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Osmoconditioning of Seeds in Relation to Growth and Fruit Yield of Aubergine, Pepper, Cucumber and Melon in Unheated Greenhouse Cultivation

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ABSTRACT

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Seeds of aubergine, pepper, cucumber and melon were osmotically conditioned in mannitol solutions and dried back to their original weight prior to sowing. Seedling emergence and initial growth, yield, fruit quality (grade) and mean fruit weight were recorded throughout the cultivation. Osmoconditioning promoted early emergence of the seedlings in all cases and, with the exception of cucumber cultivar 'Sandra', encouraged more rapid growth of the plant for at least 1 month after emergence. There was no effect of treatment on the total yield of any crop, and where differences in early yield occurred these were generally not statistically significant. There was no significant difference in fruit quality (grade) or size between treatments except for melons, where fruits from osmoconditioned seed were smaller than the controls. It is concluded that the application of osmoconditioning of seeds to commercial production is limited to its effects on germination and early growth alone.

Keywords: aubergine; cucumber; emergence; melon; osmoconditioning; pepper; seedling; yield.

INTRODUCTION

Osmoconditioning (priming) of seeds has been demonstrated to bring about more rapid and uniform germination (Heydecker et al., 1973; Heydecker and Coolbear, 1977; Georghiou et al., 1982; Brocklehurst and Dearman, 1983).

Although the effect of osmoconditioning on germination is thus well-established, its effects on maturity and yield are less certain. Brocklehurst et al.

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(1984) showed that leek (*Allium porrum* L.) plants from osmoconditioned seeds had a significantly higher mean weight than plants from untreated seeds over a 10-week growth period. Early maturity and increased yields as a result of pregermination or osmoconditioning treatments have also been reported for onion and carrot (Lipe and Skinner, 1979; Szafirowska et al., 1981). In each of these crops it is the vegetative organs that are harvested. By contrast, Alvarado et al. (1987) showed that although osmoconditioned seeds of processing tomatoes (*Lycopersicon esculentum* Mill.) germinated faster and the seedlings maintained a greater plant dry weight, leaf area and ground cover than the untreated controls throughout the pre-flowering period, there was no improvement in earliness, total yield or soluble contents of the fruit. Effects of osmoconditioning on the yield of soybean (*Glycine max* (L) Merr.) were inconclusive (Helsel et al., 1986).

Since the effects of osmoconditioning are more evident at low temperatures (O'Sullivan and Bouw, 1984; Bradford, 1986), we have examined its possible applications to out-of-season vegetable crops cultivated in unheated greenhouses. The crops studied were: aubergine (*Solanum melongena* L.), pepper (*Capsicum annuum* L.), cucumber (*Cucumis sativus* L.) and melon (*Cucumis melo* L.).

MATERIALS AND METHODS

Samples of seed were obtained from commercial sources in 1982 (cucumber and melon) and 1983 (aubergine and pepper). The cultivars were: cucumber, 'Sandra' and 'Farbiola'; aubergine, 'Black King' and 'XP-966'; melon, 'Galia' and 'Roundpack'; pepper, 'Video' and '24-210'. Seeds from the same seed lots were used in both trials, seed lots being stored in sealed packets in the dark at ambient room temperature between trials.

Osmoconditioning was carried out for 6 days (aubergine and pepper) and 3 days (cucumber and melon), 1 month prior to sowing. Samples of 100 seeds (aubergine and pepper) and 50 seeds (cucumber and melon) were imbibed under darkness at 25 °C in mannitol solutions: 0.5 M (Ψs 1.24 MPa) for the former and 0.6 M (Ψs 1.49 MPa) for the latter. These were the optimum osmoconditioning treatments as defined by preliminary germination tests at 15 and 25 °C. Osmoconditioned seeds were washed twice in deionized water and air-dried for 48 h to their original weight in a dark room maintained at 25 °C. Untreated seeds were used as controls.

Two trials were undertaken, the dates of sowing being: Trial 1, 4 January 1984 (aubergine and pepper), 4 February 1983 (cucumber and melon); Trial 2, 13 January 1984 (cucumber and melon), 16 and 17 January 1985 (aubergine and pepper), respectively. Seeds were sown either singly in 8-cm diameter peat pots containing a peat–soil (2:1 by volume) compost (melons and cucumbers) or in trays of the same compost (aubergine and peppers), covered with black plastic and placed in a greenhouse. Minimal night heating was provided during

germination, and temperatures varied between 5 and 23 °C. Germination was monitored every 1–2 days and the pots and trays uncovered once seedlings had emerged.

When seedlings of aubergines and peppers had reached a suitable handling stage, they were transplanted to peat pots using the same compost mix. Transfer to the growing houses occurred when the roots of approximately 10% of the total plants, irrespective of treatment, had appeared through the walls of the pots. This was approximately 1 month (cucumber and melon) or 2 months (aubergine and pepper) after sowing. Growing-houses were unheated, polyethylene-covered units of 500 m^2. Four replicates of 20 plants each (cucumber) or

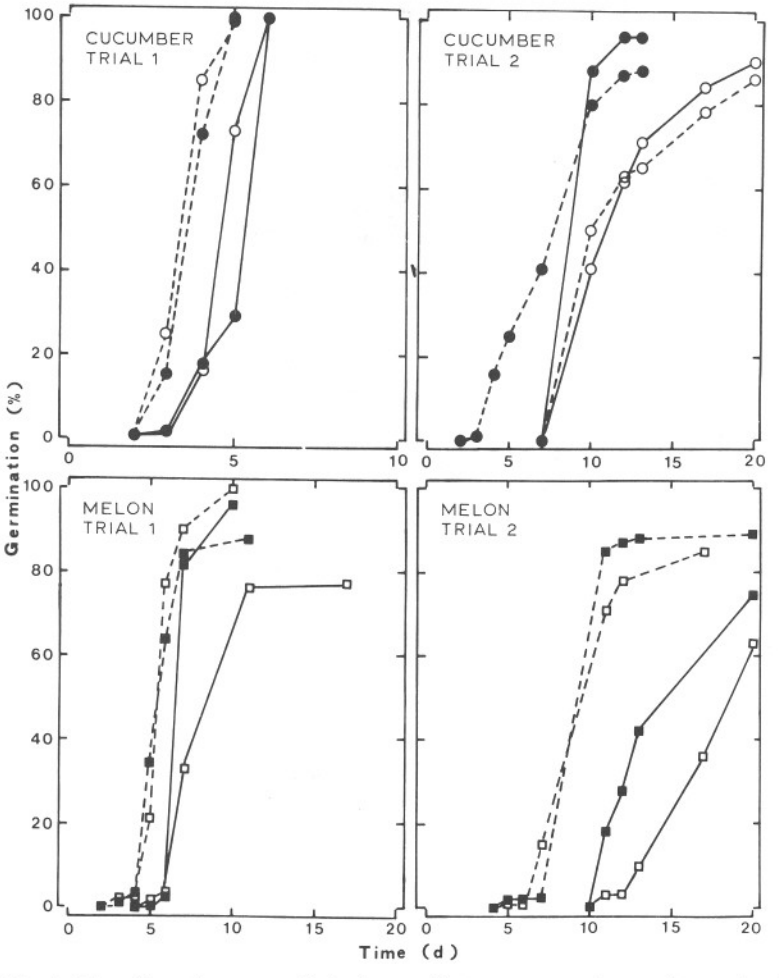

Fig. 1. The effect of osmoconditioning on the emergence of cucumber and melon seedlings. ○, 'Farbiola'; ●, 'Sandra' (cucumbers); □, 'Galia', ■, 'Roundpack' (melons); solid lines, untreated seed; broken lines, osmoconditioned seed.

12 plants each (other crops) were cultivated in border soil at a plant density of 1.6 m^{-2}. Conventional methods of irrigation, fertilizer application, pest and disease control were used. Crops were trained on 1 (melons and cucumbers), 2 (aubergines) or 3 (peppers) cordons. Harvesting was carried out on a weekly basis (aubergines and peppers) or twice weekly (cucumbers and melons). The duration of the cultivations was 7–8 weeks (melons), 13 weeks (cucumber), 5 months (pepper, Trial 1) and 7 months (aubergines, pepper, Trial 2) after the onset of harvesting. Because of the close similarity of yield in each trial, for simplicity the yield data for each cultivar were combined. For statistical comparisons the LSDs were determined.

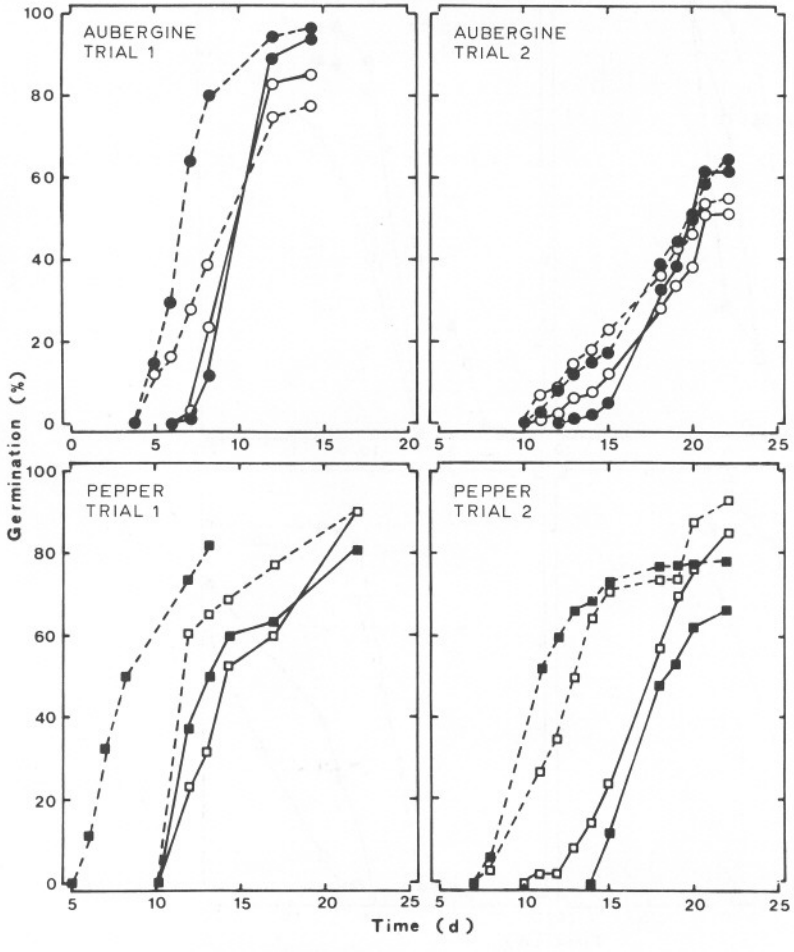

Fig. 2. The effect of osmoconditioning on the emergence of aubergine and pepper seedlings. ○, 'Black King', ●, 'XP-966' (aubergines); □, 'Video', ■, '24-210' (peppers); solid lines, untreated seed; broken lines, osmoconditioned seed.

RESULTS

The time courses of seedling emergence are given in Figs. 1 and 2. For each cultivar the emergence was earlier in the case of osmotically treated seed than in the untreated controls. In the first year's trials, there was a difference of 1–3 days in the time to reach 50% emergence between treated and untreated samples, with the exception of pepper '24-210' where the difference was 6 days. In general, there was no, or little, difference in final percentage of emergence between treatments. In the second year's trials, the rates of emergence in all cases were lower and, with the exception of the pepper cultivars, the final percentage was reduced. The reduction in the rate of emergence was more pronounced in untreated than in treated seed, with the exception of aubergines where, during the second year's trial, rates of emergence and total emergence of both treated and untreated seed lots were low.

The earlier emergence of osmoconditioned seed was reflected also in the

TABLE 1

Effect of osmoconditioning treatment on height of plant at the planting stage for cucumber and melon (1 month after sowing) and aubergine and pepper (2 months after sowing)

Crop and cultivar	Treated	Height of plant (cm)	
		Trial 1	Trial 2
Aubergine			
'Black King'	–	5.8	2.5
	+	6.6	3.4
'XP-966'	–	8.9	2.0
	+	9.8	2.7
Pepper			
'Video'	–	12.2	9.1
	+	14.4	11.3
'24-210'	–	7.6*	8.1
	+	11.9*	8.9
Cucumber			
'Sandra'	–	nd[a]	9.9
	+	nd	9.4
'Farbiola'	–	nd	3.4
	+	nd	5.6
Melon			
'Galia'	–	nd	10.6*
	+	nd	25.9*
'Roundpack'	–	nd	5.5*
	+	nd	10.6*

*Significant difference in height between treatments ($P=0.05$).
[a]nd = not determined.

initial stages of growth of the seedlings. As shown in Table 1, the height of plants from untreated seed at the time of planting in the greenhouse was less than that of plants from treated seed. The only exception was cucumber 'Sandra' in Trial 2, the final percentage emergence of which (see Fig. 1) was also lower in treated than untreated seed. However, apart from the melons 'Galia' and 'Roundpack' and pepper '24-210' (Trial 1), the differences in plant height were not significant.

There was no significant difference in weekly or total yields of cucumbers in either trial, and the time from sowing until the first harvest was the same for both treated and untreated seed lots (Fig. 3). Similarly, no significant differ-

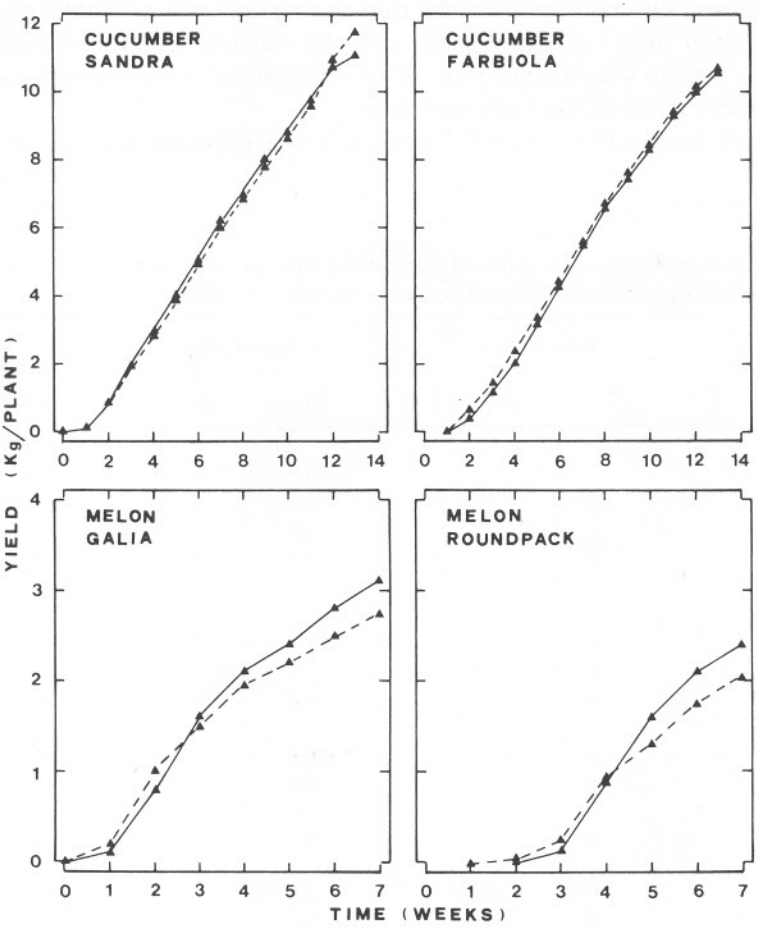

Fig. 3. The effect of osmoconditioning of seeds of cucumber and melon on the subsequent weekly yield of the crops. The dates of first harvest were 10 June 1983 (Trial 1) and 28 May 1984 (Trial 2) for melon and 22 April 1983 (Trial 1) and 11 April 1984 (Trial 2) for cucumber. Solid lines, untreated seed; broken lines, osmoconditioned seed.

ences in weekly or total yields were seen between plants of treated and untreated seed of the melon 'Galia' (Fig. 3). Although the total yields per plant of the melon 'Roundpack' were not significantly different, some plants from the osmoconditioned treatments did come into harvest 1–2 weeks earlier than those of untreated lots.

In the case of aubergines, no differences in yield were observed throughout the duration of harvest (Fig. 4). Where differences in yield were observed in peppers they were small and not of statistical significance (Fig. 4).

Tables 2 and 3 present a summary of the early and total yields of all the crops in kg m^{-2} together with the mean fruit grade (as employed in marketing) and mean fruit weight. Differences in early and total yields between treatments were generally small and without statistical significance. Neither was there

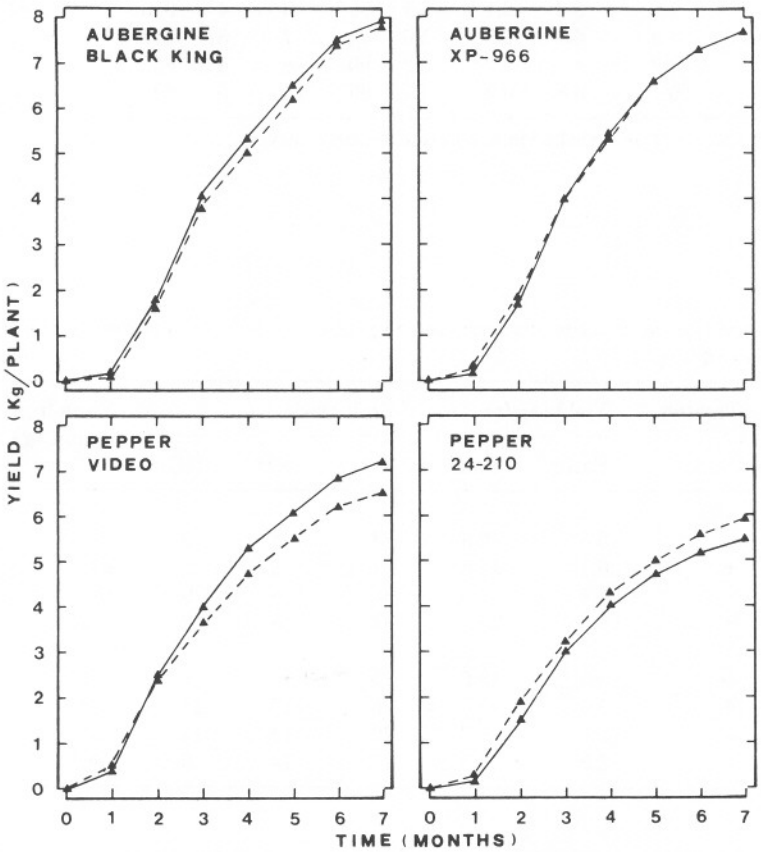

Fig. 4. The effect of osmoconditioning of seeds of aubergine and pepper on the subsequent monthly yield of the crops. The dates of first harvest were 14 May 1984 (Trial 1) and 17 May 1985 (Trial 2) for pepper and 25 May 1984 (Trial 1) and 30 May 1985 (Trial 2) for aubergine. Solid lines, untreated seed; broken lines, osmoconditioned seed.

TABLE 2

The effect of osmoconditioning of seeds of cucumber and melon on the early and total yields of the crops, fruit grade and weight

Crop and cultivar	Treated	Yield ($kg\ m^{-2}$)		Yield ($fruit\ m^{-2}$)		Fruit grade			Fruit weight (g)	
		Early[a]	Total	Early[a]	Total	%A	%B	%C	Early[a]	Total
Cucumber										
'Sandra'	–	4.7	17.6	12.5	41.2	77	16	7	373	429
	+	4.4	17.3	11.8	40.1	78	15	7	372	432
'Farbiola'	–	3.4	16.7	9.4	42.6	69	20	11	357	394
	+	3.9	16.9	10.7	42.5	70	18	12	365	399
Melon										
'Galia'	–	1.8	5.6	2.1	5.1	90	6	4	915	1183
	+	1.9	4.9	2.5	5.0	88	7	5	818	1046
'Roundpack'	–	0.2	4.5	0.2	5.2	90	6	4	838	863
	+	0.1	3.6	0.2	5.1	85	10	5	690	828

[a]Yield for 4 weeks (cucumber) or 2 weeks (melon) after the first harvest.

TABLE 3

The effect of osmoconditioning of seeds of aubergine and pepper on the early and total yields of the crops, fruit grade and weight

Crop and cultivar	Treated	Yield (kg/m^{-2})		Fruit grade			Mean fruit weight (g)
		Early	Total	%A	%B	%C	
Aubergine							
'Black King'	–	6.5	12.6	83	8	9	253
	+	6.1	12.5	84	8	8	260
'XP-966'	–	6.4	12.3	83	8	9	154
	+	6.3	12.4	84	8	8	155
Pepper							
'Video'	–	3.5	10.6	75	14	11	71
	+	3.5	9.5	76	13	11	72
'24-210'	–	2.4	8.2	72	14	14	25
	+	2.9	8.8	77	14	9	26

any significant difference in fruit quality as indicated by the grade. The mean fruit weights of melon 'Galia' and 'Roundpack' were lower for treated than for untreated seed, but in the cases of the other cultivars there was essentially no difference in fruit weight.

DISCUSSION

Osmoconditioning of aubergine, pepper, cucumber and melon seeds resulted in promotion of the rate of seedling emergence in all cases. This result agrees with previous studies of the effects of osmoconditioning (priming) on seed germination (Heydecker et al., 1973; Heydecker and Coolbear, 1977). Promotion of the rate of seedling emergence was more evident in the second trial using 2-year-old seeds, indicating that effects of osmoconditioning were greater in aged seed. Similar observations on the promotion of germination of aged seeds of *Brassica oleracea* var *gemmifera* (Burgass and Powell, 1984) were interpreted as evidence for the repair of deterioration incurred during ageing, repair being promoted by hydration processes such as those induced by osmoconditioning.

It was reported for leeks that 10 weeks after sowing the fresh weight of plants from osmoconditioned seed was higher than those from untreated seed (Brocklehurst et al., 1984). In the present experiments, the promotive effect of osmoconditioning also persisted for several weeks after emergence. At the time of transfer to the growing houses, plants from osmoconditioned seed were taller than the controls (Table 1), and this difference in height was generally maintained for at least a further month. Since root growth per se was not measured, it is not certain whether there was a parallel effect of osmoconditioning on root growth also.

However, the promotive effect of osmoconditioning was virtually lost by maturity and, apart from small differences in early yield (melon 'Roundpack' and pepper '24-210', second trial) and fruit size (melons 'Galia' and 'Roundpack'), there was no influence on the harvest parameters measured. Thus, similar to the results of Alvarado et al. (1987), it would appear that in fruit-bearing crops such as tomato and the crops tested here, the promotional effect of osmoconditioning are limited to the stages of germination, emergence and early growth. Unlike the leafy crops such as leek and onion (Brocklehurst and Dearman, 1983; Lipe and Skinner, 1979) or root-yielding crops such as carrot (Szafirowska et al., 1981), there is no practical effect on earliness or yield.

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