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Evaluation of Short-duration Groundnut Genotypes for the Arid Zone of Northwestern Rajasthan, India

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The hot arid ecosystem of northwestern Rajasthan, India is characterized by low and erratic rainfall, frequent droughts, high temperatures, and high wind velocity leading to high rate of evapotranspiration and drought (Rao and Singh 1998). The introduction of Indira Gandhi Nahar (an irrigation canal) in the region has increased the availability of irrigation water. Therefore, groundnut (*Arachis hypogaea*) crop has become an important component of the cropping systems of the northwestern arid zone for both fodder as well as grain production. Traditionally, farmers of this region tend to sow groundnut varieties of 8–9 months duration. These varieties experience peak summer months when lot of irrigation is required to raise a successful crop. Moreover, if the crop is sown more than three consecutive years in the same field, farmers reported a steady decline in groundnut yield. This seems to be due to the imbalance of soil nutrients created by traditional long-duration varieties. Recently, shortage of water in irrigation canals has been experienced and the crop has additionally begun to suffer from intermittent droughts. Hence, there is an urgent need to introduce short-duration groundnut varieties that have intermittent drought tolerance for this region. A preliminary experiment was, therefore, conducted to evaluate short-duration groundnut genotypes for intermittent drought tolerance.

A field experiment was conducted at the research farm of the Regional Research Station, Central Arid Zone Research Institute (CAZRI), Bikaner in Rajasthan. The field was disc plowed and a basal dose of single superphosphate at 40 kg P_2O_5 ha^{-1} was incorporated into the soil at the time of land preparation. The experiment was laid out in a split plot design with sowing beds [flat bed (FB); and broad-bed and furrow (BBF)] as main plots and genotypes as sub-plots. The broad beds were of 1.2 m width with 0.3 m wide furrows. The seeds of 10 groundnut genotypes (ICGS 11, ICGS 44, ICGVs 86015, 87846, 89104, 91117, 92109, 92113, 92116, and 92206) procured from ICRISAT were used in the study. Before sowing, seeds were treated with thiram and captan (at 3 g kg^{-1} seed) to prevent seedling diseases. Sowing was done on February 14, 2001. The plot size for each entry was 2.0 m × 1.2 m, with planting space of 30 cm between rows and 10 cm within a row. The crop received adequate sprinkler irrigation throughout the growing period, except during mid-season drought. Mid-season drought was imposed from 52 to 75 days after sowing (DAS) by withholding irrigation. The total rainfall during the crop-growing season was 130.5 mm, out of which only 5 mm was received during the drought period. The treatments were replicated three times. Plants were sampled from an area of 0.2 m × 4 rows at the onset of intermittent drought (52 DAS), end of drought (72 DAS), and at final harvest (FH). Total dry matter [vegetative (i.e., aboveground parts) mass + pod mass], pod mass, crop growth rate, and partitioning coefficient were estimated as described by Nageswara Rao et al. (1988). Crop growth, pod growth, and partitioning during mid-season drought and recovery phase following the alleviation of mid-season drought were quantified as follows:

Crop growth rate (CGR) $= (Dm\ t_3 - Dm\ t_2)/(t_3 - t_2)$

Pod growth rate (PGR) $= (Pd\ t_3 - Pd\ t_2)/(t_3 - t_2)$

Partitioning factor (P_f) $=$ PGR/CGR

where t_2 = 72 DAS, t_3 = at FH, Dm = Total dry matter, and Pd = Pod dry mass.

The results showed that the recovery in growth rates following the release of drought was higher in most of the genotypes when grown on the BBF system as compared to FB (Table 1). Four genotypes, ICGVs 92113, 86015, and 87846, and ICGS 11, achieved a significantly higher CGR during the recovery phase when grown on BBF than on FB. PGR during the recovery phase was significantly higher in three genotypes (ICGVs 92113, 92116, and 86015) when grown on BBF than on FB, unlike ICGV 92206 and ICGS 11. About half of the genotypes studied maintained higher partitioning when grown on BBF than when grown on FB. The sowing bed × genotype interaction was significant for PGR and P_f but was not significant for CGR. Significant variations for CGR, PGR, and P_f were noticed among genotypes sown either on BBF or FB. The bi-plotting of CGR and P_f during the recovery phase following the termination of drought showed that chances of combination of higher CGR with higher P_f are greater when genotypes are grown on BBF rather than on FB (Fig. 1). Three genotypes (ICGVs 92113, 92116, and 86015) achieved above average CGR and P_f when grown on BBF, while only one genotype achieved this when grown on FB. The total dry matter and pod yield were higher in most genotypes (7 out of 10) when grown on BBF as compared with FB. ICGV 92113 produced the highest pod yield and total dry matter under both BBF and FB. But there is a marked improvement in both the parameters in all test genotypes when grown on BBF than on FB (Table 1). The sowing bed × genotype interaction was not significant for total dry matter but was significant for pod yield.

These results indicate that the BBF system of raising the crop is promising for short-duration groundnut genotypes in the arid zone of north-western Rajasthan. Thus some superior short-duration genotypes could help boost yields in this region. More experiments are needed to validate this observation and develop as a production practice for the farmers of this region.

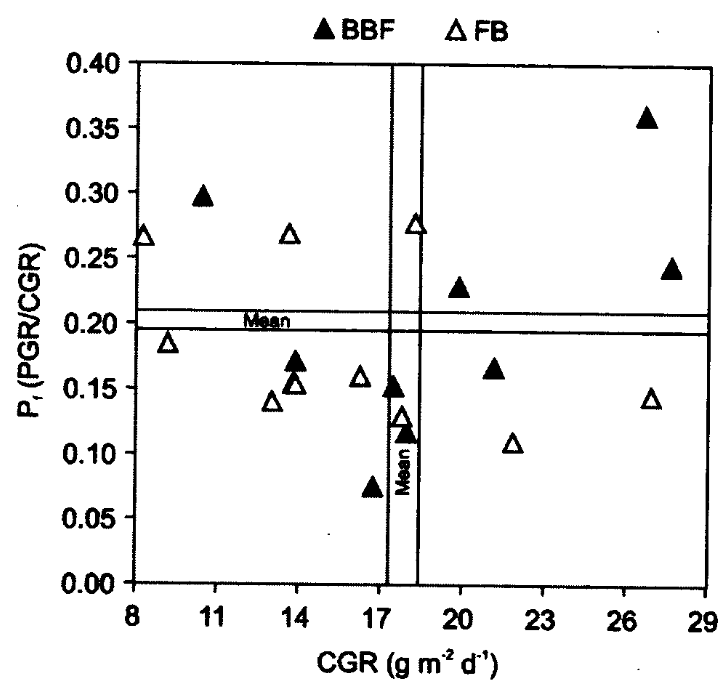

Figure 1. Bi-plot between crop growth rate (CGR) and partitioning (P_f) during recovery phase following the termination of drought in 10 selected groundnut genotypes grown on broad-bed and furrow (BBF) or flat bed (FB) (PGR = Pod growth rate).

Table 1. Variation in crop growth rate (CGR), pod growth rate (PGR), and partitioning factor (P_f) during the recovery phase following the termination of drought and in total dry matter and pod yield at maturity in groundnut genotypes during summer 2001 at Regional Research Station, CAZRI, Bikaner, Rajasthan, India.

Genotype	CGR ($g\ m^{-2} d^{-1}$)		PGR ($g\ m^{-2} d^{-1}$)		P_f		Total dry matter ($g\ m^{-2}$)		Pod yield ($g\ m^{-2}$)	
	FB[1]	BBF[1]	FB	BBF	FB	BBF	FB	BBF	FB	BBF
ICGS 11	8.3	16.7	1.9	1.2	0.27	0.08	907.5	1629.4	165.0	103.1
ICGS 44	13.9	13.8	2.2	2.2	0.15	0.15	1381.9	1340.6	185.6	185.6
ICGV 86015	13.0	19.8	1.9	4.6	0.14	0.23	1237.5	1815.0	165.0	391.9
ICGV 87846	9.2	17.5	1.7	2.7	0.18	0.15	907.5	1691.3	144.4	226.9
ICGV 89104	21.9	21.2	2.2	3.4	0.11	0.17	2062.5	1959.4	185.6	288.8
ICGV 91117	16.2	10.4	2.1	3.1	0.16	0.30	1568.1	1093.1	185.6	266.1
ICGV 92109	17.8	18.0	2.2	2.7	0.13	0.12	1711.9	1753.1	185.6	226.9
ICGV 92113	18.2	26.7	5.3	9.2	0.28	0.36	1744.9	2516.3	453.8	783.8
ICGV 92116	26.9	27.6	3.9	6.8	0.15	0.24	2563.4	2619.4	330.3	577.5
ICGV 92206	13.6	13.9	3.5	2.1	0.26	0.17	948.8	1381.9	309.4	185.6
Mean	15.9	18.6	2.7	3.8	0.18	0.20	1502.7	1779.9	231.0	323.8
CV (%)	16.2		19.2		18.0		15.2		16.3	
LSD (0.05)										
Sowing Bed (SB)	2.00		1.32		0.088		306.7		72.8	
Genotype (G)	1.78		0.29		0.023		147.9		18.4	
SB × G	NS[2]		2.37		0.075		NS		97.0	

1. FB = Flat bed; BBF = Broad-bed and furrow.
2. NS = Not significant.

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Performance of Groundnut Germplasm at High Temperature During the Reproductive Phase in Rajasthan, India

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The availability of irrigation has increased cultivation of rabi (October–March) and summer (February–June) groundnut (*Arachis hypogaea*) in several areas in Rajasthan, India; however, crop sown in January in Nachana, Bikaner, Hanumangarh, and Durgapura areas encounter low (8 to 18°C) temperatures during germination phase. Under such a situation, the crop takes about 20–25 days to emerge, and uniform crop stand is generally not achieved. If the crop is sown in the last week of February or first week of March, it germinates well but encounters high temperatures at the time of pollination and pod-filling (May and June), when maximum ambient temperatures vary from 30 to 45°C. A high temperature adversely affects performance of groundnut. Therefore, cultivars that can tolerate high temperatures are required for late sowing conditions. The objective of this study was to screen groundnut germplasm accessions for their tolerance to high temperature during the reproductive phase.

Seventy-two germplasm accessions belonging to different botanical groups (spanish, valencia, and virginia) were screened for tolerance to high temperature at Hanumangarh and Durgapura. These were sown on 27 February and 16 March 1996 at Hanumangarh, and on 3 and 24 February 1996 at Durgapura. The experiment was conducted in a randomized block design with three replications. Each genotype was sown in 5 rows, each of 4 m length, with a spacing of 10 cm (between seed) and 45 cm (between rows). The crop sown on the first date was harvested after 140 days, and that sown on the second date was harvested after 120 days at the two locations.

The early-sown crop (first date) experienced minimum temperature between 5 and 10°C, and maximum temperature between 20 and 25°C during germination and early seedling stage at both the locations. During the reproductive phase, temperatures ranged between 30 and 40°C at Hanumangarh, and between 30 and 38°C at Durgapura (Fig. 1). Thus the crop experienced sub-optimal temperatures during germination and early seedling stage, and supra-optimal temperatures during the reproductive phase at both the locations. At the final harvest, an area of 0.30 m^2 from each plot was sampled; from each sample observations such as number of pegs, immature pods, and mature pods $plant^{-1}$ were recorded on 6–7 plants. The vegetative plant parts from each sample were dried in an oven at 80°C until a constant weight was achieved. Harvest index (HI) was calculated as a ratio of dry mass of pods to dry mass of total biomass. The data of two sowing dates at each location were pooled and analyzed. Significant genotypic variation was found in number of pegs and pods, dry mass, and HI. The interactions between the date of sowing and genotype were also significant for all the traits (Table 1). The crop sown early took 7–10 days longer for seedling emergence, and for flower initiation, probably due to low soil and ambient temperatures (soil data not given), than the second date of sowing.