A Continuous Spray-type Seed Treater[1]

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In recent years most seed treatment has been done by dusting the fungicides upon the seeds in either batch or continuous treaters. This method, however, has not been entirely satisfactory, chiefly because the dusts may be offensive to the operator during treating or to the grower during planting.

The introduction of the slurry treater, the development of the Spreckels batch spray treater (1) (2) and the formulation of wettable fungicides represent real advances in dust elimination. However, there still remains a demand for a continuous seed treater of high capacity which will apply soluble or wettable fungicides to all types of seeds in a uniform manner.

The spray treater discussed in this paper was developed in an attempt to satisfy this demand. After tests on a full-scale experimental unit had shown that seeds could be treated uniformly and effectively with it, a model suitable for commercial production and large-scale operation was designed, and one machine was built for the Holly Sugar Corp. This paper will deal primarily with the tests and operating principles of the experimental unit, but occasional reference will be made to the commercial unit.

Description and Operation

A side view of the experimental unit is shown in Fig. 1. During the tests, two cup-type elevators (not shown) were used to recirculate seed into the hopper when the spray was not being used or to put sprayed seed into bags or into a weighing can on scales. In the operation of the treater, seed is metered into one end of the rotating drum and is spilled out at the opposite end after being treated. Metering of the seed is accomplished by means of a 4 1/2 inch diameter-vaned wheel 14 inches long, which maintains a practically constant volumetric rate at a given rpm. On the inside of the drum is a liner made from sheets of corrugated aluminum roofing (Fig. 2). As the drum rotates, the corrugations carry seed up from the bottom, spreading it over a band about 1 to 2 inches thick, extending from the lowest part of the drum up through an angle of 80 to 100 degrees. The spray material is directed onto this band of seed by a fan-type weed nozzle mounted inside the drum about 2 ft. from the inlet end and 45 degrees down from the top of the drum. The drum was made 3 ft. in diameter so that the nozzle could be placed far enough away from the seed surface to allow good dispersion of the spray before striking the seed. The 6-ft. length of the drum accommodates a standard size of corrugated roofing. The corrugated liner is self-cleaning because of the absence of sharp corners, the flatness of the corrugations with respect to the drum, and the resultant scouring action of the seed.

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[4] The numbers in parentheses refer to literature cited.

The spray system is the most involved part of a spray-type seed treater and is the part most likely to give trouble in field use, primarily because most of the presently-used treating materials are insoluble powders which must be kept in suspension (usually in water) during application. In order to keep these insoluble materials in suspension, agitation is required in the supply tank, and adquate velocities must be maintained in pipes. The suspended material tends to clog screens and nozzles and may permanently plug small pipes after a shutdown unless the system is flushed. Nozzles must be small because only a very low percentage of moisture can be applied to seeds (less than one per cent maximum on some seeds) ; yet they and the screens must be large enough to pass the suspended particles of treating material.

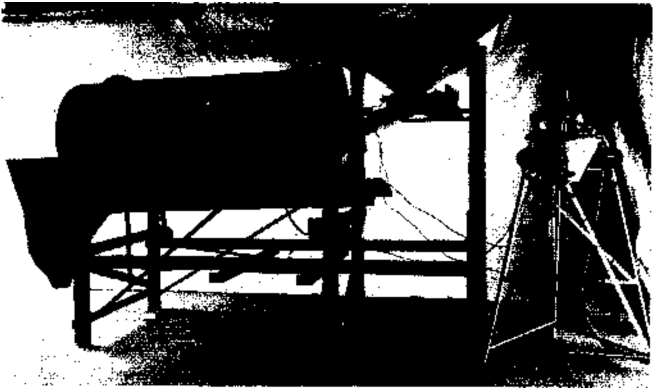

Figure 1. Experimental Seed Treater. Seed **hopper** is **above right end** of rotary drum, with seed meter attached to bottom of hopper.

Another problem encountered in connection with the spray system is that of abrasion caused by the suspended particles. Some of the materials are so abrasive that a gear pump will wear out in a few days, and brass nozzles would have to be replaced after only a few hours of operation. Because of the abrasion problem, it was decided to use a pressurized supply tank with the agitator shaft entering from the top, so that no pump would be required and no wearing parts would be in contact with the suspension.

The 5-gallon pressurized tank used with the experimental machine is shown at the right in Fig. 1. The commercial treater has a 25-gallon tank. In regard to nozzle erosion, preliminary checks indicated that stainless steel nozzles are much superior to brass nozzles in this respect (3). Later tests (4) have shown hardened stainless steel nozzles to be even better than ordinary stainless steel.

Performance

The experimental treater was tested for treating decorticated sugar beet seed, milo (grain sorghum) and baby lima beans, under various combinations of drum speed, drum slope, nozzle pressure and seed rate. For all treating runs, a green dye was used in the spray mixture; sprayed seeds were then examined visually and sorted into light, medium and heavily colored groups, using an arbitrary standard of division. In addition, plantings were made in sterile soil or sand to check for injurious effects and in infested soil to measure protection. Preliminary developmental work was carried out with decorticated sugar beet seed because its rough, absorbent outer surface makes uniform distribution of a liquid more difficult than on smooth-coated seeds, such as lima beans.

The maximum rate for satisfactory coverage of sugar beet seed appeared to be about 3,300 pounds per hour. A 2 percent application of moisture was used in most of the beet seed runs, although 4 percent was used in one trial. In treating milo, the only seed rate tried was 6,300 lbs. per hour, using a 1 percent moisture application. With baby lima beans, trials were made with ½ percent moisture added at a seed rate of 8,100 lbs. per hour and with 1/4 percent at 11,000 lbs. per hour. Satisfactory coverage was obtained in each case, with no mechanical injury to the seed. In limited comparisons with beet and milo seeds, nozzle pressures of 25 to 28 lbs. per sq. inch appeared to give as uniform coverage as a pressure of 60 lbs. per sq. inch.

With both sugar beet seed and milo, the most uniform application was obtained when the drum axis was about 2 degrees below horizontal. The results of an analytical study of the action on the rotating drum (3) are interesting and useful in understanding the effect of drum slope and of other variables involved. The action of the corrugated liner (Fig. 2) is such that one layer of seed is being carried upward by the corrugations, while a second layer in contact with the first one is moving downward as a result of gravity. Spray from the nozzle strikes those seeds which are at or near the exposed inner surface of the downward-moving layer. If we neglect the effect of turbulence and intermixing between the two layers, it is evident that the probability of a particular seed's being hit by the spray would be a function of the thinness of the downward-moving layer, the size of the seeds, and the number of times a seed passes downward within the longitudinal limits of the spray zone.

Based upon measurements of the total amount of seed in the drum during operation and the total area covered by the seed band, the average total thickness can be computed readily. By further calculations, based on some rather broad assumptions (3) , the thickness of the *downward-moving* portion of the seed layer can be determined in terms of number of seeds, and the average number of times that a seed would pass downward within the spray zone can be "estimated." Table 1 shows the results of these cal-

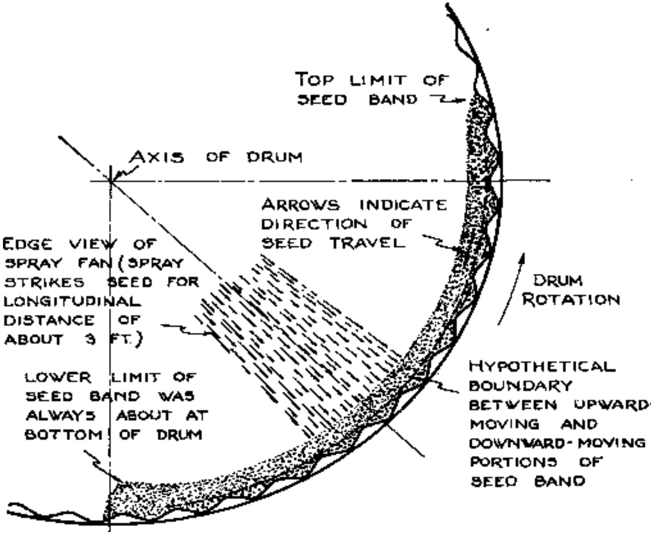

Figure 2. A cross section of the rotating drum showing details of its operation.

culations, as well as the results of the color sorting, for one group of runs at various drum slopes, using sugar beet seed. The percent light-colored seeds is an experimental measure of non-uniformity of coverage, while the relative magnitudes of the figures *in* the two right-hand columns give a theoretical indication of expected uniformity of coverage. For example, changing the drum slope from 1 degree to 2 degrees (outlet end lower than inlet) reduces the layer thickness from 7 to 4 seeds but reduces the possible number of exposures only from 7.5 to 6.4; thus this change would be expected to improve the coverage. Note that the 2-degree run does show the lowest percent of light-colored seeds, indicating the most uniform coverage.

Table 1.—Uniformity of Coverage as Related to Drum Slope.

Drum slope, degrees below horiz.	Percent light colored seeds	Percent medium colored seeds	Avg. total thickness of seed band, inches	Estim. avg. thickness of downward moving layer, No. of seeds	Calc. Avg. No. of times a seed passes down through spray zone
0	13	87	1.95	13	7.4
1	11	89	1.26	7	7.5
2	5	95	0.83	4	6.4
3	9	91	0.60	3	5.1

Used decorticated sugar beet seed at 53 lbs. per min., with 2 percent moisture added. Drum speed, 25 rpm; nozzle pressure, 60 lbs. per sq. inch.

As a further test of the protection afforded by fungicides applied with the experimental treater, samples from a number of runs were planted in greenhouse flats in soils infected by *Pythium ultimum,* in comparison with non-treated seeds and with dusted seeds. The degree of protection was measured by the emergence and survival of seedlings under conditions extemely favorable for both pre-emergence and post-emergence damping-off. In nearly all cases the spray-treated seeds produced stands significantly higher than non-treated seeds. Because of the limited extent of these trials and the normal variability in this type of test, most of the differences between runs of the spray treater are not statistically significant. However, with sugar beets, the runs which appeared most uniform in the color sorting tended to provide the highest degree of protection. With milo, there were no significant differences in protection between the different spray applications or dusting, but all treated lots showed significantly better emergence than the non-treated seed.

In connection with performance tests of the commercial version of the spray treater (at Holly Sugar Corp., Stockton) , additional tests were made using seed from a single lot to obtain a direct comparison between spraying, dusting and slurry treating. Since tests involving all three treating methods were not run in connection with the experimental unit, the results obtained with the commercial unit are included in this paper. With each of the three methods, the treatment was 4 oz. Phygon XL plus 5 1/3 oz. 75 percent lindane, per 100 lbs. of seed, applied simultaneously. The slurry treater was operated at about 70 lbs. of seed per min. with 1 percent moisture added, while the spray treater had a seed rate of 52 lbs. per min. with 2 percent moisture added. The commercial spray treater has a fixed drum slope of 2 degrees below horizontal and operates at a drum speed of 25 rpm; the nozzle pressure during these runs was 30 lbs. per sq. inch.

Table 2.—Protection and Uniformity of Coverage on Beet Seed for Three Methods of Treating.

Treating Method	Color sorting results: % Heavily Colored	% Light Colored	% Medium Colored	Seedlings per 100 seed units: Pasteurized soil, emerg.	Pythium-infested soil: emergence	Survival
Non-treated	0	100	0	164	60[1]	18
Slurry treated	7	35	58	147	97	45
Spray treated	0	3	97	146	127	67
Dusted	...	....	....	140	141	90
Least significant difference, 19:1 odds				n.s.	29	31
Least significant difference, 99:1 odds				n.s.	41	42

[1] Blackface figures indicate significant difference from dusting (99:1 odds)

Table 2 presents the results of the color sorting and the results of the greenhouse tests in Pythium-infested soil. Note that the sprayed sample had only 3 percent light-colored seeds and no heavily-colored seeds, while the slurry treatment gave 35 percent light seeds and 7 percent heavily colored. With some treating materials, the over-dosage indicated on heavily-colored seeds would be injurious to these seeds. In regard to the greenhouse tests (last three columns in Table 2), there were no significant differences in emergence in pasteurized soil, indicating no injurious effects from the treatments. In the Pythium-infested soil, emergence and survival of both the slurry-treated and the nontreated samples were significantly lower than for the dusted sample. Differences between the dusted and sprayed samples were not significant, although the sprayed sample was slightly lower than the dusted sample in both emergence and survival. However, in subsequent tests involving several other lots of beet seed (4), the results favored the spray treatment as often as they favored the dust treatment; in general, they indicated that protection obtained with the spray treater was equal to that obtained by dusting.

Summary

The seed treater discussed in this paper is essentially a high-capacity constant-rate machine and is not particularly suited to the treatment of small lots of seed. The maximum seed rate is determined by the ability of the machine to apply the treating material uniformly. For sugar beet seed, this maximum is probably about 3,300 lbs. per hour. Protection obtained at this rate was equal to that obtained by dusting at the same dosages. The minimum seed rate when applying materials suspended in water is determined chiefly by the minimum size of nozzle which can be used without clogging and by the maximum percentage of moisture which can be added to the seed. A 2 percent application of moisture was used in most of the beet seed runs, although 4 percent can be applied safely.

The principal problems encountered in the use of such a treater are:

(a) *Clogging of nozzles and screens by suspended materials.* Proper selection of nozzle and screen sizes **minimizes this problem. The use of soluble or liquid materials and the improvement of present formulations of insoluble materials would also help.**

(b) *Abrasive action of suspended materials.* Pump troubles have been eliminated by use of a pressurized supply tank with the agitator shaft entering from the top. Erosion of nozzles apparently can be kept within reason by use of hardened stainless steel instead of brass.

(c) *Settling of suspended materials in pipe lines.* Overcoming this problem requires the use of small-diameter lines to maintain adequate velocities and involves flushing the lines with air or water whenever the machine is shut down.

The chief advantages of this treater are:

(a) Uniform coverage, even on rough absorbent seeds, such as sugar beets.

(b) Protection of the operator from dangerous or obnoxious materials. (The commercial model is completely enclosed to confine the treating spray.)

(c) Reduction of dust nuisance in subsequent handling of treated seed (as compared to dusted seed).

(d) Ease of complete emptying and cleaning. The drum is self-cleaning, with no corners in which wet seed might stick and accumulate, and at a 2-degree slope will empty itself within a minute or two after the seed supply is stopped.

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