Comparison of methods to measure the sphericity of seed

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Introduction

We report a study to compare the sphericity index values calculated on pelleted seed samples using three different measurement principles and to identify causal factors affecting results from alternative laboratory seed image analysis systems.

Sphericity index is the ratio between the smallest apparent diameter to the largest apparent; the value is 1 for perfect sphericity. The mean sphericity index value was considered to be the threshold value for concern in sugar beet in some French seed drills.

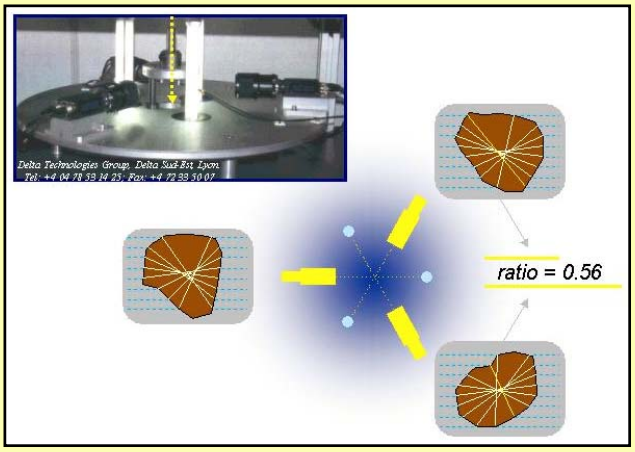

Fig. 1: Delta Technologies "pseudo 3D" system. Three cameras capture views of individual seeds falling under gravity. An algorithm determines the minimum and maximum diameters (yellow lines), and the sphericity index is calculated as ratio between them (here illustrated as 0.56).

Material and Methods

Three different measurement principles were used: [1] an image analysis method (3D) that captures views of individual seeds falling under gravity; [2] two different (2D) image analysis systems that capture images of individual seeds lying on a flat surface; [3] size screening of a population of seeds using round-hole and slot-hole sieve screens.

The sphericity index was calculated using the ratios of minimum and maximum diameters determined by computer algorithms in [1] and [2], and the ratio between the median population seed-size values determined by the two series of screens in [3].

Pelleted seed with three basic different geometric ellipsoid shapes were made from seed of brassica, lettuce and tomato. The three shapes were mixed in different proportions to produce six 'unknown' samples for comparative analysis, all with calculated mean sphericity indexes around 0.8 according to the 3D system.

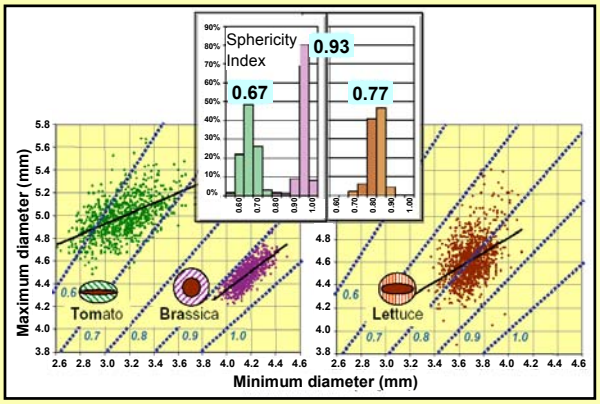

Fig. 2: Relationship between minimum and maximum diameters and sphericity index (blue dashed lines, and inset distribution histograms) of pelleted brassica, lettuce and tomato seed samples used in this study.

Results

Tab. 1: Mean Sphericity index of six samples of pelleted brassica, lettuce and tomato seed, mixed in different proportions, and measured with three different system principles.

Lab	Principle	A*	B*	C*	D*	E*	F*
I	"3D"	0.81	0.85	0.83	0.79	0.79	0.79
II		0.81	0.85	0.83	0.79	0.76	0.78
III		0.82	0.85	0.83	0.80	0.77	0.77
IV	"2D"	0.94	0.93	0.93	0.94	0.95	0.89
V	"2D"	0.87	0.87	0.87	0.88	0.89	0.84
VI	Size Screen	0.87	0.94	0.90	0.85	0.81	0.87

*Mixtures (%) of brassica:lettuce:tomato pellets;
A 50:25:25, B 50:50:0, C 50:35:15, D 50:15:35, E 50:0:50, F 10:80:10

Conclusions

- Results showed close conformance between the sphericity values obtained by the three laboratories equipped with the same 3D system, as might be expected.
- Results from 2D system produced higher means sphericity index values than 3D systems, and also differed from each other, presumably because of the different algorithms used.
- The size screening analysis in general produced sphericity values intermediate between the 3D and the two 2D systems.

These results can be partly explained by the different geometric aspects of the seed measured by the three systems. Each system measures the ratio between a different combination of the three ellipsoid 'diameters'.

The question remaining to be addressed in further research is: which sphericity index values are most meaningful for pellet handling performance through which drills?

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