MATRICONDITIONING INTEGRATED WITH GIBBERELLIC ACID TO HASTEN SEED GERMINATION AND IMPROVE STAND ESTABLISHMENT OF PEPPER AND TOMATO

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ABSTRACT - Emergence and stand establishment of tomato (*Lycopersicon lycopersicum* (L.) (Karsten ex Farw)) and pepper (*Capsicum annus* L.) seeds are often slow and erratic, particularly under stress conditions. Field emergence trials sometimes have not responded to priming in pepper. This study examined the combined effects of matriconditioning and gibberellin application on the germination and stand establishment of pepper and tomato seeds. Pepper and tomato seeds were conditioned with a solid carrier, Micro Cel E, in the presence of gibberellic acid (GA) for 1, 2, 3 and 4 days at 15 and 25°C. The results showed that, in all cases, even under stress conditions, the combination of matriconditioning with GA was effective in improving germination and emergence of pepper and tomato. The germination time was, in average, reduced by 2 to 3 days by primed seeds. Thus, matriconditioning, during which germination is suspended, provides an unique means to rapidly and efficiently digest the endosperm by GA-induced enzymes and reduce the mechanical restraints of endosperm thus providing energy to start and sustain embryo growth.

Index terms: priming, growth regulator, endosperm.

INTRODUCTION

The emergence and stand establishment of tomato and pepper seeds are often slow and extremely erratic, particularly under cool stress conditions. Tomato and pepper seeds have a well defined non-starchy endosperm. It has become clear in recent years that the endospermic tissue enclosing the radicle tip of the embryo offers a mechanical barrier to the growing
embryo, thus affecting germination (Watkins et al., 1985; Groot & Karssen, 1987; Andreoli & Khan, 1993). Seed conditioning (priming) has consistently improved the rates of germination and emergence of pepper and tomato seeds under optimal conditions (Aljaro & Martinez, 1987; Alvarado & Bradford, 1988; Sundstrom & Edwards, 1989; Frett & Pill, 1991). However, field emergence sometimes gave little response to seed conditioning (Ghate & Phatak, 1982; Bradford et al., 1990). If these differences in response to stress condition are due to mechanical restraints of endosperm is a subject still unknown.

Very few studies have examined the role of the endosperm in germination. In lettuce seeds, the hydrolysis of mannan by mannanase during gibberellin application caused weakening of the endosperm cell wall. It does not appear to be a prerequisite for germination since the event is subsequent to radicle protrusion (Halmer et al., 1976). Gibberelins have also been shown to degrade endosperm both celery seeds and isolated endosperm (Jacobsen & Pressman, 1979). In studies with pepper seeds, Watkins & Cantlife (1983) and Watkins et al. (1985) found that the mechanical constraint by endosperm in the tip region of the radicle contributed to slow germination rate and that the weakening of the endosperm by externally applied (GA) occurred prior to germination. A weakening of the endosperm in response to red light, which mimics GA effect, has been shown in seeds of Datura spp. prior to radicle protrusion (Sanchez et al., 1990). Recently, Andreoli & Khan (1993) showed a substantial increase in emergence of papaya seeds when matriconditioning was combined with GA. It was observed that the pericarp split along a suture after conditioning and that the loosening and dissolving of the cell wall were induced by exogenous applied GA and matricontioning. Evidence has been presented for the weakening of the endosperm enclosing the radicle tip during matricontioning of carrot seeds and for the completion of initial related to the radicle protrusion (Dawidowicz-Grzegorewska & Maguire, 1993).

That the endogenously produced GA may be involved in the digestion of the endosperm prior to germination was indicated from recent studies with mutant tomato seeds. Unlike wild type, the GA-deficient mutant tomato seeds did not produce endo-[b]-mannotase needed for the digestion of the endosperm, thus implicating that the enzyme was induced by GA for endosperm degradation and germination (Groot & Karssen, 1987). That the endogenous GA may control germination of pepper and tomato seeds as well as of papaya (Khan & Andreoli, 1993) was further indicated by the fact that tetcyclas, an inhibitor of GA synthesis, inhibited the germination and the process was reversed by adding GA.

Few studies have attempted to combine the unique advantage of rapidly removing the endosperm restraint with added GA during suspension of germination with the benefits of preplant conditioning in order to improve germination and stand establishment.

This paper explored the possibility of combining GA and matricontioning as a means of reducing mechanical restraints of the endosperm cells in order to hasten pepper germination and improve emergence of pepper and tomato seeds.

**MATERIAL AND METHODS**

Seed lots of tomato cv. Super Marmande and pepper cv. El Paso were kindly supplied from Ferry Morse Seed Co., Modesto, CA and used in this study. The experiments were carried out at the Laboratory of Seed Science, Department of Horticultural Sciences, New York State Experimental Station, Cornell University, Geneva, NY, USA, in 1992.

Seeds of tomato and pepper were preconditioned in batches of 5 to 10 g with the moist solid carrier, Micro Cel E (a synthetic calcium silicate produced by hydrothermal reaction of diatomaceous silica, hydrated lime and water, Manville Products Corp., Denver, CO.). The ratio of seed: carrier: water or Gibberellic acid (GA4+7) solution by weight in the conditioning mixture was 10:3:10. Water or aqueous solution of GA contained thiram 75W (tetramethylthiauram disulfide) at the rate of 3.4 kg–1 seeds. Seeds were firstly imbibed in water or GA solution containing the fungicide for 30 min at 25°C and then, the required amount of Micro Cel E was added. After thoroughly mixing the contents in 0.43 L jars, the jars were loosely capped and transferred to a 15 and 25°C room for 0, 1, 2, 3, 4 days. After matricontioning, the mixture was washed with running water for 1 min to remove the carrier from the seed. Seeds were spread and wiped...
out on dry blotters on the laboratory bench, then were left
to dry back to original moisture content at 25°C and 42%
RH room for 4 hours. The nonconditioned seeds were
treated with the same amount of fungicide in a slurry of
1.5% methylcellulose and dried overnight.

Laboratory germination tests were done on three
replicates of 50 pepper seeds each in 9 cm Petri dishes
lined with filter paper moistened with 5 mL water. The
plates were incubated at 15 and 30°C with continuous
fluorescent light. The seedlings were counted every day
until no further germination was observed.

For seedling emergence trials, four replicates of 50
tomato seeds each were sown 2.0 cm deep in a plastic box
containing moist Cornell peat-line mix in a growth
chamber at 25 and 30°C set at 12 hours light/12 hours dark
regime. Water was added to the mix as needed. Seeds of
pepper cv. Yolo Wonder and El Paso were sown in a
growth chamber at 32°C. Emergence of pepper and tomato
were determined by daily counting with unfolded
cotyledon leaves.

Field emergence trials were conducted at the Fruit
& Vegetable Research Farm, New York State Agricultural
Experiment Station, Cornell University, Geneva. One
hundred tomato seeds replicated five times each were sown
at a depth of 2.5 cm in rows 5 m long and 75 cm apart with
a John Deer cone planter. The planting date was June 18,
1992. Counts of emerged seedlings (cotyledons unfolded)
were recorded on alternate days until emergence was
complete. Final emergence was calculated as a percentage
of the number of seed planted.

RESULTS AND DISCUSSION

The period taken for conditioning pepper seed at
15°C combining with 200 μM GA did not affect the
final counts and the rate of germination (Fig. 1). Control and conditioned seeds at 15°C from 1 to 4
days germinated more than 90%. Matriconditioning
at 25°C for 2 days resulted in more rapid germination
than untreated seeds (advanced the T_50 for 2 days)
and the final germination was nearly 100% after 4
days soaking. However, pepper seeds conditioned
at 25°C for 4 days, reduced the germination,
indicating that longer period of conditioning could
be harmful to seeds, i.e. deterioration process has
been initiated.

The effects of combined conditioning plus GA
(0 to 400 μM) treatments of pepper seeds at 25°C on
subsequent germination at 15 and 25°C are shown
in Fig. 2. More than 80% of seeds germinated in
24 hours in the combined treatment containing 100
to 400 μM GA at 25°C, while untreated seed reached
that level only after 6 days. Combined treatments

FIG. 1. The effect of matriconditioning for 0, 1, 2, 3,
and 4 days plus 200 μM GA at 25°C (A) and
15°C (B) on germination of pepper seeds at
30°C. Denotation: UNT: untreated seeds;
GA 1, GA 2, GA 3 and GA 4: matricondi-
tioning in the presence of 200 μM GA for 1,
2, 3, and 4 days.

FIG. 2. The effect of matriconditioning plus GA (0 to
400 μM) for 2 days at 25°C on subsequent
germination of pepper seeds at 25°C (A) and
15°C (B). Denotation: UNT: untreated seeds;
GA 50, GA 100, GA 200, and GA 400: matri-
conditioning in the presence of that
respective dose of GA.
performed as well at 15°C, with no significant difference between treatments. Untreated (control) seeds or seeds conditioned in the presence of GA did not begin germination until the 3rd day of soaking.

The combined treatments (matriconditioning plus GA) consistently improved the final emergence and resulted in the most rapid seedling emergence of tomato (Fig. 3). At 25°C, matriconditioning alone improved emergence; however, matriconditioning in the presence of 20 μM of GA resulted nearly twice as many seedlings in 24 hours. At 30°C, the emergence start time was shortened by more than 2 days in seeds treated with matriconditioning + GA compared to the nonconditioned (untreated) seeds and more than one day compared to seeds conditioned in the absence of GA.

The effects of combined conditioning with 200 μM GA treatment of two pepper cultivars at 25°C and 15°C on subsequent seedling emergence at 32°C is shown in Fig. 4. The combined conditioning treatment at 25°C was more effective in reducing the emergence time and in ameliorating seedling stand over nonconditioned (UNT) seeds for both cultivars. Conditioning pepper seeds at 25°C in the presence of GA advanced the germination process by 4 to 6 days.

In the field with tomato seeds, the combined conditioning plus GA treatment improved emergence percentage by 20% of the control value and reduced the time for seedling emergence by 4 days (Fig. 5). Although the combined matriconditioning gave 90% field stand in 6 days after planting, only 80% of emergence was observed for matriconditioned and untreated seeds after 10 days. The effect of the treatments was more pronounced at the beginning of the emergence and there was no difference in the final counts.

The data of this experiment have demonstrated that matriconditioning in the presence of GA for 2 to 3 days, preferably at 25°C, followed by drying, greatly stimulates germination and seedling emergence of pepper and tomato seeds. The digestion of endosperm cells is an important phase of germination for many seeds. In monocots, this process has long been studied as the major pathway of mobilizing food reserves for the seedling. In many dicots, the endosperm cells are thick and consist largely of mannan. Several researches have speculated if enzyme activity (mannanase) occurred prior to radicle emergence and if the lack of that enzyme correlated with germination. A similar system has been reported in celery by Jacobsen & Pressman (1979). Also Watkins et al. (1985) and Groot &...
Karssen (1987) found that GA-mediated enzyme activity may participate in the weakening of the endosperm of pepper and tomato prior to germination. The seed germination and stand improvement performance by matriconditioning has been suggested for several crops (Khan et al., 1990, 1992; Khan, 1992). Furthermore, Andreoli & Khan (1993) have found the additive effect of matriconditioning and GA for papaya seed. In this study, in all cases, even under stress conditions, the combined matriconditioning plus GA treatment was effective in improving germination and field stand of pepper and tomato seeds. Thus, matriconditioning during which germination is suspended, provided a unique means to rapidly and efficiently degrade the endosperm by GA, reducing not only the mechanical restraints but also providing the energy for embryo growth.

**CONCLUSIONS**

1. The integration of matriconditioning with 200 μM GA was effective in improving germination and stand establishment of pepper and tomato seeds.
2. The matriconditioning seed treatment provides a means to efficiently digest the endosperm cell by GA-induced enzymes and reduce the mechanical restraints of tomato and pepper.

**REFERENCES**


