sirable characteristics of high acidity and low total soluble solids. The results do allow an estimation of the amount of detachment force required to obtain fruit of a minimum processing standard based upon deformation force, total soluble solids, and acidity. Fruit with a detachment force less than 4 kg could be expected to have a pulp having pH 3.0 less than 16 meq/100 g fresh weight titratable acidity and at least 6° Brix. Fruit detachment with a force 2 kg or less had a pulp with pH 3.0, less than 14 meq/100 g titratable acidity with 7° Brix. Fruit detachment force, total soluble solids, and titratable acidity can therefore be used as maturity indexes for harvesting. Total soluble solids greater than 12° Brix has been recommended as a maturity index for a dessert-type cultivar (12), the corresponding value for the cultivar used in this study would be 6° Brix. Delaying harvesting means that more fruit would both show disease and be more susceptible to mechanical injury during harvesting (Fig. 1B). There would also be an increase in fruit falling before harvesting.

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Field Inoculation of Sweet Corn with the Head Smut Pathogen (*Sphacelotheca reiliana*)[1]

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Abstract. **Methods of field inoculation of sweet corn (*Zea mays* L.) with *Sphacelotheca reiliana* (Kühn) Clinton for head smut resistance tests were evaluated. Application of a mixture of teliospores and slightly dampened vermiculite with the seed by means of a V-belt planter was the best method tested and resulted in a 95% disease incidence in the most susceptible cultivar. Application of this mixture by hand in individual planting holes resulted in greater disease incidence but required much more labor and inoculum.**

Head smut, caused by *Sphacelotheca reiliana*, is a serious disease of sweet corn (*Zea mays* L.) in several western states (2, 6, 10) and has recently been reported in Minnesota (12). Because host resistance is potentially an effective control for head smut, a field method is needed to produce high and consistent incidence of disease to identify resistant germplasm. Inoculation techniques have been developed for greenhouse screening, using spores mixed with potted soil (4, 7, 8), hypodermic inoculation (3), and vacuum infiltration (9, 11). Halisky (5) performed some field soil inoculations, but his methods are not adaptable to extensive screening. In a preliminary, nonreplicated field trial, Baier and Krüger (1) tested soil-sand, vermiculite, and sand as spore carriers, but these were not superior to soil alone.

Reported below is an inoculation method which has provided acceptable disease incidence for 4 years and is routinely used in screening cultivars and testing progenies in a study of the inheritance of head smut resistance in sweet corn.

Inoculation experiments were conducted on a research farm at Corvallis, Ore. The area used had not been infested artificially but was subject to natural infestation by spores drifting from infested plots and commercial fields in the area. The corn plants were spaced 22–30 cm apart in rows one m apart. Fertilizer (600 kg/ha of 8N–10.3P–6.6K) was band-applied prior to planting. A light irrigation by sprinkler was used immediately after planting to obtain uniform germination. Otherwise, irrigation was avoided during the early growth stages to increase infection potential.

The experiments involved 4 sweet-corn cultivars representing several relative levels of susceptibility: 'Sugar Daddy' (extremely susceptible), 'Sundance' (susceptible), 'Jubilee' (intermediate), and 'Gold Cup' (relatively resistant).

Inoculum was obtained by harvesting teliospore masses from infected ears the previous season. The inoculum was dried in the sun or a warm room, stored overwinter in plastic bags in a dry, unheated room, and rubbed through coarse screens in preparation for use. The average spore concentration of the screened mass was 1.4×10^8 spores/cc as determined by dilution and direct count with a haemocytometer.

Disease incidence was determined after corn reached full edible maturity. A plant was counted as infected if sori were found on an ear or tassel.

A preliminary nonreplicated test was made in 1977. Methods tested were: 1) coating seeds with a mixture of one part spores with 2 parts of a 5% solution of methylcellulose; 2) about 240 cc (1 cup) of spores mixed in 3.8 liters (1 gallon) slightly dampened vermiculite, and applied with spore-coated seeds in a V-belt planter[4], using about 470 cc (1 pint) of the vermiculite-spore mix in 7.6 m of row; 3) about 17 cc of spores suspended in one liter (1 qt/15 gallons) and 120 cc (1/2 cup) poured over each seedling at coleoptile emergence; 4) seeds planted in spaced holes and covered with about 100 cc per hole of spore-vermiculite mix and 2–3 cm of soil; and 5) noninoculated control. Methods 2, 3, and 4 were also tested in combination with spore-coated seeds.

The preliminary 1977 tests indicated that

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[4]The belt planter was fabricated locally using wheels, planting shoe, and other parts from a standard Planet Jr. unit. It employs a rubber V-belt obtained from Bridge and Tank Ltd., Winnipeg, Canada.

Table 1. Effect of inoculation method on head smut incidence in 4 sweet corn cultivars, 1978.

Treatment	Incidence of head smut (%)				
	Sugar Daddy	Sundance	Jubilee	Gold Cup	Treatment mean
1. Vermiculite and spores; belt planter	95.8 b[z]	91.7 a	44.0 a	15.4 b	61.7 b
2. Vermiculite and 1/2 rate of spores; belt planter	96.0 b	91.2 a	33.0 a	13.0 b	58.3 b
3. Vermiculite and spores; hill planting	100.0 a	95.0 a	47.6 a	33.8 a	69.1 a
4. Spore-coated seed	37.6 q	54.5 p	4.0 r	2.3 r	24.6
5. Noninoculated control	4.7	10.8	4.7	1.2	5.4
Cultivar means	66.8	68.6	26.6	13.1	

[z]Mean separation in columns of treatments 1–3 by Duncan's multiple range test, 5% level, based on arc sine transformation. Treatments 4 and 5 were determined to be the source of a treatment × cultivar interaction and are considered separately from treatments 1–3. Mean separation in rows of treatment 4 by Duncan's multiple range test, 5% level.

a mixture of spores and vermiculite applied with a belt planter could be used effectively to inoculate field plots. Infection on 'Sugar Daddy' was 98% with this method and there was a good differential between cultivars in different susceptibility categories. There appeared to be a slight advantage in hill-planting compared to a belt-planter application. Pouring a water suspension of spores over the emerging plants produced as much infection as the vermiculite method, but this method was discontinued because it required a large volume of water. Coating seed with spores slightly increased infection over the control and usually resulted in only slight increases when used with the vermiculite method.

In the 1978 experiments, plots were 10.6-m long, containing an average of 45 plants/plot. Five treatments were replicated 4 times in a randomized block design: 1) spores in vermiculite (50 cc spores/liter of vermiculite) applied with the seed in a V-belt planter at about 0.7 liters of inoculum per 10.6-m plot; 2) same as treatment 1 with 25 cc spores/liter of vermiculite; 3) same inoculum as treatment 1, applied over seed in holes at the rate of about 100 cc of spore-vermiculite mix per hole, covered with about 2–3 cm of soil; 4) seed heavily coated with spores and methyl cellulose; and 5) noninoculated control.

A second, smaller 1978 experiment was conducted to determine further if seed inoculation is of benefit when used with the vermiculite and spore mixture. In this test, the following treatments were replicated 2 times in a randomized block design: 1) spores in vermiculite at the same concentration as in treatment 1 in the first 1978 experiment; and 2) vermiculite and spores as in treatment 1, but with spore-coated seed.

In the first 1978 experiment (Table 1), the use of vermiculite as a spore carrier was effective either in hills or with the use of a belt planter, giving infections of 96–100% with 'Sugar Daddy' and 91–95% with 'Sundance'. There was no difference between the 2 rates of spores mixed with vermiculite. Use of vermiculite in individual planting holes gave a greater mean percent infection. The difference was not statistically significant for 'Sundance' and 'Jubilee', but the cultivar × treatment interaction for treatments 1–3 was not significant. The potential benefits from using the hole method do not warrant the additional labor required.

The use of spore-coated seeds was less effective than the use of vermiculite ($F = 328$ for treatment 4 vs. treatments 1–3). The average percent infection was greater for spore-coated seeds than for the noninoculated control, but the difference occurred only with the 2 most susceptible cultivars, 'Sugar Daddy' and 'Sundance'. Cultivars were affected very differently by the use of spore-coated seeds and noninoculation than they were by the other 3 treatments. In the case of the noninoculated control, this difference was likely due to a random natural infestation of the soil. This random infestation was over-shadowed by the high amounts of inoculum provided by treatments 1–3.

In the second 1978 experiment there was no increase in infection by coating seeds with spores when they were planted with the spore-vermiculite mix in the belt planter. For the 2 most susceptible cultivars, coating the seeds resulted in a decrease in percent infection, but the differences were not significant. The cultivar × treatment interaction was not significant.

In these tests we were seeking a method that would result in a high disease incidence and would also be adapted to the extensive field plantings which might be needed in breeding programs, cultivar tests, and genetic studies. The application of a spore-vermiculite mixture with the seed in a belt planter was the most efficient method we tried and has been adopted for general use in our research program. Although effective, the water suspension of spores was discontinued because it required a large amount of water. The use of vermiculite placed over the seed in individual holes was slightly more effective than the belt-planter method, but required 5–10 times as much labor in the field, as well as a greater quantity of inoculum. There appears to be no advantage in further trials of seed-inoculation methods, because of mediocre to poor results and because coating seeds with spores requires as much labor as the vermiculite method.

Routine, uniform use of inoculum in planting could minimize variations in infection caused by variations in natural inoculum. In our tests, there has been some expansion of the plot area into noninfested soil each year without resultant variation or reduced disease incidence. A major disadvantage of large-scale inoculation is the requirement for harvest and preparation of large amounts of inoculum.

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