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REDUCED RATES OF TACHIGAREN SEED TREATMENT FOR CONTROL OF *APHANOMYCES* ON SUGARBEET

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Aphanomyces damping-off and root rot caused by the "water mold" *Aphanomyces cochlioides* (= *A. cochlioides*) has been increasing in severity and prevalence in the Red River Valley (RRV) since the early 1990s. This pathogen also is well-established and prevalent in sugarbeet fields in southern Minnesota. Currently, Tachigaren (= hymexazol) is the only seed treatment fungicide available for early-season control of *A. cochlioides.* Tachigaren has been registered in the United States since 1996 for use on pelleted sugarbeet seed at rates of 45 to 90g per unit (100,000 seed). These rates of Tachigaren can be phytotoxic if applied directly to seed but are safe when applied to pelleted seed (which then is sealed with a film coat). Adoption of Tachigaren-pelleted sugarbeet seed has been excellent in southern Minnesota, where *A. cochlioides* has been a long-standing, economic pathogen. Most RRV sugarbeet producers, however, have been reluctant to plant Tachigaren-treated seed unless they have a history of severe Aphanomyces damping-off on seedlings. Because of increasing prevalence of this pathogen in the RRV there is interest in planting sugarbeet seed treated with lower rates of Tachigaren than currently are available. This practice may benefit sugarbeet producers who are unaware of *A. cochlioides* in their fields or those who have the pathogen in their fields but do not typically plant Tachigaren-treated seed.

OBJECTIVES

Our objectives were to evaluate 1) efficacy of low levels of Tachigaren as a standard treatment on sugarbeet seed pellets subjected to low or moderate disease pressure (Trial 1) and 2) efficacy and phytotoxicity to sugarbeet of low levels of Tachigaren on minimum build-up pellets subjected to low or moderate disease pressure caused by *A. cochlioides* (Trial 2). Trials were conducted in controlled environment chambers and in the field during 2002.

MATERIALS AND METHODS

Controlled Environment Trials. Sankyo Company, LTD, Tokyo, Japan provided sugarbeet seed of ACH 999 (partially resistant to *A. cochlioides*) treated with fungicides (Seed Systems, Gilroy, CA). For Trial 1, 4M (regular) pelleted seed was treated as follows: standard rates of Apron + Thiram + Tachigaren (20, 30, or 45 g/unit) and two controls (Apron + Thiram and Thiram alone). For Trial 2, seeds were treated with standard rates of Apron + Thiram + Tachigaren (20 or 30g/u) on minimum build-up pellets, Apron + Thiram + 20g Tachigaren on regular pelleted seed, and Apron + Thiram on minimum build-up pellets.

Soil was collected from a field near Crookston, Minnesota (MN) and another near Wolverton, MN that were naturally infested with *A. cochlioides* and had Aphanomyces soil index values of 62 and 56, respectively (soil index values range from 0 to 100, where 0 = all sugarbeet seedlings remain healthy during a 4-week assay of soil in a controlled environment, 100 = all seedlings die during the assay). A third field soil from Crookston, MN was artificially infested with oospores of *A. cochlioides* (20/g soil) and had an index value of 69. Soil was screened and added to plastic pots (4 x 4 x 4 inches, 650 cc soil/pot). Twenty-five seeds were sown at a 1-inch depth per pot and six replicate pots were prepared per treatment. Pots were arranged in a randomized block design in a controlled environment chamber set at 73 °F/68 °F (day/night, 16 h photoperiod) for 1 week to favor optimal emergence and then set at 82 °F/77 °F (day/night, 16 hr photoperiod) to favor disease. Soil was watered daily to keep moist.

Stand counts were made at emergence and then two or three times per week, except weekends, until 4 weeks after planting. Dying seedlings were removed at each stand count, washed free of soil, surface-treated in 0.05% NaOCl for 15 sec, rinsed twice in sterile distilled water (SDW), placed in 5 ml SDW, and microscopically examined 24 to 48 hours later for *A. cochlioides* and other fungal pathogens. Four weeks after planting, surviving seedlings were rated for root rot. Then, an Aphanomyces root rot index (0 – 100 scale, same as the Aphanomyces soil index scale) was calculated for each seed treatment. Percent total emergence, percent final stand, and root rot index values were subjected to analysis of variance and if significant ($P \leq 0.05$), means were separated by Least Significant Difference.

Field Trial. Treated sugarbeet seeds (as described previously) were sown in a field near Crookston, MN (same as Soil 1 in controlled environment trial) on May 24, 2002. Each treatment was sown at a 5.25-inch spacing in 4-row plots; rows were 30 ft in length and 22 inches apart. Treatments were replicated four times in a randomized block design. Plots were fertilized (81 lb Nitrogen and 80 lb $P_2 0_5$/A) just before planting to supplement residual soil fertility for optimal sugarbeet quality and yield. The insecticide Counter (1.8 lb active ingredient/A) was applied over the furrow in a 7-inch band at planting to control the sugarbeet root maggot. Microrates of herbicides were applied on June 18 (0.5 pint Betamix + 1/8 oz Upbeet + 40 ml Stinger + 60 ml Select + 1½ pint Scoil) and on June 27 (8.7 oz Progress + 4 oz. Nortron + 2 oz Select + 1 pint MSO + 40 ml Stinger + 1/8 oz Upbeet [product/A]). Plots were cultivated on July 3 and hand-weeded for the remainder of the summer, as needed. Cercospora leaf spot was controlled by an application of Eminent (13 oz product/A) on August 5 and SuperTin (5 oz product/A) on August 24.

Stand counts were performed daily (excluding weekends and when the field was too wet to enter) on the two middle rows of each plot during the period of emergence (about 10 to 14 days after planting) and at least weekly thereafter until 5½ weeks after planting. A 4-inch plastic straw was placed next to each seedling as it emerged to account for newly emerged and dying seedlings. Several dying seedlings were removed and assayed in the laboratory, as previously described, to identify fungal pathogens.

The two middle rows of each plot were hand harvested on October 3, 2002. Data were collected on number of beets per 60 ft of row and all of these roots were assessed for severity of Aphanomyces root rot (0-7 scale, where 0 = root healthy and 7 = root completely rotted and foliage dead). Ten roots then were randomly selected for yield and quality analyses (provided by American Crystal Sugar Co., East Grand Forks, MN). Data were subjected to analysis of variance and if significant ($P \leq 0.05$), means were separated by Least Significant Difference.

RESULTS

Controlled Environment, Trial 1 (Regular Pellets). Total emergence (includes dead seedlings and those surviving the 4-week soil assay) usually was over 81% and there were no differences among seed treatments in Soils 1 and 3 (Table 1). In Soil 2, there was a significantly lower total plant stand for Thiram-treated seed compared to the other seed treatments (Table 1) because of Pythium seed rot. Thiram provides fair to good protection from Pythium seed rot but is not as effective as Apron or Tachigaren in controlling this pathogen.

The dynamics of seedling emergence and stand loss during the 4-week assay is illustrated in Fig. 1. Most seedlings from all seed treatments emerged from 5 to 7 days after planting. All data for Tachigaren-treated seed (also treated with Apron + Thiram) noted throughout this report will be referred to by rate of Tachigaren per unit of seed. During this period, seed treated with 20g of Tachigaren tended to have the best rate of emergence and highest stands (Fig. 1). Seed treated with Thiram alone had the lowest emergence compared to other seed treatments in the three soils (Fig. 1). The 45 g rate of Tachigaren tended to delay emergence and stand in the three soils but by 7 days after planting, stands were not statistically different among rates of Tachigaren seed treatments (Fig. 1). The 30g rate of Tachigaren delayed emergence in Soil 1 (Fig. 1A), was comparable to stands attained by 20g of Tachigaren in Soil 2 (Fig. 1B), and was similar to stands from seed treated with 45g of Tachigaren in Soil 3 (Fig. 1C). During 5 to 7 days after planting, seed treated with Apron + Thiram resulted in stands similar to the Tachigaren seed treatments (Fig. 1).

Aphanomyces damping-off started to occur in the controls (seed treated with Thiram only or with Apron + Thiram) beginning about 7 or 12 days after planting, depending upon the soil (Fig. 1). Seedlings from seed treated with Thiram resulted in earlier and greater stand loss than the Apron + Thiram control and isolations from dying seedlings confirmed infection by *Pythium* species and *A. cochlioides*. All Tachigaren seed treatments were effective in delaying the onset of Aphanomyces damping-off until 12 to 17 days after planting, but these delays varied with rate of seed treatment and soil (Fig. 1). Aphanomyces damping-off caused further decreases in stand regardless of Tachigaren seed treatment, although losses were slower and less severe compared to the controls. Tachigaren decomposes slowly in soil as a result of microbial activity and solubility in water, so it's effectiveness in protecting

Table 1. Effect of various rates of Tachigaren on pelleted sugarbeet seed (Trial 1) and minimum build-up pelleted seed (Trial 2) in comparison to standard seed treatment fungicides for percent total emergence and root rot indices 4 weeks after sowing seed in three soils infested with *Aphanomyces cochlioides*; experiments were conducted in controlled environment chambers.

	% Total emergence[u]			Root rot index[v]		
Treatment	**Soil 1[w]**	**Soil 2[x]**	**Soil 3[y]**	**Soil 1[w]**	**Soil 2[x]**	**Soil 3[y]**
Trial 1: 4M (regular) pellets						
0g/u Tachigaren, standard rate Apron + Thiram	86	87	87	59	60	65
0g/u Tachigaren, standard rate Thiram	82	74	81	62	55	74
20g/u Tachigaren, standard rate Apron + Thiram	89	89	95	63	36	23
30g/u Tachigaren, standard rate Apron + Thiram	81	90	87	49	43	22
45g/u Tachigaren, standard rate Apron + Thiram	82	89	87	39	26	30
LSD ($P \leq 0.05$)[z]	NS	10	NS	17	NS	17
Trial 2: Minimum build-up pellets						
0g/u Tachigaren, standard rate Apron + Thiram	85	93	92	64	54	67
20g/u Tachigaren, standard rate Apron + Thiram	87	85	85	52	12	52
20g/u Tachigaren, standard rate Apron + Thiram on regular pellet	85	91	88	49	36	40
30g/u Tachigaren, standard rate Apron + Thiram	85	91	89	34	38	38
LSD ($P \leq 0.05$)[z]	NS	NS	NS	NS	NS	20

[u] Percent total emergence is based on planting 150 seed (25 seed/pot x 6 pots).

[v] Root rot index: 0-100 scale, 0 = no disease, 100 = all seedlings died.

[w] Soil 1 = from a naturally infested field near Crookston, Minnesota.

[x] Soil 2 = from a naturally infested field near Wolverton, Minnesota.

[y] Soil 3 = from a field near Crookston, MN that was inoculated with oospores (20/g soil) of *A. cochlioides.*

[z] LSD = Least Significant Difference; if significant, LSD value provided for mean separations; NS = not significant.

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seedlings from infections by *A. cochlioides* also decreases about 3 to 4 weeks after planting. Stands from seed treated with Tachigaren, however, usually were the same and statistically higher than the controls from 17 to 26 days after planting in the three soils (Fig. 1).

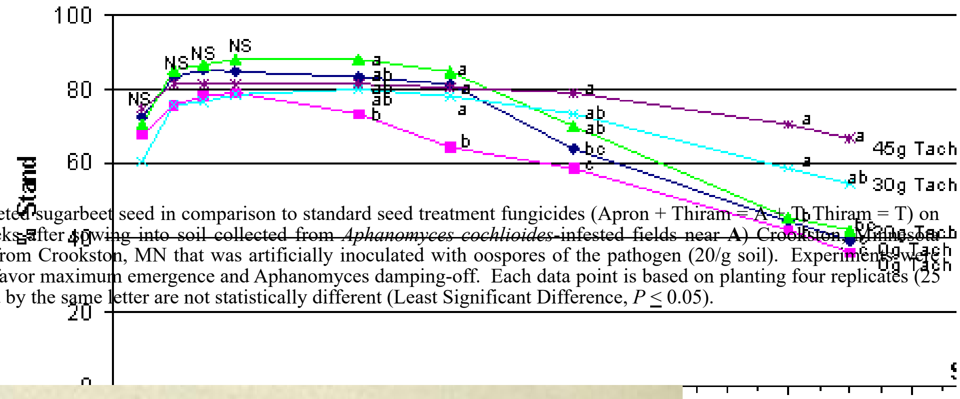
Final stand counts were made when the assay ended 28 days after planting (Fig. 1) and disease ratings of dead and surviving plants were used to calculate root rot indices (Table 1). In Soil 1, final stands were highest when planting seed treated with 45g of Tachigaren (67%) followed in descending order by 30g and 20g of Tachigaren, Apron + Thiram, and Thiram at 54, 42, 39, and 36%, respectively (Fig. 1A). These final stands are illustrated in Fig. 2A. Correspondingly, root rot indices in this soil were lowest when seed had been treated with 45g of Tachigaren (39), followed by the 30g rate (49). The root rot index value of seedlings from seed treated with 45g of Tachigaren was statistically lower compared to indices of plants from seed treated with 20g of Tachigaren and the controls, which were equally high (Table 1).

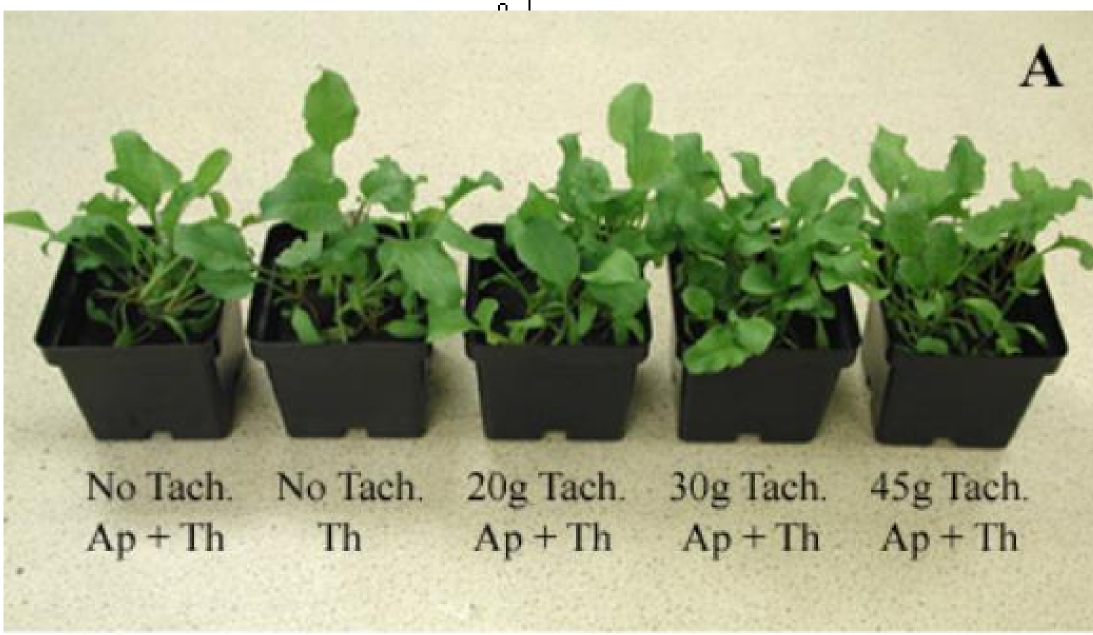
Final stands in Soil 2 also were highest from seed treated with 45g of Tachigaren (77%) followed in descending order by 20g and 30g of Tachigaren, Apron + Thiram, and Thiram at 69, 66, 44, and 42%, respectively (Fig. 1B). Root rot indices, however, were not significantly different among seed treatments, but seed treated with 45g of Tachigaren tended to result in the lowest index value (Table 1).

In Soil 3, final plant stands were equal and significantly higher (Fig. 1C) and root rot indices were equal and significantly lower (Table 1) for seed treated with all rates of Tachigaren compared to the Thiram and Apron + Thiram controls.

CONTROLLED ENVIRONMENT TRIAL 1

Fig. 1. Effect of various rates of Tachigaren (Tach) on pelleted sugarbeet seed in comparison to standard seed treatment fungicides (Apron + Thiram = A + T, Thiram = T) on percent emergence and damping-off during 4 weeks after sowing into soil collected from *Aphanomyces cochlioides*-infested fields near **A)** Crookston, Minnesota (MN) and **B**) Wolverton, MN and **C)** a field soil from Crookston, MN that was artificially inoculated with oospores of the pathogen (20/g soil). Experiments were conducted in controlled environment chambers to favor maximum emergence and Aphanomyces damping-off. Each data point is based on planting four replicates (25 seeds/replicate); for each date, data points followed by the same letter are not statistically different (Least Significant Difference, $P \leq 0.05$).





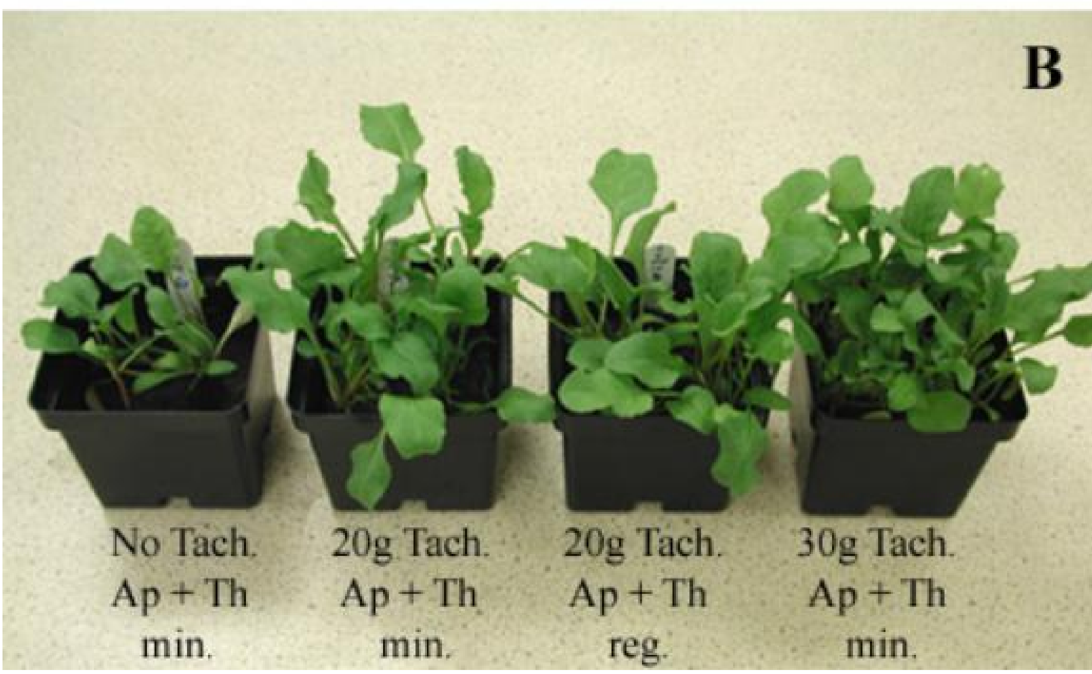


Fig. 2. Sugarbeet seedling stands at 4 weeks after planting seed treated with **A)** various rates of Tachigaren (Tach) on pelleted sugarbeet seed (Trial 1) and **B)** various rates of Tachigaren on minimum build-up pellets (min) and 20g of Tachigaren on pelleted seed (reg) (Trial 2) in comparison to standard seed treatment fungicides(Apron + Thiram = A + T, Thiram = Th). Seed was sown into soil collected from a field near Crookston, Minnesota that was naturally infested with *Aphanomyces cochlioides*. Experiments were conducted in controlled environment chambers to favor maximum emergence and Aphanomyces damping-off.

CONTROLLED ENVIRONMENT TRIAL 2

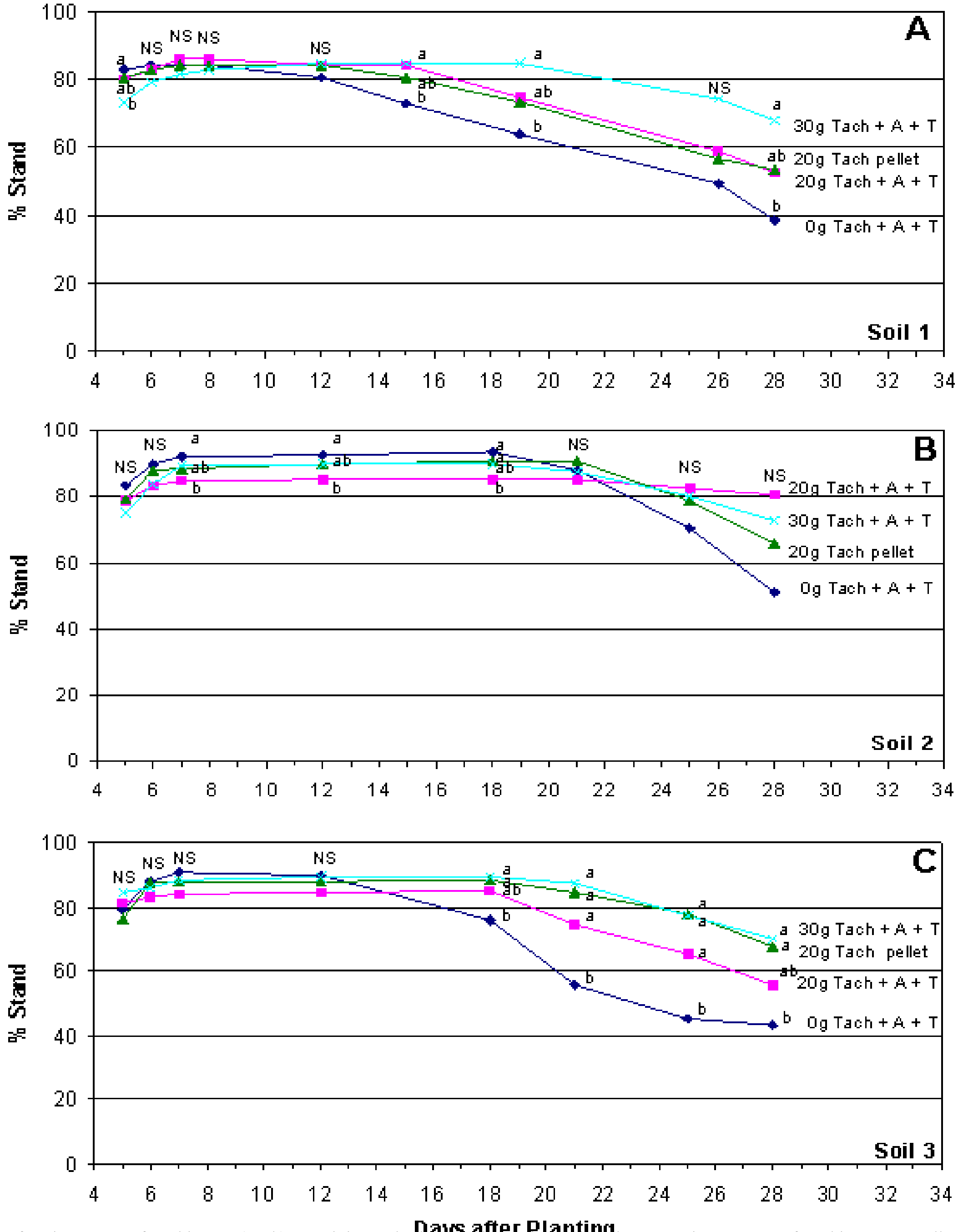


Fig. 3. Effect of various rates of Tachigaren (Tach) on minimum build-up pellets of sugarbeet in comparison to 20g of Tachigaren on pelleted seeds and controls (Apron + Thiram = A + T) on minimum build-up seed) on percent emergence and damping-off during 4 weeks after sowing into soil collected from *Aphanomyces cochlioides*-infested fields near **A)** Crookston, Minnesota (MN) and **B)** Wolverton, MN and **C)** a field soil from Crookston, MN that was artificially inoculated with oospores of the pathogen (20/g soil). Experiments were conducted in controlled environment chambers to favor maximum emergence and Aphanomyces damping-off. Each data point is based on planting four replicates (25 seeds/replicate); for each date, data points followed by the same letter are not statistically different (Least Significant Difference, $P \leq 0.05$).

Controlled Environment, Trial 2 (Minimum Build-Up Pellets). Total emergence of seedlings throughout the 4-week assay was very good (ranged from 85 to 93%) and there were no statistical differences among seed treatments sown in the three soils (Table 1). Total emergence, however, masked the dynamics of seedling emergence and stand loss during the 4-week assay, which is illustrated in Fig. 3. Most seedlings emerged from 5 to 7 days after planting (Fig. 3). During these first few days, stands tended to be highest for seed treated with Apron + Thiram and there usually were no statistical differences among seed treatments (Fig. 3). Seedling emergence of Tachigaren-treated seeds from 5 to 7 days after planting tended to be best for 20g on minimum-build up pellets in Soil 1 (Fig. 3A) but this seed treatment resulted in the lowest stands in Soil 2 (Fig. 3B) and Soil 3 (Fig. 3C) compared to the other seed treatments. The 30g of Tachigaren on minimum build-up seed tended to delay emergence slightly compared to other seed treatments in Soil 1 (Fig. 3A) and Soil 2 (Fig. 3B) but not in Soil 3 (Fig. 3C). The 20g rate of Tachigaren on pelleted seed resulted in stands comparable to the highest stands attained by the most effective rate of Tachigaren seed treatment on minimum build-up pellets sown in each soil (Fig 3).

Stand loss first occurred in the Apron + Thiram control from 8 to 18 days after planting, depending upon the soil. This seed treatment resulted in the most rapid and extensive stand losses compared to Tachigaren-treated seed throughout the assay and final stands averaged 39, 51, and 43% in Soils 1, 2, and 3 respectively (Fig. 3) Seed treatment with Tachigaren delayed the onset of Aphanomyces damping-off from 17 to 21 days after planting, depending upon the rate of product applied and soil (Fig. 3). Based on isolations from dying seedlings, the main cause of stand loss across all seed treatments was *A. cochlioides*, although *R. solani* also caused some losses in Soil 1.

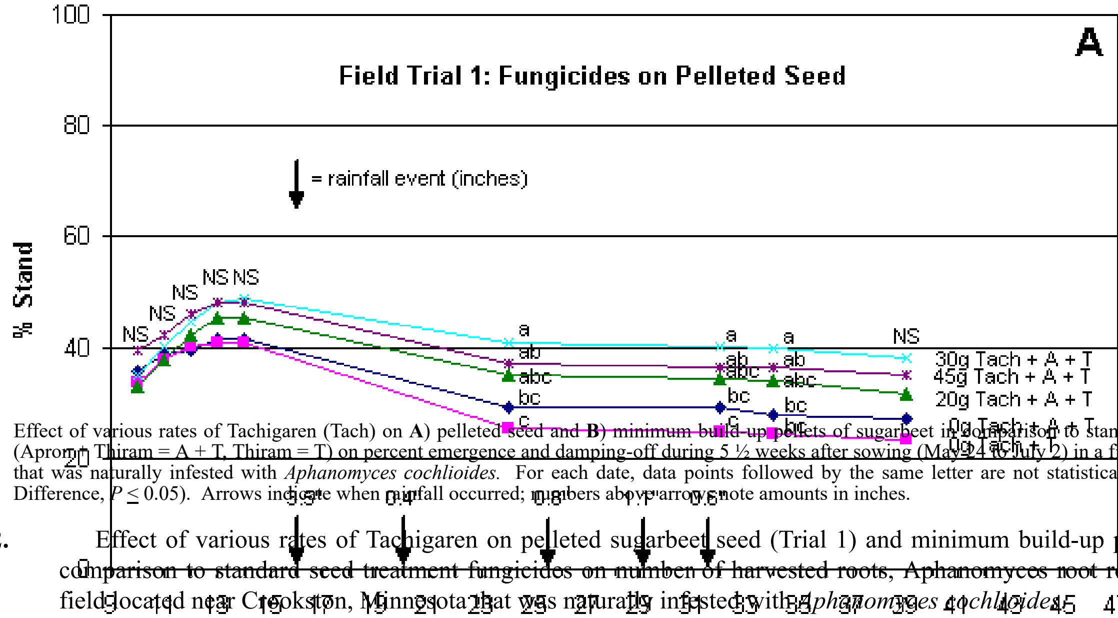
After the onset of Aphanomyces damping-off in Soil 1, seed treated with 30g of Tachigaren maintained the highest plant stands (compared to 20 g of Tachigaren on minimum build-up and pelleted seeds, which performed similarly) and was statistically greater than stands from seed treated with Apron + Thiram (Fig. 3A). These final stands are illustrated in Figure 2B. Root rot indices at 4 weeks after plating were not statistically different among seed treatments but tended to be lowest when 30g of Tachigaren had been applied to seed (Table 1).

In Soil 2, the 20g rate of Tachigaren on minimum build-up pellets resulted in the lowest stands among all seed treatments throughout the assay. By the last week of the assay, however, the 20g rate of Tachigaren on minimum build-up pellets maintained stands better than other seed treatments, although stands were not statistically different (Fig. 3B). Root rot indices were not significantly different among seed treatments in Soil 2, but seed treated with 20g of Tachigaren on minimum build-up pellets had the lowest index value (Table 1).

In Soil 3, 30g of Tachigaren on minimum build-up pellets and 20g of Tachigaren on regular pellets maintained equal and better stands than the 20 g rate on minimum build-up seed from 6 to 28 days after planting, although these results were not statistically different (Fig. 3C). Root rot indices were statistically lower for 30g of Tachigaren on minimum build-up pellets and 20g of Tachigaren on pelleted seed compared to the Apron + Thiram control (Table 1). The index value of seedlings from the 20g rate of Tachigaren on minimum build-up pellets was intermediate and not statistically different from the Apron + Thiram control and the other two Tachigaren seed treatments (Table 1).

Field Trial 1 (Regular Pellets). Emergence was delayed because soil was dry at planting on May 24, 2002. Only 0.16 inches of rainfall had fallen the previous 2 weeks and no rainfall occurred after planting until 16 days later (June 9). Seedling stands peaked about 2 weeks after planting and averaged only 50 to 60% (depending upon seed treatment) (Fig. 4A) because germinating seedlings desiccated and died due to lack of moisture. There were no statistical differences in stand at this time, but the 45 and 30g rates of Tachigaren had equally high emergence followed in descending order by the 20g rate, and the controls (Apron + Thiram, Thiram alone), which were equal. After a June 9 rainfall of 3.5 inches, the field was too wet to enter (plots were located about 1 mile into the field) until about 8 days later and by that time, Aphanomyces damping-off was occurring (confirmed by isolations from dying seedlings). From that point on, the 30g rate of Tachigaren retained the greatest stand and was the only seed treatment statistically better than the Apron + Thiram control through July 2 (39 days after planting), when the last seedling stand count was made. The other Tachigaren seed treatments resulted in intermediate final stands and the 45g rate resulted in a slightly higher stand than the 20g rate, but neither were statistically better than the controls. Seed treated with Thiram only had the lowest stand, which suggests that *Pythium* species also caused some stand loss, although it was not isolated from dying seedlings. An additional 2.9 inches of rainfall in the remainder of June continued to result in additional infections by *A. cochlioides.*

FIELD TRIAL



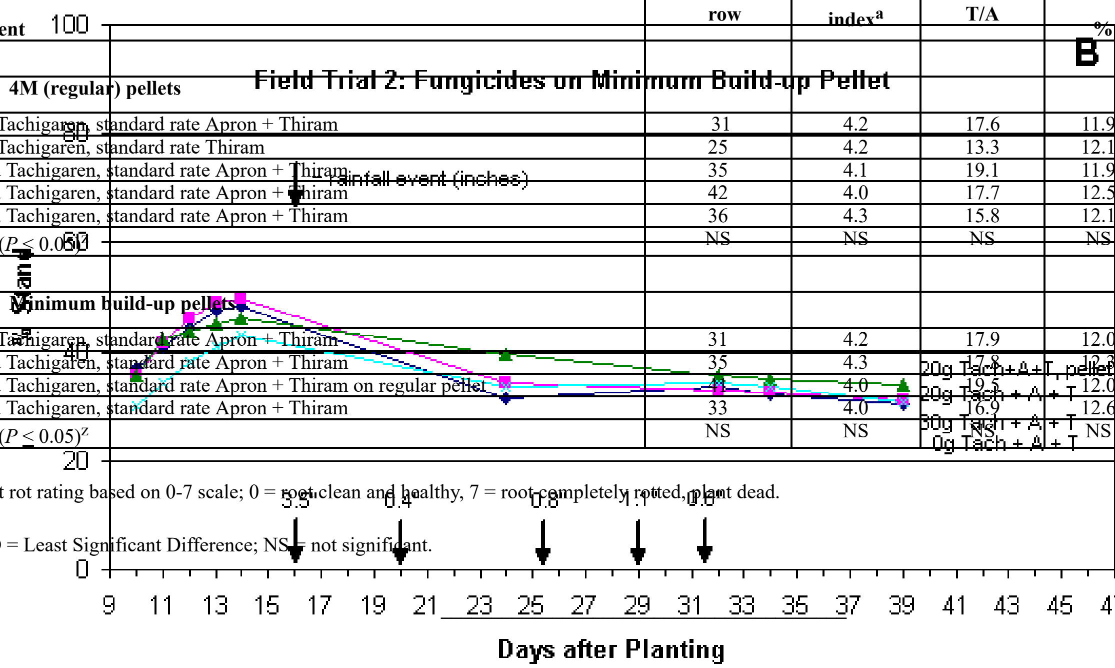


Fig. 4. Effect of various rates of Tachigaren (Tach) on **A**) pelleted seed and **B**) minimum build-up pellets of sugarbeet in comparison to standard seed treatment fungicides (Apron + Thiram = A + T, Thiram = T) on percent emergence and damping-off during 5 ½ weeks after sowing (May 24 to July 2) in a field near Crookston, Minnesota that was naturally infested with *Aphanomyces cochlioides*. For each date, data points followed by the same letter are not statistically different (Least Significant Difference, $P \leq 0.05$). Arrows indicate when rainfall occurred; numbers above arrows note amounts in inches.

Table 2. Effect of various rates of Tachigaren on pelleted sugarbeet seed (Trial 1) and minimum build-up pelleted seed (Trial 2) in comparison to standard seed treatment fungicides on number of harvested roots, Aphanomyces root rot ratings, and yield in a field located near Crookston, Minnesota that was naturally infested with *Aphanomyces cochlioides*.

Treatment	No. roots/60 ft row	Root rot index[a]	T/A	Sucrose %	Sucrose lb/T	Sucrose lb recover-a
Trial 1: 4M (regular) pellets						
0g/u Tachigaren, standard rate Apron + Thiram	31	4.2	17.6	11.9	192	3404
0g/u Tachigaren, standard rate Thiram	25	4.2	13.3	12.1	195	2650
20g/u Tachigaren, standard rate Apron + Thiram	35	4.1	19.1	11.9	190	3630
30g/u Tachigaren, standard rate Apron + Thiram	42	4.0	17.7	12.5	205	3606
45g/u Tachigaren, standard rate Apron + Thiram	36	4.3	15.8	12.1	198	3148
LSD ($P \leq 0.05$)	NS	NS	NS	NS	NS	NS
Trial 2: Minimum build-up pellets						
0g/u Tachigaren, standard rate Apron + Thiram	31	4.2	17.9	12.0	191	3430
20g/u Tachigaren, standard rate Apron + Thiram	35	4.3	17.8	12.3	198	3537
20g/u Tachigaren, standard rate Apron + Thiram on regular pellet	40	4.0	19.5	12.0	191	3741
30g/u Tachigaren, standard rate Apron + Thiram	33	4.0	16.9	12.6	206	3466
LSD ($P \leq 0.05$)[z]	NS	NS	NS	NS	NS	NS

[y] Root rot rating based on 0-7 scale; 0 = root clean and healthy, 7 = root completely rotted, plant dead.

[z] LSD = Least Significant Difference; NS = not significant.

Wet weather in July (3 inches) and unusually wet weather in August (9.2 inches) created conditions very favorable for Aphanomyces root rot throughout the season and ACH 999, a partially resistant variety, did not perform well. Plant stands continued to decrease throughout the summer and by harvest, there were no significant differences ($P \leq 0.05$) among treatments for number of roots harvested, root rot ratings, yield (tons of roots per acre), percent sucrose, pounds of sucrose per ton, or pounds of recoverable sucrose per acre (Table 2).

Field Trial 2 (Minimum Build-Up Pellets). As occurred in the pelleted seed trial, emergence was delayed and low for all seed treatments (Fig. 4B). Initially, the 30g rate of Tachigaren resulted in slightly lower stands than the other seed treatments, which were equal. After the onset of Aphanomyces damping-off, there were no significant differences in stand among seed treatments at any time.

Aphanomyces root rot continued to be active throughout the season. By harvest, there were no significant differences among treatments for number of roots harvested, root rot ratings, yield (tons of roots per acre), percent sucrose, pounds of sucrose per ton, and pounds of recoverable sucrose per acre (Table 2).

DISCUSSION

Seed treatment trials conducted in the three *Aphanomyces*-infested soils in controlled environment chambers showed considerable variation in seedling stands throughout the 4-week assay. All rates of Tachigaren seed treatment provided protection against Aphanomyces damping-off, although all underwent some stand loss. Based on previous trials in controlled environments where conditions are favorable for infections by *A. cochlioides*, a minimal stand loss from Tachigaren-treated seed usually begins about 3 weeks after planting. This initial loss in stand coincides with decomposition of the fungicide in soil and it's high solubility in water. In both controlled environment trials reported here, the 20g rate of Tachigaren on pelleted and minimum build-up seed tended to result in the highest initial emergence, which suggests that higher rates of Tachigaren can slightly retard emergence. When Aphanomyces damping-off became active, however, plant loss usually was greater for seedlings from Tachigaren-treated seeds at the 20 g rate compared to the highest rate of Tachigaren. Results were inconsistent for relative effectiveness of the 20g rate of Tachigaren on pelleted verses minimum build-up seeds for total emergence and ability to withstand Aphanomyces damping-off.
Environmental conditions in the 2002 field trial were inadequate to measure possible benefits of 20g rates of Tachigaren on rate of seedling emergence. Aphanomyces damping-off occurred across all treatments in both field trials but the 30g rate of Tachigaren in the pelleted seed trial was the only one that provided significant retention of stands compared to the Apron + Thiram and Thiram controls during June. The 3.5 inch rainfall that occurred on June 16 may have hastened decomposition of Tachigaren and thus, limited it's effectiveness. Although ACH 999 has partial resistance to *A. cochlioides*, 9.2 inches of precipitation in August created conditions overwhelmingly favorable for disease and plant resistance was ineffective. The combination of 5-inch space planting, poor emergence, and favorable environmental conditions for damping-off and root rot resulted in a poor harvest. Sugarbeet yields were very low because surviving plants tended to compensate for low stands by producing large roots that were low in sucrose. Overall, it was impossible to measure the benefit of any seed treatment. For future field trials it would be advisable to plant seed closer together to ensure higher plant populations and avoid poor yields and quality typically associated with poor stands.

Attempts were made to select a field trial site with moderate inoculum levels of *A. cochlioides*. When small-scale trials are conducted in fields with very low populations of *A. cochlioides* (e.g., soil index values less than 25), it often is difficult to show benefits from Tachigaren-treated seed because insufficient disease or no disease develops. In previous controlled environment trials, we found that planting Tachigaren-treated seed (45g rate) of a susceptible or a partially resistant variety resulted in statistically significant reductions in root rot compared to seed treated with Apron + Thiram at soil index values of about 37. Although not statistically significant, we also noted that planting Tachigaren-treated seed (45g rate) resulted in less root rot than Apron + Thiram–treated seed at soil index values of 10 when planting a susceptible variety and soil index values of 25 for a partially resistant variety. Thus, fields with soil index values as low as 10 can benefit when planting seed treated with 45g of Tachigaren.

If the 20g rate of Tachigaren were adopted as a standard sugarbeet seed treatment, it would be of most potential benefit to producers who are unaware of an Aphanomyces problem in their fields. Growers with fields known to be infested by *A. cochlioides*, even at low levels, should plant seed of partially resistant varieties treated with a 45g rate of Tachigaren. Tachigaren ensures the best protection from Aphanomyces damping-off that is available when favorable (wet and warm) soil conditions occur; after the first month, plant resistance becomes more active and expressed. Plant resistance, however, cannot withstand enduring and persistent disease pressure throughout the growing season and should not be relied on as the sole method for managing *A. cochlioides*.

Producers who have low soil index values due to *A. cochlioides* should be cautious in planting seed treated with low rates of Tachigaren (e.g., 20g). This is because the soil index value is an <u>average</u> value based on soil cores collected from multiple sites in a given area. Consequently, some parts of the field will be more heavily infested, and others less infested, than the average soil index value reveals. Thus, "hot spots" could show up in fields with a low soil index value when conditions are favorable for damping-off. Then, stands from seed treated with 20g of Tachigaren could suffer considerable stand loss and root rot.

Overall, the trials reported here show that the 45 g rate of Tachigaren is the most consistent seed treatment in maintaining seedling stand and reducing root rot within 4 weeks after planting. While the 20g rate was the most consistent Tachigaren seed treatment in achieving stand, it performed erratically in maintaining stand and any benefits gained in higher emergence were typically negated by Aphanomyces damping-off. Planting seed treated with 20g of Tachigaren may be most beneficial for growers who do not have a history of *A. cochlioides* in their fields but are located in regions where neighboring fields have documented Aphanomyces problems. If this approach is adopted in Minnesota and North Dakota (where *A. cochlioides* is fairly widespread), it would be advisable for at least a 20g rate of Tachigaren to be applied as a standard with seed treatment with Apron + Thiram. Growers with a known history of *A. cochlioides*, however, are advised to plant seed of varieties with partial resistance to *Aphanomyces* that are treated with 45g of Tachigaren.

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