moisture regimes during growth stages. The seeds were kept for germination in germination chamber and the data was recorded for germination percentage, radicle length (cm), plumule length (cm), vigor index-I at 8th day.

Germination percentage was calculated using the formula

$$\text{Germination (\%)} = \frac{\text{Number of normal seedlings}}{\text{Total number of seeds placed}} \times 100$$

Radicle length (cm) was calculated by selecting ten normal seedlings randomly from each treatment from all the replications on 8th day and was used for measuring radicle length. The radicle length was measured from the tip of the primary root to base of hypocotyl with the help of a scale. The mean values were calculated and expressed in centimetres.

Plumule length (cm) was calculated by selecting ten normal seedlings used for root length measurement, was also used for the measurement of shoot length. The shoot length was measured from the tip of the primary leaf to the base of the hypocotyl and mean shoot length was expressed in centimetres.

Vigor Index I was calculated by germinating 100 seeds of different treatments combinations in four replicates by using between paper method (BP) and was kept at 20 ℃ in germinator for 8 days (Anonymous, 1999). Ten normal seedlings from each replication was selected for calculation of vigour index I (Abdul-Baki and Anderson, 1973) and was calculated as under:

Vigour index I =Average seedling length x Average germination percentage
{Root + Shoot (cm)}

## Result and Discussion

### Germination percentage

The data regarding germination percentage influenced by genotypes, moisture stress treatment and their interaction effects are presented in Table 1. The differences among the moisture stress treatments and genotypes are statistically significantly for radicle length. However, interaction effects are also statistically significant

Among the different moisture stress treatments, $T_1$-control treatment recorded significantly maximum germination (94.00%), whereas $T_3$-stress at peg and pod formation stage treatment recorded significantly minimum germination (63.40%). Genotype $G_2$ recorded significantly maximum germination percentage (83.33%) over the other genotype and was found at par with $G_{10}$ (81.17%) while genotype recorded significantly minimum $G_4$ (72.67%) germination. Whereas in the interaction effect of different stress treatment at different growth stages on germination percentage was found maximum under $G_2T_1$ (97.50%) and it was at par with $G_1T_1$ (94.00%), $G_3T_1$ (94.50%), $G_6T_1$ (95.00%), $G_8T_1$ (94.50%), $G_9T_1$ (97.00%) and $G_{10}T_1$ (97.00%).

The results of the present findings are in accordance with Shekari (2000) [18] who observed that with increasing severity of drought, the percentage and rate of germination, root and shoot length was reduced in millet. Drought has affected many aspects of plant growth and delaying germination addition, the growth of shoot and reduces the production of dry matter. In peanut (*Arachis hypogaea* L.), drought stress during seed development moderately reduced seed germination (Ketring, 1991) [12], (Smiciklas *et al*., 1992) [19] and Dombos and Mullen (1985) [6] in soybean, (Harris *et al*., 2002) [11].in rice, (Okcu *et al*., 2005) [14] in pea.

**Table 1:** Effect of moisture stress on germination percentage, radicle length and plumule length

| Genotypes | Germination (%) | | | | Radicle length (cm) | | | |
|---|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | Mean | T1 | T2 | T3 | Mean |
| $G_1$ | 94.00 | 83.50 | 64.00 | 80.50 | 12.67 | 9.91 | 8.44 | 10.34 |
| $G_2$ | 97.50 | 83.50 | 69.00 | 83.33 | 11.67 | 10.31 | 9.74 | 10.57 |
| $G_3$ | 94.50 | 82.50 | 64.00 | 80.33 | 12.09 | 10.47 | 8.85 | 10.47 |
| $G_4$ | 87.50 | 73.50 | 57.00 | 72.67 | 11.07 | 9.94 | 9.57 | 10.19 |
| $G_5$ | 92.00 | 81.50 | 63.00 | 78.83 | 10.47 | 10.13 | 9.32 | 9.97 |
| $G_6$ | 95.00 | 79.50 | 59.00 | 77.83 | 9.66 | 8.62 | 8.04 | 8.77 |
| $G_7$ | 91.00 | 79.50 | 67.00 | 79.17 | 11.88 | 10.35 | 9.48 | 10.57 |
| $G_8$ | 94.50 | 82.50 | 63.00 | 80.00 | 10.05 | 9.19 | 8.02 | 9.08 |
| $G_9$ | 97.00 | 80.00 | 64.00 | 80.33 | 10.15 | 7.79 | 7.97 | 8.64 |
| $G_{10}$ | 97.00 | 82.50 | 64.00 | 81.17 | 10.65 | 9.76 | 8.83 | 9.74 |
| GM | 94.00 | 80.85 | 63.40 | 79.42 | 11.03 | 9.64 | 8.82 | 9.83 |
| | G | T | G×T | | G | T | G×T | |
| S.Em(±) | 0.58 | 0.32 | 1.02 | | 0.13 | 0.07 | 0.22 | |
| CD@1% | 2.39 | 1.25 | 3.96 | | 0.53 | 0.27 | 0.88 | |

### Radicle length (cm)

The data regarding radicle length influenced by genotypes, moisture stress treatment and their interaction effects are presented in Table 1. The differences among the moisture stress treatments and genotypes are statistically significantly for radicle length. However, interaction effects are also statistically significant.

Among the different moisture stress treatments, $T_1$–control treatment recorded significantly maximum radicle length (11.03 cm) whereas $T_3$ -stress at peg and pod formation stage treatment recorded significantly minimum radicle length (8.82 cm). Similarly, among the different genotype $G_2$ and $G_7$ (10.57 cm) recorded significantly same and maximum radicle length over the other genotype and was found at par with $G_3$ (10.47cm) and $G_4$ (10.19cm), while genotype $G_9$ (8.64 cm) recorded significantly minimum radicle length.

Whereas in the interaction effect of different stress treatment at different growth stages on radicle length was found maximum under $G_1T_1$ (12.67cm) and it was at par with $G_3T_1$ (12.09 cm) and $G_7T_1$ (11.88 cm).The results of the present findings are in accordance with Shekari (2000) [18] who observed that with increasing severity of drought, the percentage root length was reduced in millet.

### Plumule length (cm)

The data regarding plumule length influenced by genotypes, moisture stress treatment and their interaction effects are presented in Table 2. The differences among the moisture stress treatments and genotypes are statistically significantly for plumule length. However, interaction effects were statistically significant.

**Table 2:** Effect of moisture stress on Seedling length (cm) and Vigor index I

| Genotype | Plumule Length (cm) | | | | Vigor Index 1 | | | |
|---|---|---|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | Mean | $T_1$ | $T_2$ | $T_3$ | Mean |
| $G_1$ | 5.75 | 4.83 | 3.50 | 4.69 | 1779.16 | 1234.26 | 654.25 | 1222.56 |
| $G_2$ | 4.20 | 3.46 | 2.99 | 3.55 | 1498.63 | 1137.45 | 712.21 | 1116.10 |
| $G_3$ | 5.05 | 4.70 | 3.69 | 4.48 | 1648.26 | 1202.69 | 613.76 | 1154.90 |
| $G_4$ | 4.86 | 3.76 | 2.46 | 3.69 | 1320.22 | 920.05 | 528.68 | 922.98 |
| $G_5$ | 5.06 | 4.53 | 2.87 | 4.15 | 1411.82 | 1032.26 | 595.98 | 1013.35 |
| $G_6$ | 3.97 | 2.90 | 2.81 | 3.22 | 1357.20 | 946.09 | 529.31 | 944.20 |
| $G_7$ | 5.07 | 3.15 | 2.96 | 3.72 | 1557.01 | 1133.79 | 568.66 | 1086.49 |
| $G_8$ | 4.68 | 4.54 | 3.80 | 4.34 | 1397.84 | 1072.41 | 468.56 | 979.60 |
| $G_9$ | 4.98 | 3.57 | 2.40 | 3.65 | 1438.74 | 856.68 | 534.40 | 943.27 |
| $G_{10}$ | 3.85 | 3.30 | 3.07 | 3.40 | 1494.77 | 1076.42 | 517.04 | 1029.41 |
| Mean | 4.74 | 3.87 | 3.05 | 3.89 | 1490.37 | 1061.21 | 572.29 | 1041.29 |
| | G | T | G×T | | G | T | G×T | |
| S.Em (±) | 0.08 | 0.04 | 0.14 | | 19.19 | 10.51 | 33.24 | |
| CD@1% | 0.33 | 0.17 | 0.55 | | 78.13 | 40.88 | 129.30 | |

Among the different moisture stress treatments, $T_1$ –control treatment recorded significantly maximum plumule length (4.74 cm) whereas $T_3$ -stress at peg and pod formation stage treatment recorded significantly minimum plumule length (3.05 cm).

Similarly, among the different genotype $G_1$ (4.69 cm) recorded significantly maximum plumule length over the other genotype and was found at par with $G_3$ (4.38 cm).while genotype $G_6$ (3.22 cm) recorded significantly minimum plumule length. Whereas in the interaction effect of different stress treatment at different growth stages on plumule length was found maximum under $G_1T_1$ (5.75cm) The findings of the present investigation are in accordance with Arooj *et al.*, (2017) [3] who reported that shoot length (SL) were recorded lower in moisture stress condition. Shekari (2000) [18] who observed that with increasing severity of drought shoot length was reduced in millet. Similar findings were reported by Mingli *et al.* (2015) [13] in maize, Wondimu Bayu *et al*. (2005) [22] in sorghum.

## Vigor index I

The data regarding vigor index I influenced by genotypes, moisture stress treatment and their interaction effects are presented in Table 2. The differences among the moisture stress treatments and genotypes are statistically significant for vigor index I. However, interaction effects are also statistically significant.

Among the different moisture stress treatments, $T_1$–control treatment recorded significantly maximum vigor index 1 (1490.37) whereas $T_3$-stress at peg and pod formation stage treatment recorded significantly minimum vigor index I (572.29). Similarly, among the different genotype $G_1$(1222.56) recorded significantly maximum vigor index I over the other genotypes and was found at par with $G_3$(1154.90)., while genotype G4 (922.98) recorded significantly minimum vigor index I. Whereas in the interaction effect of different stress treatment at different growth stages on vigor index I was found maximum under $G_1T_1$ (1779.16). The findings of the present study are in accordance with the findings of Wijewardana *et al.* (2019) [21] who reported that soil moisture stress reduce the vigor. Pallas *et al*. (1977) [15] who reported that in groundnut (*Arachis hypogaea* L.), both viability and vigour of progeny were lowered by water stress on the maternal plant. Similar results were reported by (Dhanda *et al.*, 2004) [5] in wheat. One of the most important environmental factors affecting on the seed vigor, is the stress on the mother plant in the course of seed formation which caused small and shrivelled seeds and cause a reduction in seed vigor (Galeshi and Bayat Tork, 2005) [9].

## Conclusion

Considering the above results obtaining from the present piece of work it may be concluded that seeds from the mother plant subjected to moisture stress and their interaction reduce the germination percentage and seedling growth traits such as radicle length, plumule length, vigor index I. A wide range of differences existed among the groundnut genotypes. The seeds of the mother plant subjected to moistures stress during peg and pod formation resulted in reduction of germination percentage and seedling growth traits such as radicle length, plumule length and vigor index I. This indicated that germination percentage, radicle length, plumule length and vigor index I may be an important traits used to screen drought tolerant and susceptible varieties.

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