Pea Cultivar Effect on Seed Treatment With *Penicillium oxalicum* in the Field

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ABSTRACT

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Seedling stands from seeds treated with *Penicillium oxalicum* were greater than those from untreated seeds in four of five cultivars in 1 of 2 yr. At harvest, each cultivar showed no differences in stands or weights of plants from seeds treated with *P. oxalicum* or captan or from untreated seed. When seed treatment means were compared at harvest, *P. oxalicum* and captan-treated seeds resulted in greater stands than did untreated seeds in 2 of 3 yr. In 1980, *P. oxalicum*-treated seeds gave plant stands, vine and pod weights equal to those from captan-treated seeds, and these results were significantly greater than values from untreated seeds.

Additional key words: biological control.

Organisms have been applied to seeds of a variety of crops throughout the world in efforts to control seedling blights or root diseases (1,3,5,8). Previously we reported that of 100 isolates of bacteria and fungi applied to seeds of peas (*Pisum sativum* L. 'Little Marvel'), the fungus *Penicillium oxalicum* Currie and Thom was the most effective antagonist (4). Performance of this antagonist depended upon the numbers of spores applied per seed, the substrate for growing the antagonist, and storage temperature of treated seed, but not upon spore age (14).

In this study, our objectives were to ascertain whether the results reported for one pea cultivar were applicable to four other cultivars frequently grown in the garden and field, and to evaluate the efficacy of *P. oxalicum* as a seed treatment in three field seasons.

MATERIALS AND METHODS

Cultures of *P. oxalicum* were grown on Difco Czapek-Dox agar (CDA) for 4–5 wk at 23 ± 2 C, and conidia were harvested by gently scraping the colony surface with a bent glass rod or by brushing it with a camel's hair brush. A 50-mg quantity of conidia per 100 pea seeds was added to an Erlenmeyer flask and shaken by hand 150 times. Captan (*N*-trichloromethylmercapto-4-cyclohexene-1,2-dicarboximide) 80% WP was applied as a dust (50 mg/100 seeds) in the same way. Untreated seeds were shaken 150 times in a sterile flask. The cultivars tested included Alaska, Green Giant 359, Little Marvel, New Era, and Perfection Dark Seeded. Conidia were harvested and seeds treated in a laminar-flow biological safety cabinet.

Treated and untreated seeds of the five pea cultivars were planted in a disease nursery on 12 May 1978 and on 6 June 1979. Peas have been planted in the nursery every year for several decades and soilborne pathogens present include: *Aphanomyces euteiches* Drechs., *Fusarium oxysporum* Schl. emend Snyd. and Hans. f. sp. *pisi*, *F. solani* (Mart.) App. and Wr. emend Snyd. and Hans. f. sp. *pisi*, *Pythium* spp., and *Rhizoctonia solani* Kühn. Each treatment was replicated 10 times (50 seeds per 1.5 m of row) in a randomized complete block. Seedling stand was recorded at 19 days after planting in 1978 and at 26 days after planting in 1979. At harvest in 1978, total stand (live and dead plants), live-plant stand, and fresh weight of roots and vines were determined. At harvest in 1979, total stand (live and dead plants), live-plant stands, fresh vine and pod weight were measured.

Treated and untreated seeds of the cultivar Little Marvel were planted in the disease nursery on 11 June 1980 in a randomized complete block. Each treatment was replicated 10 times (100 seeds per 2.7 m of row). At harvest, total stand (live and dead plants), live-plant stand, and fresh vine and pod weights were measured.

Analyses of variance were performed and means were compared by Student-Newman-Keuls' test, $P = 0.05$. For emergence and plant growth measurements, arc sin and square root transformations (sometimes with a constant of 0.5 added if some values were zero or very small) respectively, were done when appropriate, prior to analysis of variance (11,12).

RESULTS

In 1978, seedling emergence 19 days after planting was not significantly different with *P. oxalicum*-, captan-, or untreated seeds of four cultivars (Fig. 1A). However, for the cultivar New Era, significantly fewer plants were obtained from seeds treated with *P. oxalicum* than from captan-treated seeds. In 1979, organism-treated seeds gave stands significantly greater than stands from untreated seed for all cultivars except Alaska, for which stands from *P. oxalicum* or untreated seeds were nearly equal (Fig. 1B). Captan-treated seeds resulted in significantly greater emergence than did *P. oxalicum*-treated seeds except with the cultivar Little Marvel, where captan- and *P. oxalicum*-treated seeds gave no difference in seedling stand.

For field data collected at harvest, analyses of variance of percent stand of total plants (live and dead), live plants, and most of the various plant measurements indicated significant differences for seed treatments ($P \geqslant 0.05$), but that there were no interactions between the seed treatment and the pea cultivar. Thus, the seed treatment effects will be discussed only with the means of five cultivars (12).

At harvest in 1978, a significantly greater stand of total plants and live plants resulted from captan-treated seed than from organism-treated or untreated seed (Table 1). In 1979, the percentage of total and live plants at harvest was significantly greater from seeds treated with *P. oxalicum* or captan than from untreated seeds. In 1980, seeds treated with captan or *P. oxalicum* resulted in a significantly greater stand of total plants and live plants than did untreated seeds (Table 1).

Plant weights at harvest for 3 yr are listed in Table 1. Vine weights of plants from organism-treated seeds were not significantly different from vine weights from captan-treated or untreated seeds in 1978. Root weights of plants from captan-treated seeds were significantly greater than root weights from

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TABLE 1. Percent stand of total plants (live and dead); live plants; and root, vine, and pod weight at harvest resulting from seeds treated with captan or *Penicillium oxalicum* and untreated seeds planted in the field in three seasons

Year and treatment	Plant stand (%)[w]		Plant weight (g)[w]		
	Total	Live	Root	Vine	Pod
1978[x]					
Captan	78 a	68 a	20 a	254 a	···
P. oxalicum	67 b	58 b	15 b	239 ab	···
Untreated	65 b	55 b	15 b	221 b	···
1979[y]					
Captan	78 a	23 a	···	168 a	49 a
P. oxalicum	62 b	20 a	···	123 ab	34 a
Untreated	40 c	14 b	···	102 b	33 a
1980[z]					
Captan	67 a	37 a	···	345 a	352 a
P. oxalicum	60 a	39 a	···	358 a	387 a
Untreated	40 b	22 b	···	224 b	229 b

[w] Means in columns followed by the same letter are not significantly different (Student-Newman-Keuls' test, $P = 0.05$).
[x] Each value is an average of 50 replicates, 50 seeds per replicate.
[y] Each value is an average of 30 replicates, 50 seeds per replicate.
[z] Each value is an average of 10 replicates, 100 seeds per replicate.

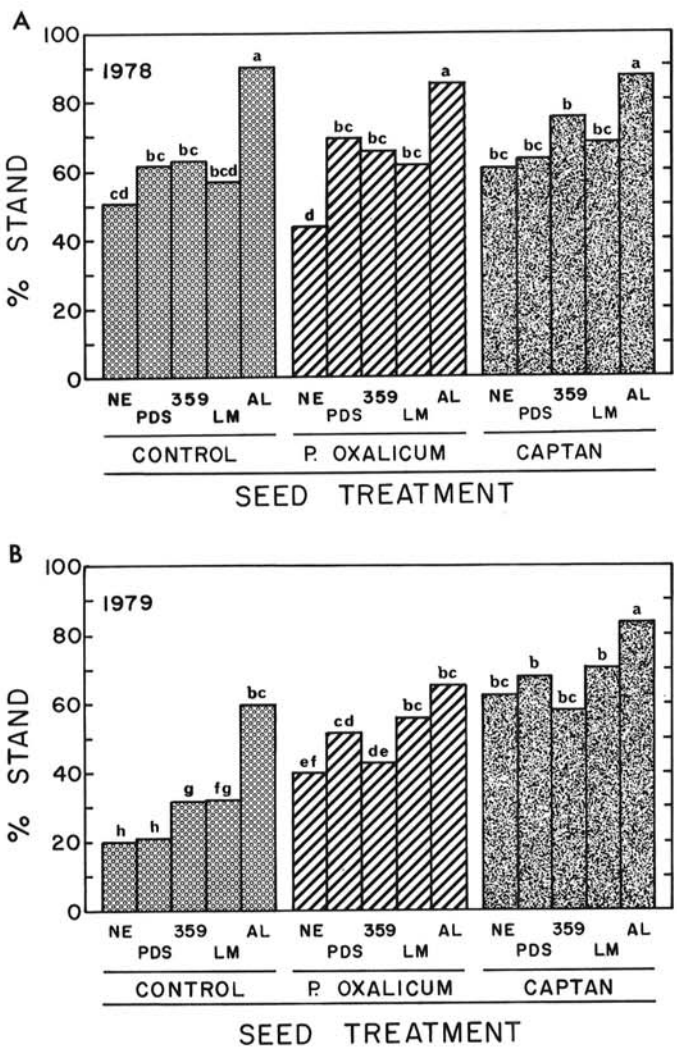

Fig. 1. Percent stand of five cultivars of *Pisum sativum* at **A,** 19 days and **B,** 26 days after planting seeds treated with captan or *Penicillium oxalicum* and untreated seeds in a pea disease nursery. Each value is an average of 10 replicates, 50 seeds per replicate. Means followed by the same letter are not significantly different (Student-Newman-Keuls' test, $P = 0.05$) (cultivars: NE = New Era; PDS = Perfection Dark Seeded; 359 = Green Giant 359; LM = Little Marvel, and AL = Alaska).

seeds treated with *P. oxalicum* and untreated seeds, which were equal. In 1979, seeds treated with *P. oxalicum* resulted in vine weights not significantly different from those from captan-treated or untreated seed. Also, seed treatment did not affect pod weight. In 1980, seeds treated with either *P. oxalicum* or captan produced plants with about the same vine and pod weights and these values were significantly greater than those of plants grown from untreated seeds.

DISCUSSION

Seed treatment with *P. oxalicum* enhanced seedling stand in the field for all cultivars except Alaska, with which seed treatment had no effect. Similarly, seeds treated with *P. oxalicum* and planted in field-collected soil in the greenhouse produced a significantly greater stand than untreated seeds for all cultivars except Alaska, in which seed treatment had no effect (*unpublished*). Exudates from wrinkle-seeded peas have a greater sugar content than those from smooth-seeded peas (2,10) (eg, Alaska [10]) and wrinkle-seeded peas were more susceptible to preemergence damping-off. Although Alaska is also susceptible to preemergence damping-off (9), it is less susceptible than the other four cultivars tested and is less likely to benefit from a chemical or biological seed treatment.

In the 3 yr of field tests and in the 1977 field test (4), seeds treated with *P. oxalicum* gave significantly greater seedling stands than did untreated seeds in 3 of 4 yr, greater yields than untreated seeds did in 2 of 4 yr, and yield equivalent to that from captan-treated seeds in only 1 yr. These field results support the conclusion by Kommedahl et al (6) that biological seed treatment was sometimes as effective as chemical seed treatment, but that variability in performance was greater for organisms than for chemicals.

Variability in performance often reflects seasonal differences in weather and pathogen activity which reduces the effectiveness of *P. oxalicum* as a biological control organism. In 1978, the soil was cool and relatively moist at planting, and environmental conditions were more favorable for pea growth than for pathogen activity. Plant growth was not affected by seed treatment in each cultivar. In both 1979 and 1980, seeds were planted in the field in early June when soil conditions (warm and moist) adversely affected seedling growth and favored preemergence damping-off (7) (conditions similar to those in greenhouse tests). In 1979, seed treatment with *P. oxalicum* resulted in seedling and final stands greater than those from untreated seeds, but treating seeds did not increase plant weight. Yet, in 1980, *P. oxalicum* give a final stand and yield greater than those from untreated seeds and these results were equivalent to stand and yield from captan-treated seeds. Early plant death and severe root rot of live plants were sustained in both seasons; however, rainfall in 1980 was more frequent than in 1979, and roots were apparently able to meet water demands of the plant.

The ability of *P. oxalicum* to protect seeds from preemergence damping-off in the field is supported by a previous study in which this antagonist grew on seeds treated with *P. oxalicum* and planted in field-collected soil (13). Whether benefits of enhanced seedling stands are maintained throughout the season is probably dependent on environmental conditions for the whole season.

LITERATURE CITED

1. Baker, K. F., and Cook, R. J. 1974. Biological Control of Plant Pathogens. W. H. Freeman Co., San Francisco. 433 pp.
2. Flentje, N. T., and Saksena, H. K. 1964. Pre-emergence rotting of peas in South Australia: III. Host-pathogen interaction. Aust. J. Biol. Sci. 17:665-675.
3. Gindrat, D. 1979. Biocontrol of plant diseases by inoculation of fresh wounds, seeds, and soil with antagonists. Pages 537–551 in: B. Schippers and W. Gams, eds. Soil-Borne Plant Pathogens. Academic Press, New York. 686 pp.
4. Kommedahl, T., and Windels, C. E. 1978. Evaluation of biological seed treatment for controlling root diseases of pea. Phytopathology 68:1087-1095.
5. Kommedahl, T., and Windels, C. E. 1981. Introduction of microbial antagonists to special courts of infection: seeds, seedlings, and wounds. Pages 227–248 in: G. C. Papavizas, ed. Biological Control in Crop

Production. Allanheld, Osmun and Co., Totowa, NJ. 461 pp.
6. Kommedahl, T., Windels, C. E., Sarbini, G., and Wiley, H. B. 1981. Variability in performance of biological and fungicidal seed treatments in corn, peas, and soybeans. Prot. Ecol. 3:55-61.
7. Leach, L. D. 1947. Growth rates of host and pathogen as factors determining the severity of preemergence damping-off. J. Agric. Res. 75:161-179.
8. Mangenot, F., and Diem, H. G. 1979. Fundamentals of biological control. Pages 207–265 in: S. V. Krupa and Y. R. Dommergues, eds. Ecology of Root Pathogens. Elsevier Scientific Publishing Co., Amsterdam. 281 pp.
9. Ohh, S. H., King, T. H., and Kommedahl, T. 1978. Genotype effect of captan-treated pea seed to *Pythium ultimum*. Plant Dis. Rep. 62:196-199.
10. Short, G. E., and Lacy, M. L. 1976. Carbohydrate exudation from pea seeds: Effect of cultivar, seed age, seed color, and temperature. Phytopathology 66:182-187.
11. Snedecor, G. W., and Cochran, W. G. 1971. Statistical Methods. 6th ed. Iowa State University Press, Ames. 593 pp.
12. Steel, R. G. D., and Torrie, J. H. 1960. Principles and Procedures of Statistics. McGraw-Hill, New York. 481 pp.
13. Windels, C. E. 1981. Growth of *Penicillium oxalicum* as a biological seed treatment on pea seed in soil. Phytopathology 71:929-933.
14. Windels, C. E., and Kommedahl, T. 1978. Factors affecting *Penicillium oxalicum* as a seed protectant against seedling blight of pea. Phytopathology 68:1656-1661.