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The Effect of Salt Priming on the Performance of Differentially Matured Cucumber (*Cucumis sativus*) Seeds

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Abstract

The influence of salt priming (3% KNO_3 for 3 days and 1% NaCl for 2 days at 20°C) on germination, seedling emergence and seedling dry weight of two Iranian cucumber cultivars of Basmenj and Varamin harvested at 25, 35 and 45 days after anthesis (DAA) was investigated in an unheated glasshouse. Seed germination and seedling emergence and growth were significantly affected by seed maturity and priming. Maximum advantage of priming seedling vigour was observed in seeds harvested at 25 DAA. Smaller effects of priming were also seen in the decreased mean germination and emergence times and increased seedling dry weight of seeds harvested at 35 and 45 DAA. Priming reduced percentage of seeds that germinated, but failed to emerge. In all cases, KNO_3 priming was more effective than NaCl priming. Therefore, KNO_3 priming can be used to improve cucumber seedling emergence and establishment, particularly in early spring sowings at low temperatures.

Keywords: cucumber, emergence, germination, salt priming, seed maturity

Introduction

Optimum seed germination and seedling growth in cucumber occur at 20-25°C. Poor seed germination is a common phenomenon at sub-optimal temperatures which causes a great concern for growers that grow this crop at early spring in cool regions of Iran. Delayed and reduced germination and seedling emergence cause non-uniform stand establishment and tender seedling subjected to soil-borne pathogens for long time. Seed maturation stage is an influential factor on germination performance in response to priming (Olouch and Welbaum, 1986; Demir and Ozokat, 2003). In general, mature seeds tend to show better germination than those of earlier and later harvests, while advancement obtained by priming is greater in earlier harvests (premature seeds). Priming is also a valuable process for improving germination and uniformity of heterogeneously matured seed lots (Olouch and Welbaum, 1986).

The three early phases of seed germination are: (1) imbibition, (2) lag phase, and (3) protrusion of radicle through the testa (Simon, 1984). Priming is a procedure that partially hydrates seed, followed by drying of seed, so that germination processes begin, but radicle emergence does not occur. The ability of the seed to germinate in the laboratory at low temperatures is not necessarily associated with the ability of the seedling to grow at low temperatures in glasshouse or field conditions (Kemp, 1968). Therefore, in this work we investigate the effect of salt priming on cucumber seedling emergence and growth in an unheated glasshouse, using seed lots from two different cultivars harvested at different stages of maturity.

Materials and methods

Seeds of two Iranian Cucumber (*Cucumis sativus*) cultivars (Basmenj and Varamin) were grown between June and September at the Research Farm of the Faculty of Agriculture, University of Tabriz, Iran. Plant spacing was 150cm between and 40cm within rows. Regular plant cultivation practices were conducted throughout the developmental period. 15 female flowers were tagged at anthesis. Five fruits per harvest were picked at 25, 35 and 45 days after anthesis (DAA). The seeds were removed from the fruit by fermentation procedure, and washed in water and dried on mesh trays in the dark for 2 days at 25°C and 35% RH. Seed moisture content was determined by the high-temperature oven method (130°C for an hour) (ISTA, 1996) to determine whether it had fallen to less than 8% prior to storage. Two sub samples of seeds (4 g each) of each harvest were primed on top of filter papers moistened with 18 ml of 3% KNO_3 or 18 ml of 1% NaCl and kept at 20°C for 2 days in the dark in 9 cm Petri dishes (Bradford, 1985).

During the priming treatment, dishes were covered with plastic film to prevent loss of liquid. At the end of the treatment, seeds were washed under tap water and dried to the original moisture content (8–9%) on top of filter papers in the laboratory (20 ± 2 °C and 45–55% RH) for 2 days. Subsequently, normal seed germination test was

Table 1 Effects of harvest time and salt priming on seed germination, seedling emergence and shoot dry weight in cucumber

Traits / Treatments		Seed Germination (%)	Mean Germination Time(days)	Seedling Emergence (%)	Mean Emergence Time(days)	Seedling Shoot Dry Weight(mg)	Abnormal Seedling (%)
Harvest Time	25 DAA	47.1c	4.2 a	39.0 c	7.6 a	23.6 c	14.0 a
	35 DAA	64.3b	2.9 b	59.9 b	5.1 b	32.6 b c	3.9 b
	45DAA	87.2 a	1.7 b	84.8 a	3.0 c	40.3 a	1.9 b
Priming	Unprimed	61.4 b	5.1 a	50.3 b	6.8 a	22.0 b	12.0 a
	NaCl	66.6 a b	3.1 b	62.2 a	5.3 a b	32.0 a	4.3 b
	KNO_3	70.0 a	2.2 b	66.0 a	4.0 b	36.0 a	3.0 b

Different letters indicating significant difference at p≤ 0.01 DAA (Days After Anthesis)

carried out at Seed Technology Laboratory of Faculty of Agriculture, Tabriz University, Iran. Then three replicates of 50 seeds of primed and control seeds of both cultivars were sown 2cm deep in perlite in trays (32 cm × 22 cm×6 cm) on 12 April 2003 in an unheated glasshouse. Daily minimum and maximum air temperatures were recorded during the test. Maximum temperatures ranged from 20 to 35˚C, whereas minimum temperatures ranged from 8 to 12° C. Seedling emergence was counted daily for 14 days with seeds recorded as emerged when the hypocotyls appeared on or above the surface of peat moss. Mean emergence time (MET) was calculated according to Ellis and Roberts, (1980). Seedlings were counted, and shoot dry weight (mg/seedling) was determined after 18 days. Finally, those seeds that germinated, but were failed to emerge through the peat moss surface were counted.

The experimental design for the greenhouse experiment was factorial split-plot, based on randomized complete block design with three replicates. Percentage data were arcsine-transformed before analysis. All the data were subjected to an analysis of variance, using MSTATC software.

Results and discussion

Seed germination

Effects of cultivar on germination percentage and mean germination time were not significant, but effects of seed maturity, priming and interaction of priming × seed maturity on these traits were significant. Final germination percentages of seeds harvested at 25 DAA were significantly lower than seeds harvested at 35 and 45 DAA in both cultivars (Table 1). The highest germination percentage was achieved at 45 DAA. Maximum and significant (P≤0.01) advancement from priming was obtained in seeds of 25 DAA, improving seed germination from 38.3% to 49.7% and 53% in seeds primed with NaCl and KNO_3, respectively (Table 2). MGT decreased as seed maturation increased. Although Priming decreased MGT of all harvested seeds from both cultivars, but effects of KNO_3 priming were more than those of NaCl priming (Table 2).

Table 2 Interaction of harvest time and salt priming on seed germination, seedling emergence and shoot dry weight in cucumber

Harvest Time	Seed Priming	Seed Germination (%)	Mean Germination time(days)	Seedling Emergence (%)	Mean Emergence Time(days)	Shoot Dry Weight (mg)	Abnormal Seedling (%)
25 DAA	Unprimed	38.3e	6.4 a	27.5 e	9.0 a	19.0 g	15.3 a
	NaCl	49.7d	4.8 b	42.8 d	7.0 ab	24.3 fg	7.2 b
	KNO3	53.0 d	3.8 bc	46.7 cd	6.7 b	27.3 ef	5.8 bc
35 DAA	Unprimed	59.0 cd	3.7 bc	52.0 cd	6.0 bc	28.3 de	5.3 bc
	NaCl	64.7 bc	2.8 cd	60.0 bc	4.8 cd	32.5 cd	3.5 cd
	KNO3	69.2 b	2.6 de	66.7 b	3.9 d	36.8 bc	2.5 d
45 DAA	Unprimed	85.0 a	2.5 de	83.4 a	3.8 d	37.2 bc	2.3 d
	NaCl	87.0 a	1.7 de	83.5 a	3.2 de	41.0 ab	2.2 d
	KNO_3	88.6 a	1.3 e	85.3 a	2.2 e	44.3 a	1.7 d

Different letters indicating significant difference at p≤ 0.01 DAA (Days After Anthesis)

Seedling emergence

Percentage of seedling emergence and mean emergence time (MET) were not significantly affected by cultivar ($p>0.01$), but they were significantly affected by seed maturity and priming (Table 1). Interaction of seed maturity and priming on these traits was also significant ($p\leq0.01$). Percentage emergence of seeds harvested at 25 DAA was significantly lower than seeds harvested at 35 and 45 DAA (Table 1). The highest improvement in seedling emergence from priming was obtained in seeds of 25 DAA, increasing emergence by 15.3% and 19.2% for seeds primed with NaCl and KNO_3, respectively (Table 2).

Priming resulted in decreasing MET of seeds from all harvests. However, KNO_3 priming was more effective than NaCl priming (Table 2). Early harvested and unprimed seeds produced more abnormal seedlings, compared to later harvested and primed seeds (Tables 1 and 2). In other words, percentage of seeds that germinated, but failed to emerge, was reduced by seed maturity and priming.

Seedling growth

Effects of seed maturity and priming and interaction of priming × seed maturity on shoot dry weight were significant ($P \leq 0.01$). Mean shoot dry weights of matured and primed seeds were more than those of immature and unprimed seeds (Table 1). KNO_3 and NaCl Primings improved shoot dry weight by 9.3, 8.5, 7.1 and 5.3, 4.2, 3.8 mg/seedling for seeds produced at 25, 35 and 45 DAA, respectively (Table 2).

Priming decreased mean germination and emergence times and increased seedling emergence and weight in unheated glasshouse conditions. The highest benefit of priming was observed for seeds harvested at 25 DAA. Seeds harvested later (35 and 45 DAA) showed high emergence, emergence rate and seedling dry weight, before priming. So, priming had small effects on these more mature seeds (Tables 1 and 2). It was, also, reported that priming was more beneficial for muskmelon seeds of 40 DAA than those of 60 DAA, concerning germination under stress (Welbaum and Bradford, 1991) and repair of post-harvest ageing (Olouch and Welbaum, 1986). This might be due to overcoming some seed dormancy or improving embryonic development.

It has been long known that one of the main merits of priming treatments is to increase germination and emergence rate (Heydecker and Coolbear, 1977). However, the question arises whether rapid radicle protrusion is always reflected in rapid seedling emergence. Halmer and Bewley (1984) proposed that emergence losses in the soil are not generally due to germination failure, but failure of seedlings to grow and emerge above soil surface. Results of the present study confirmed that a large number of cucumber seeds particularly from early harvest (25 DAA) in both cultivars were not able to emerge, despite their germination in the soil. A reduction in the percentage of such seeds after priming indicated that the beneficial effect of priming extended beyond radicle emergence and increased the vigor of emerging cucumber seedlings.

The beneficial effects of KNO_3 priming were more than NaCl priming, which are similar to those found for watermelon (Sachs, 1977; Nerson, et al., 1985; Demir and Van de Venter, 1999; Demir and Ozokat, 2003), and muskmelon (Bradford, 1985). According to Alevarado and Bradford (1988) and Bellti et al (1993), the superiority of KNO_3 priming to NaCl priming is related to more nitrogen and potassium accumulation in seeds treated with KNO_3. This positive effect of priming was clearly reflected in seedling weights. Therefore, KNO_3 priming could be used to increase the rate and percentage of cucumber seedling emergence. This can lead to the production of well – developed uniform seedlings, to ensure optimum plant establishment and yield improvement.

Conclusions

Salt priming, particularly priming with KNO_3, is an effective way to improve seed and seedling vigor of cucumber. Seed priming with KNO_3 can enhance rates and percentages of germination and seedling emergence, which ensure proper stand establishment under a wide range of environmental conditions. These beneficial effects of priming are more evident in premature, rather than mature, seeds of cucumber.

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