Genetic diversity in sunflower and seed vigour testing: no relationship established between vigour tests and field emergence

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A demand for vigour testing on sunflower seeds

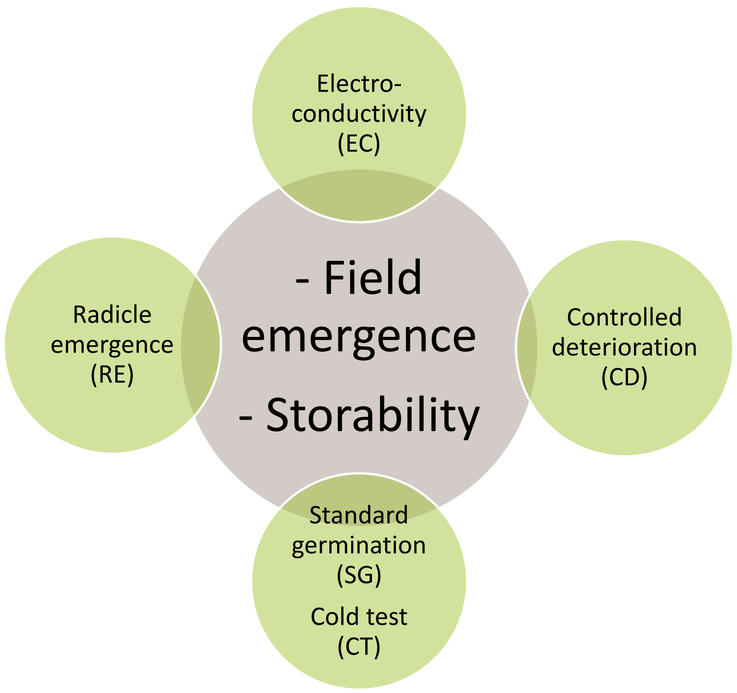
Early sowing has become common practice in spring crops to avoid water stress during flowering stage. There are two problems for sunflower cultivation: residual seed dormancy when seed lots are produced off-season, and seed vigour when acceptable germination is achieved. Dormancy can be overcome by standard germination (SG) with a pre-treatment for breaking dormancy but no vigour test is available to predict poor field emergence when seed lots have a good germination potential.

A range of vigour tests already standardised for others crops in ISTA Rules or described in literature (see references below) have been developed for sunflower. Sunflower is the second-largest oilseed crop in France, representing 20% of sunflower production in Europe.

A two-step study before field trials in 2017

1) Vigour tests were developed to enlarge physiological range of samples with acceptable germination, selected from commercial seedlots

2) Validation of repeatable tests with field or storage trials on new samples



Radicle emergence test development based on mean germination rate

23 seed lots from 10 varieties were analysed for their germination rate at 25°C using automated tools (Fig.1). 15 samples with SG>85% were selected to develop a RE test in rolled towel. The highest correlated counts to mean germination time were tested on standard germination test and a 30h RE test at 20/30°C was validated as being compatible to the SG without any damage of the early count on the same trial (Fig.2).

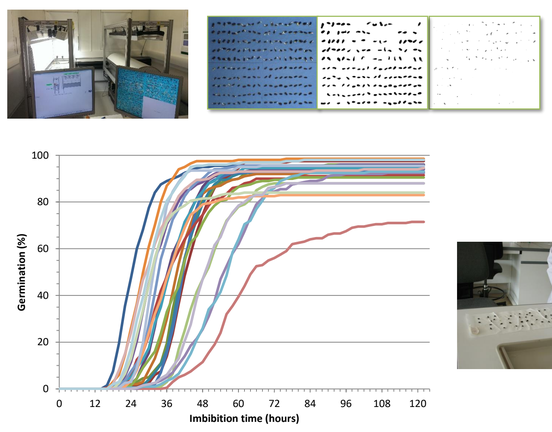


Figure 1: Automated germination curves at 25°C

A second set with 10 parental lines and 5 hybrids has also highlighted differences in germination rate (Fig.3).

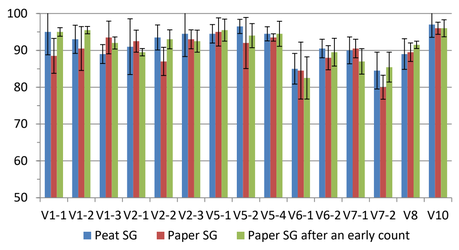


Figure 2: Normal germination of 15 samples on peat or rolled paper with or without an early count of radicle emergence.

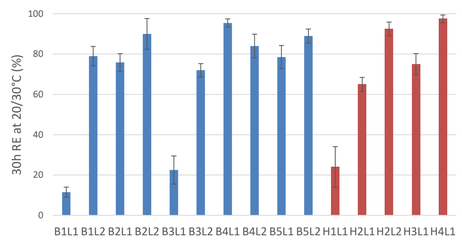


Figure 3: Ranking of 15 samples (10 lines in blue and 5 hybrids in red) according to a radicle emergence test at 20/30°C.

Controlled deterioration test: an interesting range of vigour

The CD test was conducted over 24h at 45°C after seed moisture content adjustment at 20%. This ageing test allowed to enlarge the quality range of both sets of samples. In the first set (Fig.4), the two seed lots of variety 7 had very poor germination after CD test. Whereas the two seed lots of variety 6 were different in vigour, showing that seed production had an higher effect on seed vigour than genetic background.

In 2017, normal germination was very low for most samples, only two parental lines and one hybrid were tolerant to CD test. And again, a variety (parental line B1) had two seed lots with different vigour: B1L1 with high vigour, B1L2 with low vigour (Fig.5).

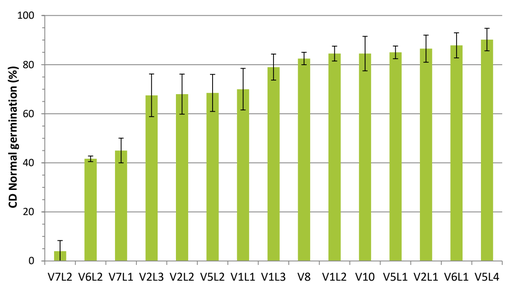


Figure 4: Normal germination after a controlled deterioration (CD) test for the 15 commercial seedlots from 7 varieties.

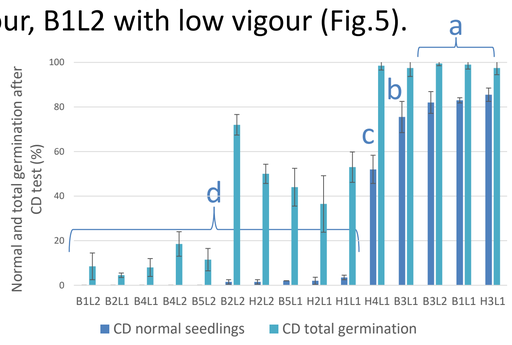


Figure 5: Normal and total germination after a controlled deterioration (CD) test for the 15 seedlots of 9 varieties (5 parental lines and 4 hybrids).

Electro-conductivity test: variability due to pericarp

Conductivity measurements were taken after 24 hours of seed leakage at 20°C for 4 x 50 seeds. Each replicate was immerged in 100ml of deionised water. Samples were mainly ranked by variety (Fig.6).

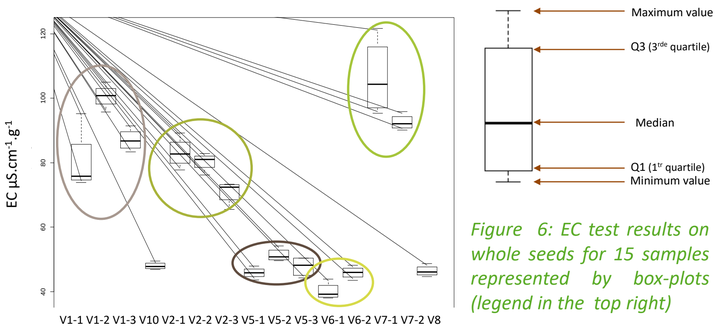


Figure 6: EC test results on whole seeds for 15 samples represented by box-plots (legend in the top right)

To confirm the maternal effect, pericarps were removed from 200 seeds of 8 samples. Seed coat contributed from 20% (V10) to 80% (V2) of the total conductivity measured on sunflower seeds (Fig.7). Ranking samples according to seed vigour was therefore difficult.

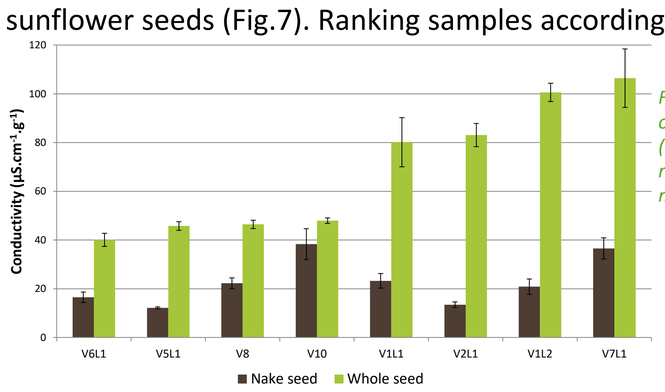
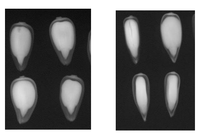


Figure 7: Seed mean conductivity (4 x 50) on whole seeds or after removing pericarp (nake seeds) on 8 samples. Seed lots are ranked from the lowest to the highest EC mean for whole seeds.



X-rays images of two samples having different shape and pericarp thickness.

Field emergence better than predicted by lab testing

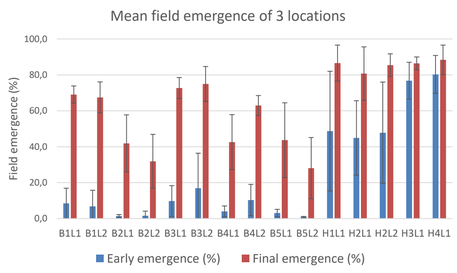


Figure 8a: Relationship between field emergence recorded in 3 locations two weeks after sowing (early emergence) or after full emergence. Hybrid H1 which was lowest for RE or CD results had a good field emergence as other hybrids.

Figure 8b: A significant correlation was obtained between RE test at 5°C and early emergence near Arras which was the Northern location but the relationship was mainly due to one sample, hybrid H4.

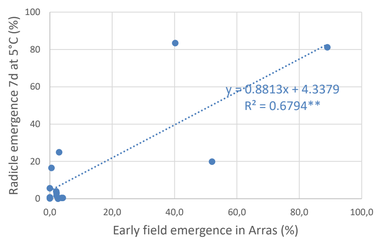
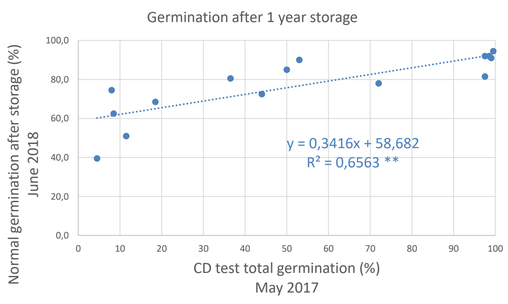


Figure 9: Relationship between normal germination after one year storage in a warehouse and total germination after controlled deterioration test carried out before storage.



CD test predictive of storage potential

This two-year comparison between several vigour tests developed on sunflower seed leads to conclude that seed lots can be ranked consistently within a variety. But the comparison between samples from different genetic background becomes difficult, especially lines and hybrids which have contrasted behaviour. The controlled deterioration test gave the most interesting results to predict storage potential rather than field emergence, at least in 2017.

Acknowledgments

Laurence Charrier, Luc Dormoy, Christelle Esquerdo, Rosie Gilonis, Lydie Ledroit, Pierre Lerebours.

References

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