centrations among treatments. This stability suggests that N leaching through the soil profile was not a significant problem even on this sandy soil and that the grower managed irrigation water effectively. That the leaf N concentration remained at ≈2.6% and did not go higher, also suggests that residual soil N from previous seasons was not an important factor since leaf N concentrations routinely exceed 3% in groves receiving high rates of fertilizer N.

These results indicate that for adequately fertilized trees applying the total seasonal N allocation early in the season does not result in a higher SSC / TA ratio, earlier color break or larger fruit diameter. Growers that apply the total seasonal N application early in the season should not expect earlier fruit maturity. However, research has demonstrated that N utilization and metabolism increases during bloom and fruit set (Kato, 1986) and applying most of the N during this period from April to June in the San Joaquin Valley has been a recommended practice.

Previous work by Embleton et al. (1978) suggests that a leaf N concentration below 2.4 might lead to a high SSC / TA ratio earlier in the season. However, the practicality of maintaining constant leaf N concentration using fertilizer management remains problematic since weather, previous and current yield and management practices all combine to produce a given leaf N concentration.

## Literature cited


Chapman, H.D. 1968. The Mineral Nutrition of Citrus, p. 187–201. In: W. Reuther, L. Batchelor, H. Webber (eds.). The citrus industry. vol. 2. Univ. of Calif., Div. Agr. Sci., Berkley.

Embleton, T.W., H. J. Reitz, and W.W. Jones. 1973. Citrus Fertilization, p. 150–156. In: W. Reuther (ed.). The citrus industry. vol 3. Univ. of Calif., Div. Agr. Sci., Berkley.

Kato, T. 1986. Nitrogen metabolism and utilization in citrus, p. 81–216. In: J. Janick (ed.). Horticultural reviews. vol 8. AVI Publ., Westport, Conn.

Embleton, T.W., W.W. Jones, C. Pallares, and R.G. Platt. 1978. Effects of fertilization of citrus on fruit quality and ground water nitrate-pollution potential. Proc. Intl. Soc. Citricult. 2:280–285.

Manugistics, Inc. 1997. Statgraphics plus. Version 3. Manugistics, Inc., Rockville, Md.

McGuire, R.G. 1992. Reporting of objective color measurements. HortScience 27:1254–1255.

Sweeney, R.A. 1989. Generic combustion method for determination of crude protein in feeds: Collaborative study. J. Assn. Off. Anal. Chem. 72:770–774.

Ting, S.V. and R.L. Rouseff. 1986. Citrus fruits and their products, analysis and technology. Marcel Dekker, New York. p. 35–47.

Valverde, M.A. and H.L. Hill. 1981. Soil survey of Kern County, southeastern part. USDA, Soil Conserv. Serv., Univ. Calif. Agr. Expt. Sta.


# Muskmelon Transplant Production in Response to Seed Priming


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**Additional index words.** *Cucumis melo*, osmoconditioning, stand establishment



**Summary. The effects of seed priming on seedling development of muskmelon (*Cucumis melo* L.) under laboratory and greenhouse conditions were studied. Seeds of 'Top Net, SR' muskmelon were primed for 6 days in darkness at 77 °F (25 °C) in $KNO_3$ (0.35 M) aerated solution. After germination in petri dishes at 77 °F, primed and nonprimed seeds were transferred to either paper towels (laboratory study) or trays, which were placed in greenhouse conditions. Leaf area and fresh and dry mass of roots and shoots were measured at 15 and 30 days. In germination under laboratory conditions, primed seeds germinated ≈16 and 60 hours earlier than nonprimed seeds at 77 °F and 63 °F (17 °C), respectively. Priming caused no beneficial effect on shoot and root development either in laboratory conditions or during transplant production in the greenhouse.**


Recently, a trend in the vegetable industry is to grow transplants in containerized cell trays. Muskmelon transplants have been used to improve stands, reduce seed usage (especially with expensive hybrids) and shorten the time from planting to harvest (Dufault, 1986). Generally, the time required for production of marketable muskmelon


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**Table 1. Muskmelon seed germination and mean time of germination (MTG) at laboratory conditions.**

| | Germination (%) | | MTG (h) | |
|---|---|---|---|---|
| Treatment | 63 °F (17 °C) | 77 °F (25 °C) | 63 °F (17 °C) | 77 °F (25 °C) |
| Primed | 87 | 89 | 98.4 | 38.6 |
| Nonprimed | 72 | 91 | 158.5 | 54.5 |
| Significance[y] | * | NS | * | * |

NS,*Nonsignificant or significant, respectively, by Duncan's multiple range test, $P = 0.05$.

transplants in traditional U.S. markets has been from 4 to 5 weeks (Vavrina, 1994). Earliness and uniformity are important characteristics in transplant production (Styer, 1997).

Seed priming accelerates germination and improves uniformity of seedling emergence of many species, especially under unfavorable growing conditions. The technique consists of imbibing seeds in an osmotic solution that allows pregerminative metabolism to proceed, but prevents radicle protrusion through the seed coat (Heydecker et al., 1975; Parera and Cantliffe, 1994). In muskmelon, studies reported the benefits of seed priming on seed germination at low temperatures (Bradford et al., 1988; Dhillon, 1995; Nerson and Govers, 1986). None of these studies reported the effects of seed priming on seedling development. In other crops, the effects of seed priming on seedling growth were not consistent (Alvarado et al., 1987; Brocklehurst et al., 1984; Jett and Welbaum, 1992; Pill, 1986; Stoffella et al., 1992; Sundstrom and Edwards, 1989; Wurr and Fellows, 1984). Passam et al. (1989) showed seed priming promoted early growth of muskmelon. Early seedling root growth and development can ensure optimal shoot development and consequently high yields of marketable fruit (Leskovar and Stoffella, 1995). Some aspects of transplant quality involve transplant size and height, which are optimum for yield and efficient handling in the field during transplantation and for rapid establishment (Maynard and Hochmuth, 1997). Little information has been reported on transplant production of muskmelon following seed priming. The objective of this study was to examine the effects of seed priming on muskmelon transplant production under greenhouse conditions.

## Materials and methods

'Top Net, SR' muskmelon seeds (Harris Moran Seed Co., Modesto, Calif.), were primed for 6 d in darkness at 77 °F (25 °C) in $KNO_3$ (0.35 M) aerated solution. Seeds were placed in 250 mL Erlenmeyer flask with 0.34 fl oz (10 mL) of soaking solution per gram of seed. The air was prehydrated by bubbling through water to minimize evaporation. The priming solution was changed every other day. After a 6-d soaking period, seeds were rinsed in running tap water (2 min) and redried at ambient laboratory conditions (75 to 80 °F (24 to 27 °C); 50% relative humidity) for 4 d. Primed and nonprimed seeds were placed in petri dishes containing two germination papers and 0.34 fl oz of deionized water and incubated in a germination chamber, in darkness, at 77 °F. To avoid the measurement differences between primed and nonprimed seeds due to chronological time of germination, nonprimed seeds were placed to germinate before (previously established) primed seeds. After radicle protrusion, ≈0.04 inches (1 mm), primed and nonprimed seeds were transferred to either paper towels (laboratory study at 77 °F for 7 d) or Styrofoam trays (200 cells with 1.34 inches$^3$ (22 cm$^3$) volume) (Speedling, Inc., Sun City, Fla.) containing a commercial peat–vermiculite growing medium (Metro-Mix 350, Scotts-Sierra Horticultural Products Co., Marysville, Ohio), and covered with 0.2 inches (0.5 cm) of the same growing medium. Four replications of 50 seeds from each treatment were used. The trays were placed in greenhouse conditions (68 to 90 °F (20 to 32° C); 65% to 85% RH) from February to March 1997 in Gainesville, Fla. Trays were kept for 30 d at greenhouse and were watered by hand as needed. Leaf area was measured at 15 and 30 d, using an area meter (LI-3100; LI-COR, Inc., Lincoln, Nebr.), as were fresh and dry mass of roots and shoots. Analysis of variance was performed on each measured variable, and treatment means were separated by Duncan's multiple range test, at $P = 0.05$, using the Statistical Analysis System (SAS Institute, Inc., 1988).

## Results and discussion

Under laboratory conditions at 77 °F, primed seeds germinated ≈16 h earlier than nonprimed seeds (Table 1). This suggests that priming accelerates muskmelon seed germination under optimal conditions. No difference was observed in percent germination. Muskmelon has an optimum temperature, e.g., 68 to 90 °F for seed germination (Association of Official Seed Analysts, 1993). Placing transplant trays in a controlled temperature room most often provides for uniformity of germination. Although muskmelon seeds will germinate over a range of temperatures, temperatures that are divergent from the optimum range result in slow, irregular and/or low germination. For example, at 63 °F (17 °C), nonprimed seeds germinated 60 h after primed seeds, and germination in the nonprimed seeds was ≈20% less than that of the primed seeds (Table 1). Thus, using primed seeds can enhance muskmelon germination performance in the greenhouse where constant temperatures are difficult to maintain over the transplant production period. In addition, seed priming minimizes seed coat adherence during emergence of muskmelon seedlings (Nascimento and West, 1998).

Seedling development between primed and nonprimed seeds under

**Table 2. Muskmelon seedling development at 7 days in incubator at 77 °F (25 °C) from seeds at 0.04 inches (1 mm) radicle emergence stage.**

| | Root[z] | | | Shoot[z] | |
|---|---|---|---|---|---|
| Treatment | No. (secondary) | Dry mass (mg) | Length (cm) | Dry mass (mg) | Length (cm) |
| Primed | 31.5 | 15.3 | 12.0 | 55.2 | 5.1 |
| Nonprimed | 27.7 | 13.8 | 11.2 | 53.6 | 4.7 |
| Significance | NS | NS | NS | NS | NS |

[z]Values represents mean of twenty muskmelon seedlings.
NSNonsignificant by Duncan's multiple range test, $P = 0.05$.

Table 3. Root and shoot dry mass and leaf area of muskmelon transplants grown from primed and nonprimed seed under greenhouse conditions.[z]

| | Root dry mass (g) | | Shoot dry mass (g) | | Leaf area ($cm^3$) | |
|---|---|---|---|---|---|---|
| Treatment | 15 d | 30 d | 15 d | 30 d | 15 d | 30 d |
| Primed | 0.22 | 0.52 | 1.2 | 3.9 | 94.5 | 279.8 |
| Nonprimed | 0.23 | 0.54 | 1.1 | 3.9 | 90.3 | 298.4 |
| Significance | NS | NS | NS | NS | NS | NS |

[z]Values represents mean of twenty muskmelon seedlings.
[NS]Nonsignificant by Duncan's multiple range test, $P = 0.05$.

laboratory conditions at 77 °F was not significant for all the parameters analyzed: number of secondary roots, root dry mass, root length, shoot dry mass, and shoot length (Table 2). Also, under greenhouse conditions, no difference was observed in root or shoot dry mass, or leaf area of transplants produced from primed or nonprimed seeds either at 15 or 30 d (Table 3). These results are consistent with Parera and Cantliffe (1994), where, in general, the major effects of seed priming on seedling growth have been observed due to earlier germination giving the seedlings a longer time to develop. However, at stressful temperature conditions, tomato shoot dry weight was higher for primed seeds than for nonprimed seeds (Odell et al., 1992). The lack of significant differences on root and shoot growth in our study was probably due to favorable temperatures for muskmelon seedling development during the experiment (e.g., from 68 to 90 °F.

Although priming caused no beneficial effect on seedling development either in laboratory or in greenhouse studies, primed seeds may give better results than raw seed in terms of germination performance where the transplant grower cannot exactly control the germination conditions within narrow ranges.

## Literature cited


Alvarado, A.D., K.J. Bradford, and J.D. Hewitt. 1987. Osmotic priming of tomato seeds: Effects on germination, field emergence, seedling growth, and fruit yield. J. Amer. Soc. Hort. Sci. 112:427–432.

Association of Official Seed Analysis. 1993. Rules for testing seeds. J. Seed Technol. 16(3):1–113.

Bradford, K.J., D.M. May, B.J. Hoyle, S. Sibinski, S.J. Scott, and K.B. Tyler. 1988. Seed and soil treatments to improve emergence of muskmelon from cold or crusted soils. Crop Sci. 28:1001–1005.

Broklehurst, P.A., J. Dearman, and R.L.K. Drew. 1984. Effects of osmotic priming on seed germination and seedling growth in leek. Scientia Hort. 24:201–210.

Dhillon, N.P.S. 1995. Seed priming of male sterile muskmelon (*Cucumis melo* L.) for low temperature germination. Seed Sci. Technol. 23:881–884.

Dufault, R.J. 1986. Influence of nutritional conditioning on muskmelon transplant quality and early yield. J. Amer. Soc. Hort. Sci. 111(5):698–703.

Heydecker, W., J. Higgis, and Y.J. Turner. 1975. Invigoration of seeds. Seed Sci. Technol. 3:881–888.

Jett, L.W. and G.E. Welbaum. 1992. Osmotic and solid phase priming of broccoli seed. Proc. Natl. Symp. Stand Establishment Hort. Crops. p. 73–82.

Leskovar, D.I. and P.J. Stoffella. 1995. Vegetable seedling root systems: morphology, development, and importance. HortScience 30(6):1153–1159.

Maynard, D.N. and G.J. Hochmuth. 1997. Knott's handbook for vegetable growers. 4th ed. Wiley, New York.

Nascimento, W.M and S.H. West. 1998. Priming and seed orientation affect seed coat adherence and seedling development of containerized muskmelon transplants. HortScience 33(5):847–848.

Nerson, H. and A. Govers. 1986. Salt priming of muskmelon seeds for low-temperature germination. Scientia Hort. 28:85–91.

Odell, G.B., D.J. Cantliffe, H.H. Bryan, and P.J. Stoffella. 1992. Stand establishment of fresh market tomatoes sown at high temperatures. HortScience 27:793–795.

Parera, C.A. and D.J. Cantliffe. 1994. Presowing seed priming. Hort. Rev. 16:109–139.

Passam, H.C., P.I. Karavites, A.A. Papandreou, C.A. Thanos, and K. Georghiou. 1989. Osmoconditioning of seeds in relation to growth and fruit yield of aubergine, pepper, cucumber and melon in unheated greenhouse cultivation. Scientia Hort. 38:207–216.

Pill, W.G. 1986. Parsley emergence and seedling growth from raw, osmoconditioned, and pregerminated seeds. HortScience 21:1134–1136.

SAS Institute, Inc. 1988. SAS / STAT user's guide. Release 6.03 ed. SAS Inst., Cary, N.C.

Stoffella, P.J., M.L. DiPaola, A. Pardossi, and F. Tognoni. 1992. Seedling root morphology and shoot growth after seed priming or pregermination of bell pepper. HortScience 27:214–215.

Styer, R.C. and D.S. Koranski. 1997. Plug and transplant production. Ball Publ., Batavia, Ill.

Sundstron, F.J. and R.L. Edwards. 1989. Pepper seed respiration, germination, and seedling development following seed priming. HortScience 24:343–345.

Vavrina, C.S. 1994. An introduction to the production of containerized vegetable transplants. Fla. Coop. Ext. Bul. 302.

Wurr, D.C. and J.R. Fellows. 1984. The effects of grading and priming seeds of crisp lettuce cv. Saladin on germination at high temperature, seed vigor and crop uniformity. Ann. Appl. Biol. 105:345–352.