Alternative Methods For Density Grading Of Sugarbeet Seeds: A Proposal

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Abstract
Sugarbeet seeds are selected on "gravity tables" to provide high density seeds that exhibit superior germination and emergence to non-selected seeds. Use of gravity tables allows separation under dry conditions, thus, the seeds do not require drying before treatment and packaging. However, the advent and increased use of seed priming and other preconditioning treatments obviate the need for keeping seeds dry, and opens alternative, and possibly more useful methods of gravity grading that involve moistening of seeds. We propose two methods of achieving gravity-based seed separation with moist seeds. 1) Premoistened seeds could be dispensed into a stream of flowing water. Seeds with densities less than 1.0 (that of water) would float, whereas those with greater densities would sink in the flowing water, with the velocity of sinking being dependant upon their relative densities. Passage of the moving stream of seeds and water through a set of baffles would allow separation of seeds into discrete, preselected density classes. 2) Alternatively, mixtures of seeds and water could be pumped into hydrocyclones. The flow of material into these devices produces a cyclonic flow within them that causes centrifugal separations of materials that then can be drawn off in a binary separation. Either of these proposed grading methods seems likely to provide improved gravity-based separations that may provide planting seed of improved quality.

Introduction

Germination and stand establishment by sugarbeet planting seed are major concerns in sugarbeet production. Among the procedures administered to sugarbeet seed is one called gravity grading. This is accomplished by passing polished seeds across a slanted, vibrating plane called a gravity table. This procedure allows separation of seeds into groups with high seed density (high ratio of mass to volume) and low density (low ratio of mass to volume). This method of selecting for high density sugarbeet seeds has been shown to enhance crop productivity through selection of seeds with a higher probability of germinating and emerging from the soil.

Sugarbeet seeds are quite irregular in shape (ie. not smooth or spherical), and thus tend not to be separated into density groups on a gravity table as effectively as within water. Gravity tables, however, have afforded the advantage of retaining the seeds in a dry condition, thus avoiding the additional processing required for seed drying.

Priming of sugarbeed seeds, a pregermination treatment that involves imbibition of seeds with water, followed by drying and pelletization, is a recent development in sugarbeet seed processing. Doing the priming immediately following gravity grading would eliminate the need to keep seeds dry through the gravity grading stage. Thus, use of gravity separation procedures involving immersion in water may now be a desirable option in sugarbeet seed processing.

We present an experiment on the performance of seeds density graded in an aqueous system. We also propose two methods of seed density grading in aqueous systems; one exploiting differential settling rates of seeds in water, and the other involving centrifugal separation in a hydrocyclone.

Experiment
Methods:

Polished, but nongraded seeds of the varieties American Crystal 185 and American Crystal 319 were obtained from the Michigan sugarbeet seed processing plant in Bay City, MI. A portion of these seeds (nonselected) were immersed in water for 5 minutes, air dried for 2 days, and saved for later use. The remaining seeds were immersed in water and separated into those that floated (low density), and those that sank. Water was drained from the seeds that sank, and they were then immersed in a sucrose solution of 200 g/L (density = 1.075). Seeds that floated on the sucrose solution were saved as medium density seeds, and those that sank were saved as high density. These seeds were washed with agitation in flowing water for 2 minutes.

Numbers of seeds in each density group were determined. Quadruplicate samples of 200 seeds were weighed. Seeds were placed in rolled germination towels (4 towels per treatment, 50 seeds per towel) and inncubated at 22 C; numbers germinated were counted 3, 6, and 9 days after the start of germination. Data were used to determine germination speed (germination index) and percentages. Samples of 200 seeds were planted in field plots (25 foot rows, 6 replications). Stand counts were made on 20 feet of each row, 5 weeks after planting

Results:

Results of the experiment are summarized in Table 1. Statistically significant differences among seed groups were found for all parameters (weight, germination percentage, germination index, and stand). The densest seeds were the heaviest, had the highest germination percentages, germinated most quickly, and gave the highest stand numbers in the field.

Discussion:

The results of this experiment confirm previous studies in demonstrating the benefits of density grading polished sugarbeet seeds. However, there are two major deficiencies in the study relative to commercial application of density grading in aqueous systems. First, experiments should involve planting to stand and determinations of the effects of density grading on yield. Second, the density grading methods employed are unlikely to be directly applicable to commercial use.

The remainder of this presentation proposes two methods of density grading in aqueous systems that may be adaptable to commercial scale use.

Proposal: Two alternative methods for density grading of sugarbeet seeds in aqueous systems

I. Differential Sedimentation Rates

This method is based upon a system developed by Dr. Otto Kunze at Texas A & M University for density grading of cottonseed. The underlying principle is that seeds of high density (mass per unit of volume) will sink at a faster rate in water than seeds with lesser densities. Seeds with densities less than that of the liquid (density of water = 1) will float.

In this system seeds are dispensed into a moving stream of water within a tank. The densest seeds sink fastest in this stream. Length and velocity of the water stream can be adjusted so that the densest seeds are near the bottom of the tank at the point where the moving water exits. The water exits the tank through a set of adjustable baffles. These baffles allow separation of the water stream into fractions containing seeds of the desired density classifications. Variability in separations is required so that differing, predetermined fractions can be collected from different varieties and seed lots.

Specific design requirements of the system would include: 1) a mechanism to assure laminar flow of water through the tank, 2) a means of controlling the flow rate through the tank, 3) a means to premoisten and provide uniform dispensing of seeds into the water stream, and 4) a baffle system that allows variations in the collection of fractions.

II. Hydrocyclone

Hydrocyclones provide established technology for density-based separations of materials. In practice, a mixture of fluid (eg. water) containing particulate materials (seeds) is pumped at a high velocity into the device, and this flow establishes a cyclonic flow within it. The cyclonic flow establishes a centrifugal field such that particulate materials denser than the fluid move toward the outside wall of the device, whereas materials that are less dense than the fluid move toward the center. The particulate-containing fluid then flows from the hydroclone, with the fraction from the central portion, and that from the outer portion of the device being collected separately, thus providing a binary (two-part) separation. With this system, variations in the minimum density of the particulate materials in the "dense fraction", and therefore, the maximum density of materials in the "light fraction", are achieved through varying the density of the carrier liquid. One means of achieving variation in liquid density would be through use of sugar solutions.

Comments

1. It is anticipated that either of the proposed systems could be engineered such that a single device would handle the seed requirements of 1-200,000 acres of sugarbeet production within a 2-month period.
2. Estimated cost of a differential sedimentation system is not available.
3. Estimated cost of a hydrocyclone system is about $25,000, including the hydrocyclone and a pump.
4. Experiments would be needed to determine the efficacy of either system in terms of cost and of benefit to the growers.

Table 1. Seed characteristics and performance of density graded seeds.

Variety	Sample*	% of Seeds	Seed weight (g/200)	Germination %	Germination Index
ACH 185	NS	100.0	2.06	71	0.51
	LD	25.5	1.92	40	0.31
	MD	39.5	2.05	65	0.45
	HD	35.0	2.11	77	0.58
l.s.d.	(0.05)	-	0.04	13	0.11
ACH 319	NS	100.0	1.93	69	0.56
	LD	29.0	1.79	53	0.43
	MD	37.8	1.92	67	0.51
	HD	33.2	1.98	81	0.69
l.s.d.	(0.05)	-	0.03	9	0.11
Combined	NS	100.0	1.99	70	0.53
	LD	27.2	1.85	46	0.37
	MD	38.7	1.99	66	0.48
	HD	34.1	2.04	79	0.63
l.s.d.	(0.05)	-	0.07	8	0.08

*NS = nonselected, LD = low density, MD = medium density, HD = high density.