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Productivity of Groundnut as Influenced by Use of Seed from a Crop with Moisture Stress History

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ABSTRACT

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In a previous experiment conducted at the ICRISAT Research Centre, Patancheru, India, groundnut (*Arachis hypogaea* L.) cv. Robut 33-1 was grown under moisture stress imposed at four periods of growth i.e., emergence to maturity, emergence to peg initiation, first flush of flowering to last pod set and beginning of seed filling to maturity. Seed from each of these treatments was used during the 1982 rainy season to study the influence of differences in moisture stress history on the productivity of groundnut.

Seeds from plants with moisture stress from emergence to initiation of pegs (early moisture stress) gave higher field emergence, better seedling vigour and resulted in increased pod and kernel yields over the other treatments. Use of seeds from crops grown with moisture stress from flowering to end of pod set resulted in yield reduction.

INTRODUCTION

India is the largest producer of groundnut (*Arachis hypogaea* L.) accounting for two fifths of the world acreage and one third of the world production (FAO, 1982). Yields of rainy season groundnut from regions characterized by erratic rainfall are highly variable and the drought patterns during the growing season are not predictable. Seed quality of the groundnut crop has been reported to suffer from moisture stress (Pallas et al., 1977; Birajdar et al., 1979). Water deficits have been reported to result in decreased seed weight (Cheema et al., 1974; Gorbet and Rhoads, 1975; Varnell et al., 1976; Pallas et al., 1979) and reduced germinability (Cox et al., 1976; Pallas et al., 1977, 1979). However, the effect of moisture stress at different growth stages on the productivity of the crop grown from the resultant seed is not known.

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TABLE 1

Proximate analysis of representative groundnut kernels drawn from moisture stress treatments during the 1981–82 post-rainy season

Treatment	100 kernel weight (g)	Oil %	Protein %	Sugar %	Starch %
1A	68.5	40.6	27.7	2.91	13.4
1B	68.4	40.1	31.6	1.26	9.8
1C	19.7	38.5	23.9	3.61	16.8
2A	66.9	44.6	30.0	4.94	10.6
2B	68.2	43.3	30.5	4.58	10.4
2C	75.4	43.8	29.6	3.95	10.1
3A	54.1	44.4	28.6	5.09	11.1
3B	47.5	44.5	27.6	5.18	12.3
3C	26.3	39.5	24.5	6.32	15.4
4A	66.0	41.9	32.8	3.25	10.1
4B	66.0	41.3	33.9	3.74	11.4
4C	32.0	36.0	33.5	2.72	13.8
SE(±)	0.15	0.55	0.23	0.07	0.40

The objective of this study was to explore the effect of using seeds from crops grown with different moisture stress histories on seedling vigour, plant stand and yield.

MATERIALS AND METHODS

The experiment was conducted during the 1982 rainy season at the International Crops Research Institute for the Semi Arid Tropics (ICRISAT), Patancheru, India (17°32′N Lat., 78°16′E Long.) on a medium deep Alfisol classified as fine, clayey mixed udic Rhodustalf.

Representative seed samples of the cv. Robut 33-1 were drawn from crops grown with 12 moisture stress treatments in a previous post-rainy season experiment conducted during 1981–82 at the ICRISAT Centre. A complete description of the various treatments used in this experiment was given by Nageswara Rao et al. (1985). Salient features of the treatments are presented here.

The previous experiment consisted of four main treatments (drought during different crop growth periods) with three sub-treatments (amount of irrigation) within each main treatment, replicated three times in a split-plot arrangement. Irrigation levels within each main treatment were created using line source irrigation (Hanks et al., 1976). The four main treatments were:

Treatment 1: Regular line source irrigation from emergence to maturity (0 to 165 days)

TABLE 2

Final plant population, pod yield and shelling percentage of groundnut during the 1982 rainy season

Treatment	Final plant population (×1000/ha)	Pod yield (kg/ha)	Shelling percentage	Kernel yield (kg/ha)
1A	150.7	1750	66	1150
1B	129.3	1760	57	1000
1C	126.7	1640	61	1000
2A	147.8	1890	71	1340
2B	138.1	1820	61	1110
2C	155.9	1880	63	1180
3A	125.9	1850	55	1020
3B	148.1	1520	70	1060
3C	110.0	1250	70	880
4A	147.4	1820	55	1000
4B	125.9	1780	57	1010
4C	122.2	1620	60	970
SE(±)	8.3	90	5	90

Treatment 2: Line source irrigation at 11 and 21 days after sowing (DAS) with no further irrigation for 30 days until the start of pegging; thereafter regular adequate irrigation

Treatment 3: No moisture stress up to first flush of flowering; a single line source irrigation at the start of flowering followed by moisture stress until the end of pod set; adequate irrigation subsequently

Treatment 4: Line source irrigation at the beginning of seed filling (93 DAS) followed by moisture stress until maturity

Three irrigation levels, A, B and C were identified in each main treatment depending on distance from the sprinkler line and water received. Plot A represented the least water stress and plot C the most. Details of irrigation schedule and cumulative amounts of water received in each sub treatment were presented by Nageswara Rao et al. (1985). Treatment 1A, irrigated at regular intervals throughout the growing season, represents the control treatment.

Groundnut pods from the experiment were stored at room temperature in well-sealed seed drums protected from storage pests. Seed samples from each treatment were analysed for oil, protein, sugars and starch. Oil content was determined using the Ab 3-49 method given by AOCS (1981) with two modifications: 18 hours extraction, and filtration of extract using Whatman No. 42 filter paper. Protein was estimated by the Micro-Kjeldahl method (AOAC, 1975). Sugars were estimated by the method outlined by Dubois et al. (1956). The method of Trivend et al. (1972) was used to estimate the starch content.

Seeds from the 12 treatments were sown on 19 June 1982 in a randomized block design with three replications. A basal dressing of 100 kg/ha of diammonium phosphate (18:20:0, N:P_2O_5:K) was applied and the necessary plant protection measures were taken.

Field emergence was recorded daily up to 18 DAS. Seedling vigour was determined by recording the number of leaves and leaflets, leaf area and dry weight at three-day intervals from 5 days after emergence (DAE) to 26 DAE. Leaf area was measured with an LI-3100 area meter (LI-COR Ltd., Lincoln, Nebraska, USA). Final plant population, yield and yield components were obtained from a net area of 9 m^2.

RESULTS

Results of kernel quality analysis of seeds used in this study are shown in Table 1. In general the groundnut crop which was under moisture stress during the early growth phase of emergence to initiation of pegs (treatments 2A, 2B and 2C) showed higher kernel weight, oil, protein and sugar in comparison to the control (1A). Moisture stress from flowering to pod set (3A, 3B and 3C) resulted in lower kernel weight but higher sugar content than the control.

Treatment 2C showed the highest (Fig. 1), and 3C the lowest, rate of emergence, which was significantly lower than control.

Treatments 1A and 1C were significantly different (Fig. 2) in leaf area production per plant at 26 DAE. Very low leaf area was recorded at this time in treatments 3C and 1C.

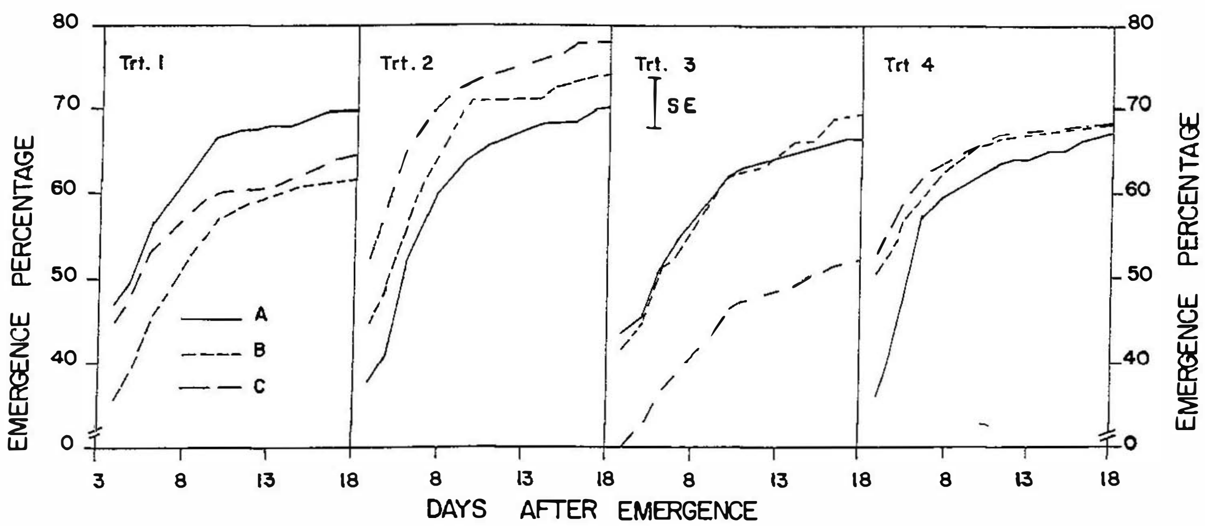
Treatment 2A was superior to other treatments in dry matter production (Fig. 3). The rate of dry matter production was low in Treatments 1 and 4.

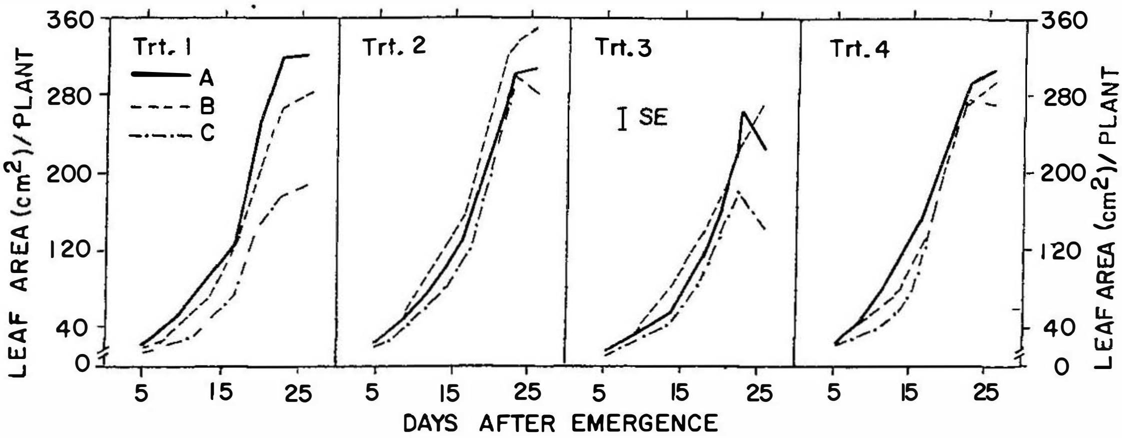
The highest final plant population was observed in treatment 2C (Table 2). Treatment 3C produced the lowest plant population followed by 4C. The highest pod yield of 1890 kg/ha was recorded in treatment 2A compared with 1750 kg/ha from the control. The lowest mean yield was recorded in treatment 3C. Treatment 2A with a shelling percentage of 71 was significantly superior to all the others.

Treatment 2A produced the highest kernel yield of 1340 kg/ha, a 15% increase in yield over treatment 1A, which had a mean kernel yield of 1150 kg/ha. Treatments 3B and 3C produced significnatly lower kernel yields than 2A while the differences between treatments 1A, 1B, 1C, 4A, 4B and 4C were not significant.

DISCUSSION

Kernel quality analysis of the crops produced from the seeds used in this experiment showed that moisture stress history from emergence to peg initiation (early moisture stress) had better seed filling, with increased oil and sugar contents and a decrease in starch content. Greater seed weight resulting from early moisture stress could be due to the higher oil and sugar contents as





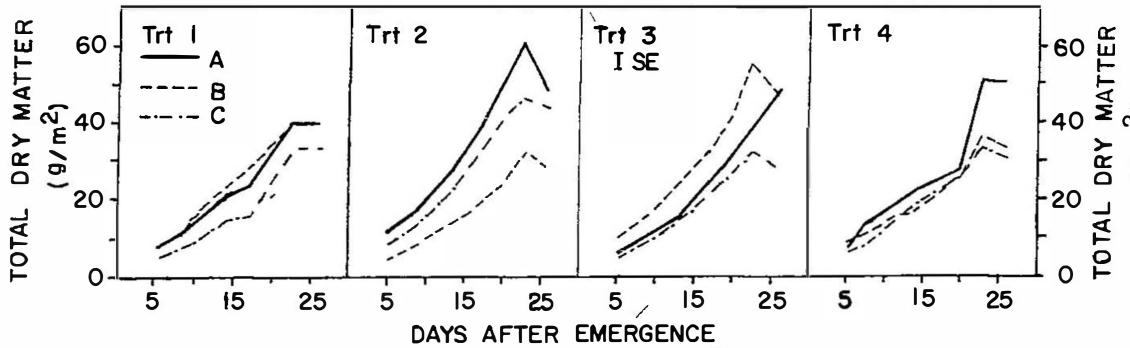


Fig. 1. Emergence percentage of groundnut as influenced by using seeds from different moisture stress treatments.

Fig. 2. Leaf area/plant of groundnut as influenced by using seeds from different moisture stress treatments.

Fig. 3. Total dry matter of above ground plant parts of groundnut as influenced by using seeds from different moisture stress treatments.

found by Unchier (1941). Use of such seeds resulted in higher field emergence and final plant polulation than those in the other treatments. Reduced germinability of seeds in treatments 3 and 4 can be attributed to the soil moisture deficit to which these treatments were subjected in the previous season (Cox et al., 1976; Pallas et al. 1977, 1979).

The treatment involving early moisture stress resulted in greater leaf area per plant. Williams et al. (1975) considered that large leaflet area early development of leaf canopy and maintenance of maximum leaf number (Maeda, 1970) were important for higher yield. This was borne out by the data presented on dry matter production, final yield and shelling percentage which were superior when seed with early moisture stress history was used.

In general, moisture stress during the period between flowering and pod-setting during the previous season resulted in low kernel weight, especially in treatment 3C. Seedling vigour in treatments 3B and 3C, indicated by emergence percentage, leaf area and dry matter production, was low. Pod and kernel yields in these treatments were the lowest among all the treatments. These results emphasize the importance of seed quality in groundnut production (Sivasubramanian and Ramakrishna, 1974; Spain, 1976; Reddy, 1978).

The improved seed quality and field performance resulting from seeds with a history of early moisture stress has implications in water management strategies during groundnut seed production.

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