*J. agric. Sci., Camb.* (1984), **102**, 505–508
*With 3 text-figures*
*Printed in Great Britain*



# SHORT NOTE

# Effect of irrigation on reproductive efficiency of bunch and spreading types of groundnut (*Arachis hypogaea* L.)

BY V. S. BHATIA*, S. C. BHARGAVA† AND S. K. SINHA*

* *Water Technology Centre and † Plant Physiology Division, Indian Agricultural Research Institute, New Delhi*-110012, *India*

(*Revised MS. received* 23 *September* 1983)

Groundnuts are mostly grown during the rainy season (kharif) in India. Most of the cultivation is without irrigation. Consequently the crop experiences water deficits of different intensities and durations, depending upon the rainfall distribution. Yields are poor under such conditions. In other leguminous species irrigation at flowering usually improves yield, if the pod development period coincides with a break in rainfall or water deficit (Khanna-Chopra, Koundal & Sinha, 1980). Thus, an understanding of reproductive behaviour and reproductive efficiency could be helpful in adjusting planting to coincide with favourable agroclimatic conditions. Alternatively, this understanding could help in scheduling irrigation.

## MATERIALS AND METHODS

Groundnut (*Arachis hypogaea* L.) cvs J-11 and M-13, representing bunch and spreading types respectively, were planted on 3 July 1981 in the field. The plot size was 4 × 4 m, rows were 50 cm apart and there were three plants per metre of row length. Fertilizer (20 kg N, 40 kg P and 20 kg K/ha) was given at the time of sowing. There were three blocks of four plots each, and the plots were randomized to the four combinations of two varieties and two irrigation treatments. No irrigation was given till the plants started flowering. Subsequently, two plots in each block were irrigated during the 4th, 6th and 8th weeks after anthesis of the first flower. Data on rainfall and relative humidity were obtained from the Meteorology Laboratory of the Water Technology Centre.

A daily record of opened flowers was maintained to establish the frequency of flowering and the absolute number of flowers per plant. The number of pegs (gynophores) formed per plant was recorded bimonthly.

### *Pollen germination*

One of the factors responsible for the poor setting of pods could be sterility of pollen grains caused by water deficit. To study pollen germination, flowers were collected between 07.00 and 07.30 h from the irrigated and unirrigated plots. *In vitro* germination of pollen grains was studied in a medium containing 12·5% sucrose and 0·01% boric acid at 25 °C (Vasil, 1964). After 4 h of incubation, total and germinated pollen grains were counted under a microscope to calculate their germination percentage. The observations on pollen germination were made three times a week and the mean value of the three was taken as an average for the week.

## RESULTS

### *Flowering behaviour*

Flowering started 24 and 30 days after planting in J-11 and M-13 respectively. For the first 4 weeks there was no difference in the number of flowers per plant between the cultivars with or without irrigation. Between the 4th and 7th weeks fewer flowers were produced in both cultivars in unirrigated plants compared with irrigated plants. However, following rainfall during the 7th and 9th weeks, more flowers were produced in M-13 but few in J-11 under unirrigated than under irrigated treatment in the subsequent period (Figs 1*a* and 2*a*). The total number of flowers produced during the whole flowering period in J-11 were 392 and 346 under irrigated and unirrigated treatments, respectively. The corresponding numbers in M-13 were 406 and 407 respectively (Table 1). Thus, the total number of flowers produced during the whole flowering period was reduced by 12% in the unirrigated treatment in J-11. There was no difference in the total number of flowers in M-13 produced under irrigated and unirrigated conditions. Ac-

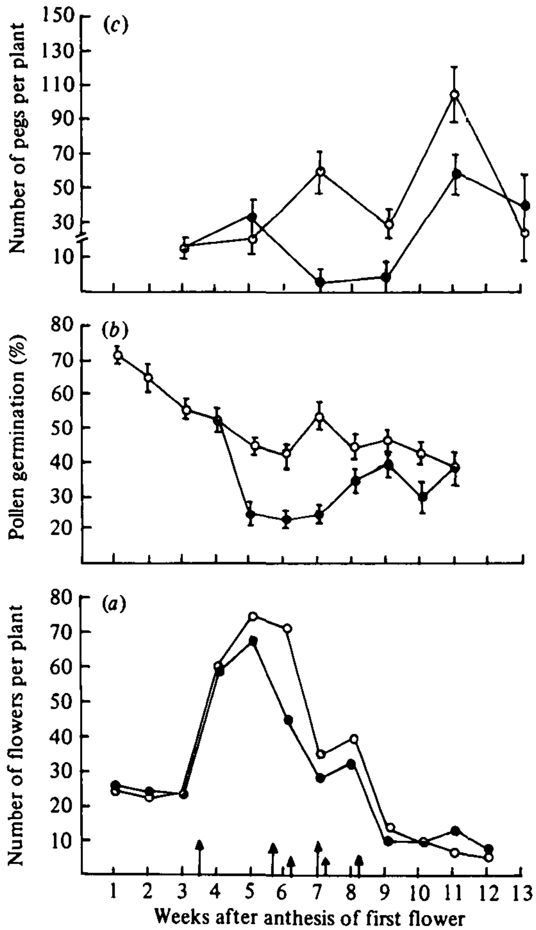


Fig. 1. Effect of irrigation on (*a*) number of flowers per plant (*b*) pollen germination percentage and (*c*) number of pegs per plant in *Arachis hypogaea* cv. J-11 (bunch type). ○, Irrigated; ●, unirrigated; ↑, irrigation; ↑, precipitation; ⧱, standard error of means.

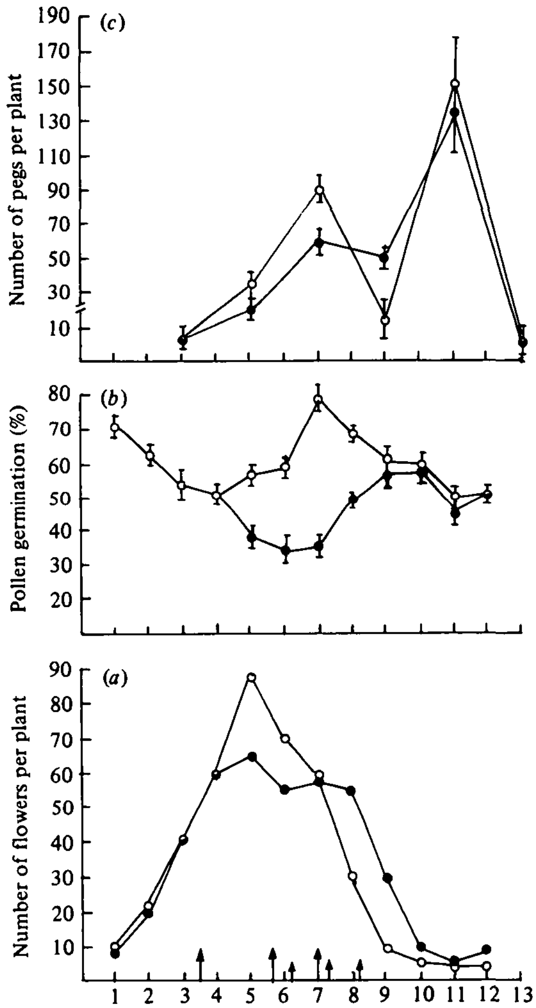


Fig. 2. Effect of irrigation on (*a*) number of flowers per plant (*b*) pollen germination percentage and (*c*) number of pegs per plant in *Arachis hypogaea* cv. M-13 (spreading type). ○, Irrigated; ●, unirrigated; ↑, irrigation; ↑, precipitation; ⧱, standard error of means.

Table 1. *Total number of pegs (pegs + pegs developed into pods) and total number of flowers formed per plant at maturity in* Arachis hypogaea *cv. J-11 (bunch type) and M-13 (spreading type) under irrigated and unirrigated conditions*

| | No. of flowers | No. of pegs |
|---|---|---|
| J-11 | | |
| Irrigated | 392 | 249 |
| Unirrigated | 346 | 158 |
| M-13 | | |
| Irrigated | 406 | 306 |
| Unirrigated | 407 | 277 |
| S.E. ± | 7·5 | 7·1 |

cordingly, M-13 had a greater capacity for withstanding drought effects and of compensation during revival due to rainfall.

*Peg formation*

Fertilized flowers produce pegs (gynophores) in this species. In J-11 and M-13, 64 and 75 % flowers formed pegs respectively, in the irrigated treatment but this percentage was reduced to 46 and 67 % respectively in these cultivars in the unirrigated treatment. Thus M-13 produced 14 and 61 more flowers per plant than J-11 with and without

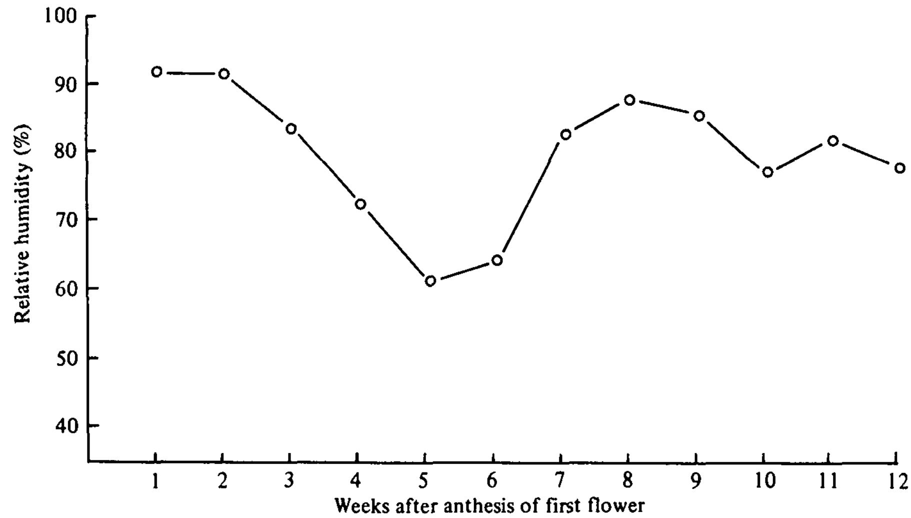


Fig. 3. Weekly relative humidity of the atmosphere.

irrigation, but it produced 57 and 119 more pegs per plant than J-11 with and without irrigation respectively (Table 1).

The weekly frequency of peg formation showed that they were visible about 2 weeks after opening of the first flower. In irrigated J-11 the first peak was observed in the 7th week and the second larger peak in the 11th week. However, in the unirrigated treatment there was a sharp decrease in peg formation between weeks 6 and 9. Subsequently, peg formation increased in the late-formed flowers. In the irrigated M-13 peg formation started 2 weeks after opening of the first flower and the first and second peaks were observed in the 7th and 11th weeks respectively. In the unirrigated treatments peg formation gradually increased and reached the peak by the 11th week (Figs 1*c* and 2*c*).

*Pollen germination*

Among the various factors responsible for poor peg formation, the failure of fertilization due to inadequate pollen germination could be important. The first-formed flowers had about 70% pollen germination but it declined gradually to 35% by 12 weeks after flowering in irrigated J-11. In the absence of irrigation, pollen germination was 25–35% between 5 and 9 weeks in this cultivar, when the atmospheric relative humidity was very low (Figs 1*b* and 3).

In M-13 pollen germination was also 70% in the first-formed flowers but decreased to 53% by week 4. However, with irrigation the pollen germination was 80% by week 7 but again declined to 50%. In the absence of irrigation, the pollen germination decreased to 35% between the 5th and 7th weeks but increased to 55% with a small amount of rain which came between the weeks 6 and 7 (Fig. 2*b*).

## DISCUSSION

It has been stated earlier that the cultivars J-11 and M-13 have erect (bunch) and spreading type habits respectively. The latter types are grown commonly in unirrigated areas because they perform better under such conditions, but the reasons for their better performance have not been described. The present study was an effort to understand their reproductive biology during the summer months when atmospheric stress can be combined with soil water deficit. The average relative humidity was 90% when the first flowers opened in both cultivars. The R.H. decreased to 60% by the 6th week from the date of flowering but it subsequently increased again to 80% owing to unexpected rainfall (Fig. 3).

It was observed that the peak of flowering occurred when the relative humidity was at its lowest point, between the 5th and 6th weeks (Figs 1*a*, 2*a* and 3). It should be noted, however, that with the decrease in atmospheric R.H., and increase in soil moisture deficit because of lack of irrigation, there was a gradual decline in the weekly number of flowers opening per plant in unirrigated conditions in both cultivars. However, the pollen germination was reasonably increased by irrigation from the 5th to 8th weeks for J-11 and M-13, and this could account for an increased number of pegs in the irrigated J-11. Irrigation had little effect on M-13.

Two points need attention in this study. First, the number of pegs formed is much less than the number of flowers although differences in the two cultivars were observed. In groundnut, flowers do not drop according to Smith (1950, 1954), unlike many other legumes, where it is a common phenomenon (Sinha, 1977). From our studies, it is clear that the flowers which do not develop pegs either drop or shrivel, which amounts to the same thing. Secondly, M-13, which is a spreading type, had better pollen germination and peg formation even under unirrigated conditions. If the soil moisture deficits are the cause of poor pollen germination, then it is clear that M-13 is better adapted to such conditions. The spreading habit could provide advantage in this respect by creating a micro-environment around the flower buds and flowers, which do not allow the R.H. to drop below a certain threshold value, for pollen germination. The alternative could be a greater tolerance of pollen grains to germinate at lower R.H. and water deficit. Recent studies by Morgan (1980) and Saini & Aspinall (1981) are suggestive of the mechanism through which pollen grains could lose their viability. This would require further investigation.

## REFERENCES

KHANNA-CHOPRA, R., KOUNDAL, K. R. & SINHA, S. K. (1980). Response of pigeon peas to water availability. *Proceedings of Legumes in Tropics*, pp. 227–230. Faculty of Agriculture, Universiti Pertanian, Malaysia.

MORGAN, J. M. (1980). Possible role of abscisic acid in reducing seed set in water stressed wheat plants. *Nature* **285**, 655–657.

SAINI, H. S. & ASPINALL, D. (1981). Effect of water deficit on sporogenesis in wheat (*Triticum aestivum*). *Annals of Botany* **48**, 623–633.

SINHA, S. K. (1977). Flowering behaviour and yield. In *Food Legumes – Distribution, Adaptability and Biology of Yield*, pp. 41–60. FAO Plant Production and Protection Paper No. 3.

SMITH, B. W. (1950). *Arachis hypogaea* – aerial flowers and subterranean fruits. *American Journal of Botany* **37**, 802–814.

SMITH, B. W. (1954). *Arachis hypogaea*. Reproductive efficiency. *American Journal of Botany* **41**, 807–816.

VASIL, I. K. (1964). Effect of boron on pollen germination and pollen tube growth. In *Pollen Physiology and Fertilization* (ed. H. F. Linskens), pp. 107–119. North Holland.