

## Effect of water stress on germination and seedling growth of three vegetable pea (*Pisum sativum* L.) varieties

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Three pea varieties—Arkel, Pant Uphar and Azad Pea 1 — were tested for germination percentage, seedling growth and changes in total lipid content of roots under different moisture conditions. Germination was highest (98%) in Azad Pea 1 after eight days of incubation at  $24\pm 1^\circ\text{C}$ , while only 48% and 50% germination was achieved in Arkel and Pant Uphar respectively. Although there was no significant difference in germination percentages between seeds germinating at 0 and  $-3.0$  bar water potential, higher water stress drastically reduced germination in all three varieties. Average root and shoot lengths and total lipid content of roots of eight-day-old seedlings decreased in all three varieties. However, total lipid content remained higher in Azad Pea 1. The results suggest that lipid content of roots may be positively correlated with per cent germination.

SEED germination phase of plants is critical for raising a successful crop as it determines the crop stand density and consequently the yield of resultant crop, especially when germinating seeds are subjected to moisture stress in soil. Although voluminous literature is available about the germination behaviour of certain crops and biochemical changes associated with germination under moisture stress, little is known about some promising varieties of vegetable pea. The present investigation was therefore undertaken to study germination percentage, seedling growth and changes in total lipid content of roots under different moisture stress conditions.

The experiments were conducted on three promising pea (*Pisum sativum* L.) varieties—Arkel, Pant Uphar and Azad Pea 1 — between 5 November and 28 December 1987 under laboratory conditions. Osmoticum solutions of  $-3.0$ ,  $-5.0$ ,  $-7.5$  and  $-10.0$  bar water potentials were prepared separately by dissolving 11.5, 19.4, 23.5 and 28.9 g of polyethylene glycol '6000' respectively, in 100 ml of distilled water<sup>1</sup>. Seeds were surface-sterilized for five min in 0.1% mercuric chloride solution, placed in sterilized 9 cm diameter glass petri dishes lined with Whatman No. 2 filter paper moistened regularly with water or PEG solution during dark incubation at  $24\pm 1^\circ\text{C}$ .

Radicle protrusion (2 mm) was the criterion used for germination, and cumulative percentages of seed germination were determined for each treatment. Seedling growth (shoot and root length) was measured after eight days of incubation (a stage at which 98% germination in one variety, Azad Pea 1, was recorded in control, i.e.  $-0$  bar water potential) at  $24\pm 1^\circ\text{C}$  in different treatment solutions. Total lipids

were extracted from roots<sup>2</sup> of eight-day-old seedlings of the three varieties incubated under different water potentials and estimated gravimetrically. The experiments were repeated thrice and data subjected to statistical analysis.

Germination of seeds of Azad Pea 1 was maximum (98%) after eight days of incubation at  $24\pm 1^\circ\text{C}$  in control while only 48% and 50% germination was achieved in Arkel and Pant Uphar, respectively, (Figure 1). Although there was no significant difference in germination percentages at 0 and  $-3.0$  bar, higher water stress ( $-5.0$ ,  $-7.5$  and  $-10.0$  bar) drastically cut down the germination percentage of all the three varieties. While at  $-5.0$  bar 40% and 38% germination could be achieved in Azad Pea 1 and Pant Uphar respectively, only 10% germination could be achieved in Arkel. Further, at  $-7.5$  and  $-10.0$  bar no germination response was recorded in Arkel, and only 15% and 10% in Pant Uphar, and 17% and 0% in Azad Pea 1. The decrease in germination percentage under moisture stress conditions has also been reported in maize composites<sup>3</sup> and wheat hybrids<sup>4</sup>.

With decrease in water potential, average root and shoot lengths retarded in all the three varieties (Table 1). However,

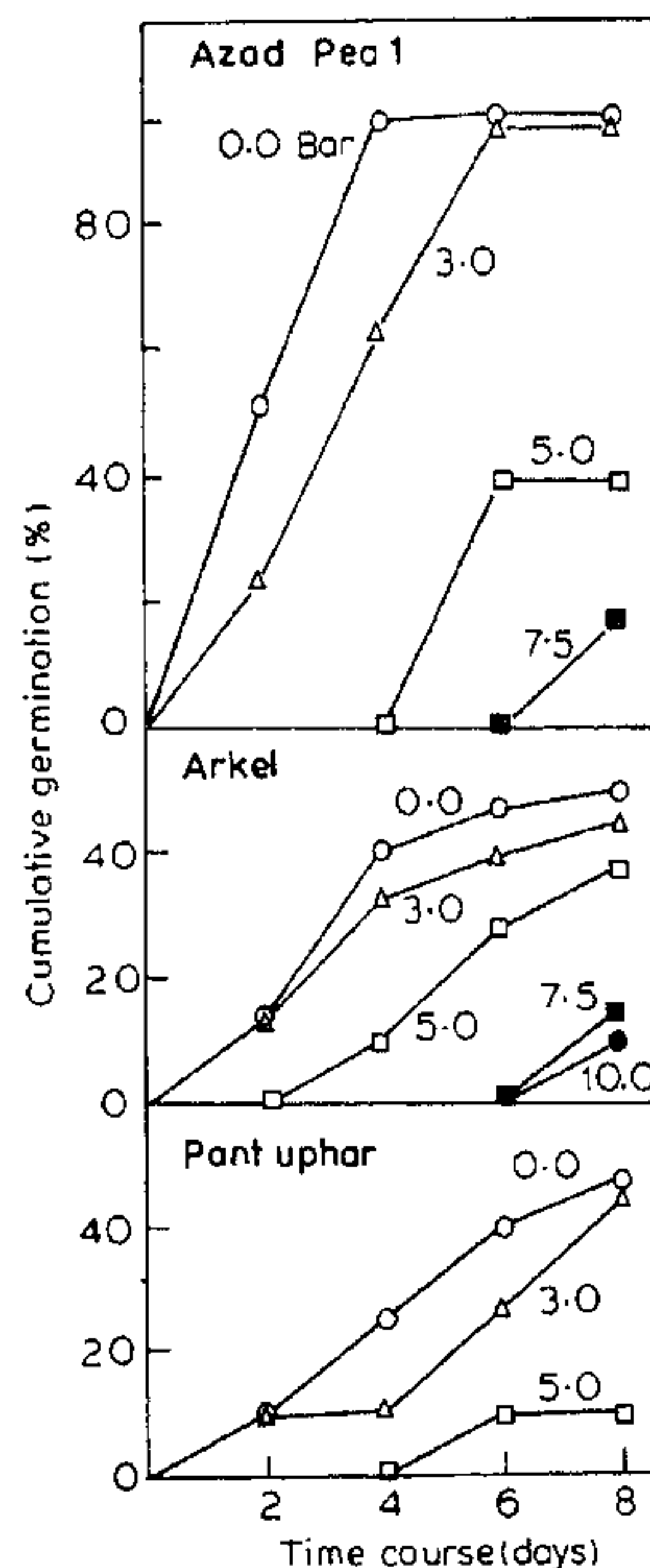


Figure 1. Germination percentage of seeds of pea (*Pisum sativum* L.) varieties Azad Pea 1, Arkel and Pant Uphar at different external water potentials. Dark incubation was at  $24\pm 1^\circ\text{C}$ . Mean  $\pm$  SE of 4 replications, each of 25 seeds.

## RESEARCH COMMUNICATIONS

**Table 1.** Changes in shoot and root lengths of 8-day-old seedlings of pea (*Pisum sativum* L.) varieties under different external water potentials. Dark incubation was at  $24\pm 1^\circ\text{C}$ .

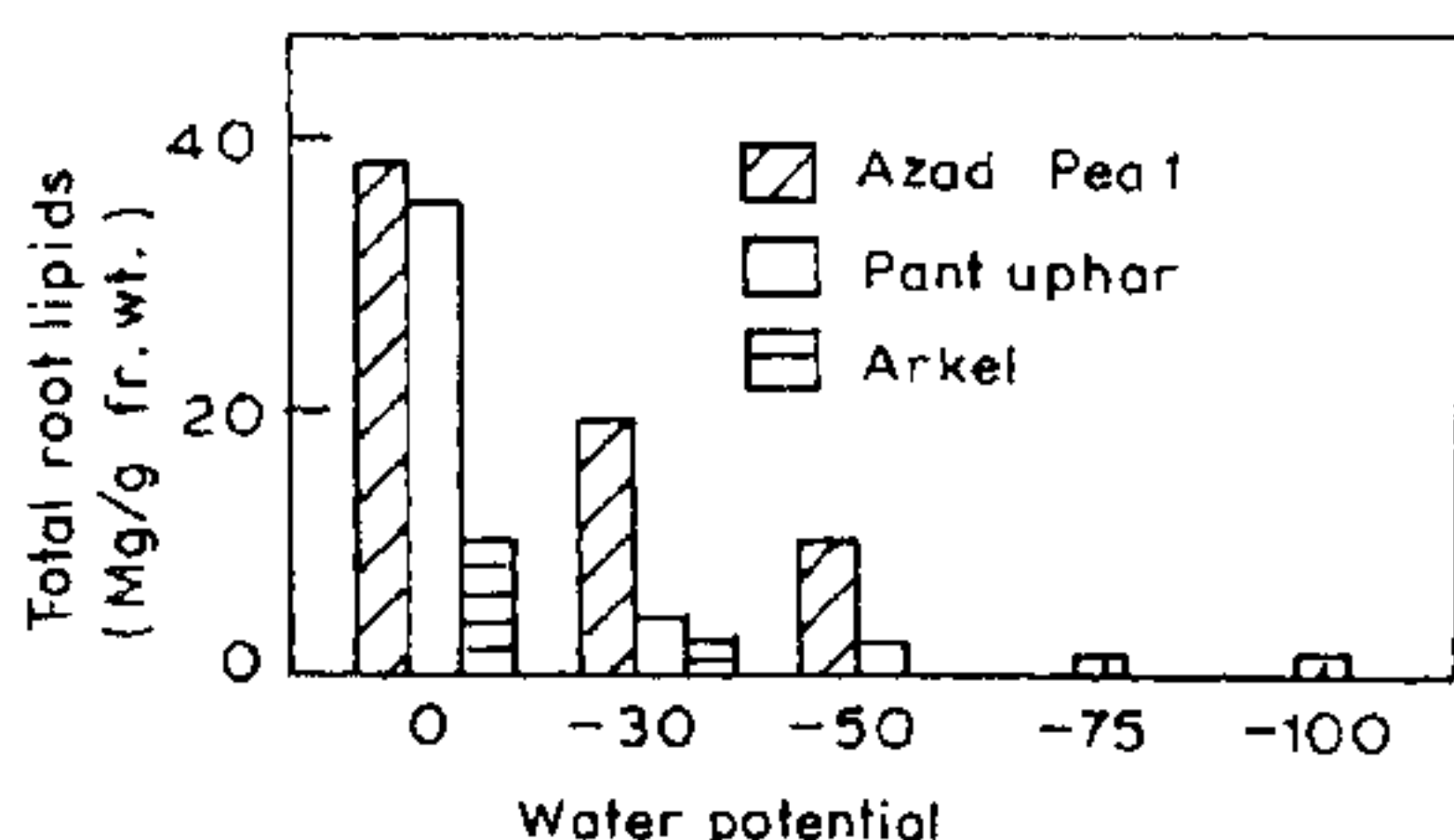
Water potential (bar)	Av. shoot length (cm)			Av. root length (cm)			Root/shoot ratio		
	Arkel	Azad Pea 1	Pant Uphar	Arkel	Azad Pea 1	Pant Uphar	Arkel	Azad Pea 1	Pant Uphar
(Control)	1.00	3.90	2.30	1.60	8.60	3.10	1.60	2.21	1.35
-3.0	0.60	2.00	1.23	1.60	3.80	1.74	2.66	1.90	1.41
-5.0	0.30	0.60	0.54	0.90	2.50	1.70	3.00	4.15	3.15
-7.5	—	0.40	0.52	—	2.20	1.60	—	5.50	3.07
-10.0	—	—	0.50	—	—	1.50	—	—	3.00

— No germination.

L.S.D. (at 5% level of significance) = 1.08.

at  $-3.0$  and  $-5.0$  bar, average root and shoot lengths were higher in Azad Pea 1 followed by Pant Uphar and Arkel while at  $-7.5$  bar average shoot length was higher in Pant Uphar and average root length was higher in Azad Pea 1. Restricted water availability of over  $-3.5$  bar has been reported to result in shorter and thinner pea roots<sup>5</sup>. Retardation in growth (shoot and root lengths) in response to increasing moisture stress has also been reported in maize composites<sup>3</sup> and wheat hybrids<sup>4</sup>. Data on root : shoot ratio (Table 1) revealed that in all the three varieties it increased with decreasing water potential. Growth of roots is reported to be less affected by water shortage than that of aerial parts<sup>6</sup>.

There was marked reduction in total lipid content of roots of eight-day-old seedlings of all the three varieties (Figure 2) with decrease in water potential. However, total lipid content at decreasing water potentials remained higher in Azad Pea 1 followed by Pant Uphar and Arkel and this pattern closely followed the germination pattern of these varieties at decreasing water potentials. More reduction in membrane phospholipids is reported in drought-sensitive varieties than that of drought-resistant varieties<sup>7</sup>. The present results (Figures 1 and 2) revealed that the variety (Azad Pea 1) exhibiting higher total lipid content of roots at decreasing water potentials showed higher germination percentage and seedling growth and *vice versa*. Higher lipid content of roots of Azad Pea 1 even at increasing water stress conditions appears to be significant in



**Figure 2.** Total lipid content of roots of 8-day-old seedlings of varieties Azad Pea 1, Arkel and Pant Uphar or pea (*Pisum sativum* L.) after dark incubation at  $24\pm 1^\circ\text{C}$  in different water potentials.

maintaining the membrane integrity of roots and providing energy to carry out essential metabolic processes during germination. Further, the sharp decrease in total lipid content of roots under water stress conditions may either be due to its degradation during germination<sup>8</sup> or lack of *de novo* synthesis.

The results thus, suggest that such studies on the evaluation of drought-resistant character should be extended to other crops as well with the use of polyethylene glycol '6000'. Knowledge of the critical water potential that prevents seed germination and retards seedling growth of a particular crop/variety is valuable for agricultural workers.

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## A new hybrid between *Aegilops* and *Secale*

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Without employing embryo culture techniques, intergeneric hybrids between *Aegilops bicornis* and tetraploid rye (*Secale cereale*) were produced. The hybrid plants were completely male sterile with dominant rye characters. Preponderance of univalents at metaphase-I indicated lack of homology between the chromosome complements of the parental species.

WITHOUT using embryo rescue and culture techniques, an intergeneric hybrid between *Aegilops bicornis* (Forsk.) Jaub