Seed Treatments for Disease Control

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Summary. Disease management is an important step in any crop establishment system. Emergence of field-seeded crops may take several weeks for many species and represents a vulnerable stage of plant growth. This paper considers various biological, chemical, and physical seed treatments for improved seed performance. The role of seed quality and cultural practices in seedling establishment also is reviewed. Multidisciplinary approaches to improving horticultural crop establishment are promising.

Optimal stands are an essential component ofvegetable production systems. Increased prices for hybrid seed, greater amounts of crop residue left on soil (which may lower soil temperatures), and the constant threat of seedling losses to soil-borne plant pathogens are just a few reasons why quality seed and seed treatments are so important. This paper offers a background on seed treatments for disease control from a crop production perspective. Good general reviews of seed treatment and biological control literature include Heydecker and Coolbear (1977) and Weller (1988). For specific crop and disease information, current plant disease textbooks, such as Sherf and MacNab (1986), or local research/extension publications should be consulted.

Quality seed is the starting point for achieving desired stands and best results from chemical, biological, or other forms of seed treatment. Vigorous seed lots have been produced, dried, packaged, and handled to deliver seeds that are free of disease, weed seeds, and mechanical injury. Many vegetable and agronomic seedlots are treated routinely with one or more crop protection chemicals. Treatments provide protection for general disease categories such as seed rot, damping-off, seedling wilt, root rots, and loose or covered smut (small grains). Common disease organisms include *Pythium, Rhizoctonia, Fusarium*, and *Penicillium* spp. (Sherf and MacNab, 1986).

Treatment categories for disease control include 1) seed protection, 2) seed disinfestation, and 3) seed disinfection. Seed protection is a chemical, biological, physiological, or combination treatment designed to protect the seed and seedling from pathogenic organisms in the soil. Seed disinfestation treatments (e.g., captan) are designed also to control spores and other forms of pathogens on the surface of seeds. Seed disinfection treatments (e.g., carboxin or "Vitavax") seek to eliminate pathogens that have penetrated into living cells of the seed, infected it, and have become established. Chemical infusions also may be helpful in disinfection. The treatment should control the pathogen, but ideally should not affect the embryo or emergence potential of seed.

Chemical seed treatments

Many formulations of chemical seed treatments are available, including flowables (F), dry flowables (DF), emulsifiable concentrates (EC), liquids (L), dusts (D), and wettable powders (WP). Chemically treated seed must be colored to prevent accidental use as food, feed, or oil. Seed treatments are applied commonly as slurries, mists, or as planter-box dust treatments. Newer coatings employ film technology, which minimizes dust and applicator risks. Film coatings also permit additives (e.g., micronutrients, fluorescent dyes, beneficial microorganisms, herbicide safeners) to improve adherence to seeds and enhance performance. Other treatment adjuvants such as binders, stickers, and carriers allow

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disease pressure at SES, but seed hydration without bacteria increased emergence over that from nontreated seed at WARC, only when seeds were planted moist.

Other strains of fluorescent *Pseudomonas* spp. have been used as seed treatments to reduce root damage caused by wheat take-all fungus (Weller and Cook, 1983). The microorganisms applied in biological seed treatments also may render nutrients more available to the developing seedling, or at best allow more efficient nutrient uptake by the protected root system (Cook, 1984). One challenge in seed bacterization work has been to show consistent results under field conditions. Commercial use of seed biopriming or other bacterization systems will require treatments to be economically and technically practical, and to produce results in soils of varying moisture content, temperature, pH, organic matter, texture, and fertility. More studies on the spermoplane (seed surface) and spermosphere (zone of influence on soil microbes around a planted seed) will improve field results with biological seed treatments.

Physical treatments, such as heat (e.g., hot water treatments of 118 to 122F for 20 to 30 min), UV, or microwave radiation procedures can be useful for certain crops with some specific pathogens (Sherf and MacNab, 1986; Heydecker and Coolbear, 1977). Seed size and maturity at harvest also influence stand of sweet corn, and may be related to disease organism interactions (Bennett et al., 1988; Tracy and Juvik, 1988).

Influence of seed quality and other cultural practices on seed treatment results

Seeds of low vigor are more vulnerable to microbial attack upon planting in the soil. Low-vigor seeds typically produce seedlings that are slower to achieve autotrophic status. Seeds of low vigor (quality) also exude increased amounts of materials into the soil (Tracy and Juvik, 1988), and become more susceptible to attack by soil-borne pathogens. Seed vigor has been defined as those seed properties that determine the potential for rapid, uniform emergence over a wide range of field conditions (McDonald, 1980). Seed vigor will, therefore, be more closely correlated to field emergence than will standard germination. Horticulturists may find seed vigor tests (e.g., electrical conductivity, cold tests) more useful in evaluating seed lot quality (Waters and Blanchette, 1983).

Seed testing plays a key role in seedling establishment, and a variety of vigor tests are available to select the best seedlots for treatment and planting into the conditions most challenging to emergence. Species and chemical or biological treatments should be matched to acquire maximum benefit. For example, soybean (*Glycine max* L. Merrill) seeds exhibited the greatest benefit from thiram treatment when planted into poor vs. acceptable soil environment conditions, or when seed quality was mediocre compared to known high seed quality (TeKrony et al., 1974).

Genetic traits that provide resistance to pathogen attack are another aspect of seed quality and disease control. For example, the seedcoat can serve as a physical barrier to pathogen penetration or seed exudate escape, but an impermeable or hard seedcoat also can delay or prevent germination under normal conditions. Dark seedcoats, and the phenolic compounds within them, actually may inhibit attack by soil microorganisms (Halloin, 1986). Embryo characteristics may contribute to seedling disease resistance in peas (Stasz et al., 1980), while cotyledon position, other chemical constituents, and seed size may be manipulated genetically to complement seed treatments and disease control (Dickson, 1980).

The impact ofreduced tillage systems and cover crops on stand problems caused by disease can be significant. A better understanding of the rhizosphere (zone of influence of soil microorganisms around a crop's root system) will be helpful in designing crop management systems (Foster, 1981). Field studies in Minnesota suggest that residue rowcover for field corn should be reduced to 10% to 20% to minimize temperature or allelopathic effects (Paul, 1987). Also, ifprevious crop residue is in the seed furrow, poor seed/soil contact will lead to slower water uptake, longer time to emergence, and spotty stand-establishment (Paul, 1987). Combinations of other cultural practices, such as fluid drilling and plant biostimulants (e.g., humic or folic acids) or pregermination treatments with biological seed treatment, can improve seedling establishment (Sanders et al., 1990; Hadar et al., 1983; Harman et al., 1989).

In summary, any practice that will reduce the time from planted seed to healthy seedling or any treatment that can protect the seed and seedling during emergence can minimize stand losses from soil-borne pathogens. These practices include:

- chemical treatments
- plastics to warm the soil
- precision seeders
- irrigation
- proper seedbed preparation
- plug mix planting
- seed enhancements (e.g., coatings, priming)
- anticrustants
- crop rotation
- biological controls

Many disciplines are involved in solving practical seed production and seedling establishment problems. AU strategies that give an advantage to the emerging seedling can be interpreted as seed treatments against diseases or abiotic stresses.

Literature Cited

Basra, A.J., S. Bedi, and C.P. Malik. 1988. Accelerated germination of maize seeds under chilling stress by osmotic priming and associated changes in embryo phospholipids. Ann. Bot. 61:635-639.

Bennett, M., R. Hassell, and D. Kretchman. 1990. Tomato plug plant studies: II. Seed enhancement, tray size, and early plant growth. Ohio Agr. Res. & Dev. Ctr. Hort. Ser. 610:15-20.

Bennett, M.A. and L. Waters, Jr. 1987. Seed hydration treatments for improved sweet corn germination and stand establishment. J. Amer. Soc. Hort. Sci. 112:45-49.

Bennett, M., L. Waters, Jr., and J.H. Curme. 1988. Kernel maturity, seed size, and seed hydration effects on the seed quality of a sweet corn inbred. J. Amer. Soc. Hort. Sci. 113:348-353.

Brown, M. 1974. Seed bacterization. Annu. Rev. Phytopathol. 12:181-197.

Callan, N.W., D.E. Mathre, and J.B. Miller. 1990. Bio-priming seed treatment for biological control of *Pythium ultimum* preemergence damping-off in *sh2* sweet corn. Plant Dis. 74:368-372.

Cantliffe, D.J. and M. Bieniek. 1988. Improving plant stands of super sweet corn by seed treatment. Proc. Fla. State Hort. Soc. vol. 101.

Cook, R.J. 1984. Boot health: Importance and relationship to farming practices, p.111-127. In: D. Bezdicek and J. Power (eds.). Organic farming: Current technology and its role in a sustainable agriculture. Amer. Soc. Agron., Madison, Wis. ASA Spec. Publ. 46.

Dickson, M.H. 1980. Genetic aspects of seed quality. HortScience 15:771-774.

Foster, R.C. 1981. Ultrastructure and histochemistry of the rhizosphere. New Phytol. 89:263-273.

Hadar, Y., G.E. Harman, A.G. Taylor, and J.M. Norton. 1983. Effects of pre-germination of pea and cucumber seeds and of seed treatment with *Enterobacter cloacae* on rots caused by *Pythium* spp. Phytopathology 73:1322-1325.

Halloin, J.M. 1986. Seed improvement through genetic resistance to pathogenesis, p. 77-96. In: S.H. West (ed.). Physiological-pathological interactions affecting seed deterioration. Crop Sci. Soc. Amer., Madison, Wis. CSSA Spec. Publ. No. 12.

Harman, G.E. and T.E. Stan. 1986. Influence of seed quality on soil microbes and seed rots. In: S.H. West (ed.). Physiologlcal-pathological interactions affecting seed deterioration. Crop Sci. Soc. Amer., Madison, Wis. CSSA Spec. Publ. 12.

Harman, G.E., A.G. Taylor, and T.E. Stasz. 1989. Combining effective strains of *Trichoderma harzianum* and solid matrix priming to improve biological seed treatments. Plant Dis. 73:631-637.

Heydecker, W. and P. Coolbear. 1977. Seed treatment for improved performance-survey and attempted prognosis. Seed Sci. & Technol. 5:353-425.

Kraft, J.M. 1986. Seed electrolyte loss and resistance to *Fusarium* root rot of peas. Plant Dis. 70:743-745.

McDonald, M.B., Jr. 1980. Assessment of seed quality. HortScience 15:784-788.

Paul, J. 1987. Resisting residue? Agrichem. Age 31(10):6-8.

Sanders, D.C., J.A. Ricotta, and L. Hodges. 1990. Improvement of carrot stands with plant biostimulants and fluid drilling. HortScience 25:181-183.

Sherf A.F. and A.A. MacNab. 1986. Vegetable diseases and their control. 2nd ed. Wiley, New York.

Stasz, T.E., G.E. Harman, and G.A. Marx. 1980. Time and site ofinfection ofresistant and susceptible germinating pea seeds by *Pythium ultimum*. Phytopathology 70:730-733.

TeKrony, D.M., D.B. Egli, A. Phillips, and T.W. Still. 1974. Effect of fungicide seed treatment on soybean germination and field emergence. Proc. Assn. Offic. Seed Analysts 64:80-89.

Tracy, W.F. and J.A. Juvik. 1988. Electrolyte leakage and seed quality in a *shrunken-2* maize selected for improved field emergence. HortScience 23:391-392.

Wann, E.V. 1986. Leaching of metabolites during imbibition of sweet corn seed of different endosperm genotypes. Crop Sci. 26:731-733.

Waters, L Jr., and B.L. Blanchette. 1983. Prediction of sweet corn field emergence by conductivity and cold tests. J. Amer. Soc. Hort. Sci. 108:778-781.

Weller, D.M. 1988. Biological control of soilborne plant pathogens in the rhizosphere with bacteria. Annu. Rev. Phytopathol. 26:379-407.

Weller, D.M. and R.J. Cook. 1983. Suppression of take-all by seed treatment with fluorescent pseudomonades. Phytopathology 73:463-469.