Pre-harvest sprouting - a risk for low-dormancy oilseed rape? Development of a simple test and first results

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Introduction

Secondary dormancy (SD) of oilseed rape (*Brassica napus*) is becoming more important for farmers and breeders as it can cause seed persistence in the soil for many years (Schlink, 1998). Volunteer plants from former dormant seeds are the source of several agricultural problems in following crops such as harvest problems due to different stages of maturity, or gene dispersal by outcrossing (Gulden et al., 2003; Knispel et al., 2007). The emergence of sown seed might be lower if the seed material has a high potential for SD. Finally, oilseed rape volunteers in sown oilseed rape cannot be controlled chemically. Thus several measurements are needed to control SD.

Many studies have shown the effects of soil tillage and genotype on SD (Gruber et al., 2004a & 2004b, Pekrun et al., 1998). Growing of genotypes with a low disposition to SD could be an effective way to reduce agricultural problems (Gruber et al., 2004b). Seeds exhibit primary dormancy during their development in the pods on the maternal plant, preventing the seeds from pre-harvest sprouting (PHSP). Primary dormancy in oilseed rape seeds decreases during ripening and is nearly completely degraded at full ripening (Gruber & Claupein, 2007). Varieties which exhibit high SD tend to show some primary dormancy at harvesting (Gruber et al., 2004c).
Thus the question emerged whether or not low-dormancy genotypes, which offer many promising options to reduce the potential of seed persistence in the soil, may also result in unwanted PHSP. The study presents a new and easy rapid test for PHSP of oilseed rape to test oilseed rape varieties with different levels of SD for their PHSP potential.

Material and Methods

A randomized field trial with four replications was carried out at the experimental station Ihinger Hof (48° 44' N; 8° 56' E) of the University of Hohenheim, Germany during the season 2009/2010. The location was a loamy soil with a mean annual precipitation of 693 mm and a temperature average of 8.1 °C. Oilseed rape was sown on the 25th of August 2009 with a row distance of 23 cm and a seed density of 50 seeds m^{-2} in a block design following winter wheat. The varieties were Smart, Nemax, Express, Lilian and Compakt with levels of SD ranging from low (Compakt) to high (Smart) according to the Hohenheim Standard Dormancy Test (Weber et al., 2010).

Ten pods of the same age were taken from the main shoot of each variety*replicate over a period of five weeks, beginning 10 weeks after flowering (BBCH 65, Lancashire et al., 1991). These dates were 12th, 19th and 26th of July and 4th of August, corresponding to 70, 77, 84 and 91 days after flowering or BBCH codes 85, 88, 89 and 99, respectively. Colour of the pods varied from yellow to light brown at BBCH 85 and grey to fawn at BBCH 99. Appearance of seed colour was brown to black (BBCH 85) as well as dark blue to black (BBCH 99).

Groups of five pods of the same variety and the same field replication were rolled into filter paper, labelled and then placed upright in a tray with water at 3 cm, so that the pods were permanently wet (Fig. 1). Afterwards the 20 paper rolls (five varieties*four replications) were placed into an incubator at 20°C with light for 7 days (group 1) or 14 days (group 2).

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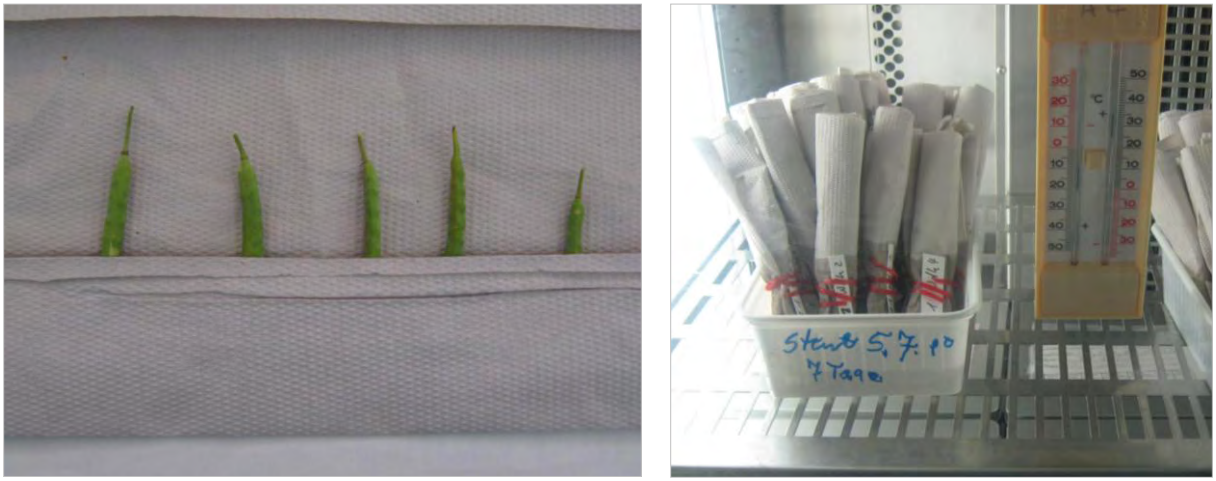

Fig. 1: Pre-harvest sprouting test. Groups of five pods (same variety and field replication) were rolled into filter paper, placed upright into a tray filled with water at 3 cm, and placed in an incubator at 20°C for 7 or 14 days.

This procedure should simulate wet conditions in the field and evoke pre-harvest germination. Germinated and non-germinated seeds in the pods were counted at the end of the incubation period. Seeds which germinated in the pods were classified as pre-harvest sprouted (Fig. 2).

Fig. 2: Cultivar Smart (left, high SD) and Nemax (right, low SD) after 7 days incubation.

SD was analysed for seed samples of the same varieties after full ripening at harvesting by the Hohenheim Standard Dormancy Test (Weber et al., 2010). Finally the five varieties were compared in their potential for PHSP, and PHSP was correlated with SD for each group and each sampling date.

Results and Discussion

After 7 days incubation time low sprouting was observed for the high-dormancy varieties but high for low-dormancy varieties (Fig. 2).

PHSP ranged under the artificial laboratory conditions from 24 % to 90 % (Fig.3).The high-dormancy varieties Smart (SD 62.3 %) and Lilian (SD 58 %) showed the lowest amounts of PHSP while the low-dormancy varieties Nemax (SD 7.6 %), Express (SD 3.5 %) and Compakt (SD 1 %) reached highest sprouting levels of the seeds.

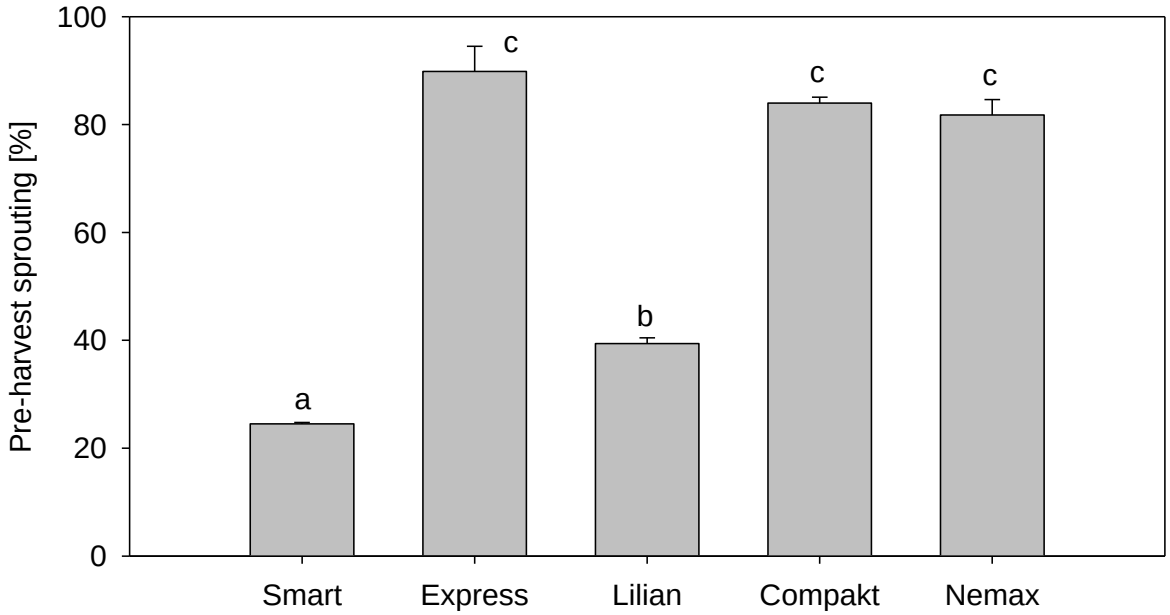

Fig. 3: Level of pre-harvest sprouting [%] depending on variety. Results are means of sampling and incubation times. Columns with the same letter are not significantly different (α≤0.05, Tukey Test)

There was a strong negative correlation between the level of SD and the number of seeds sprouting in the pods (Tab. 1). Correlations of artificially induced PHSP and SD ranged from R^2= 0.73 – 0.99. Analysed pods taken at harvest time (4th of August) at full maturation had the lowest correlation, particularly for the long incubation time of 14 days. In contrast, the highest correlation was found 70 days after flowering (12/07/2010) at BBCH 85 in the 14 day incubation test (R^2=0.99***). In this case farmers obtain the results around harvest time and can adjust their post-harvest tillage strategy immediately to prevent lost seeds from falling dormant. Generally, an incubation time of 14 days showed slightly stronger correlations compared to 7 days incubation (Tab. 1) but the test showed significant correlations between SD and PHSP during three weeks before harvest for both 7 and 14 day incubation periods. Hence the PHSP test seems to be suitable to predict potential of SD over a period of time.

Tab. 1: Correlation of secondary dormancy and artificially induced pre-harvest sprouting of seeds from five oilseed rape varieties at four different sampling dates. Results are given for incubation time 7 and 14 days, (*p≤0.05, **p≤0.01, ***p≤0.001)

Date of sampling (DD/MM/YYYY)	**12/07/2010** (70 days after flowering)	**19/07/2010**	**26/07/2010**	**04/08/2010** (harvest)
R^2 (7 days)	0.88*	0.87*	0.94**	0.83*
R^2 (14 days)	0.99***	0.97**	0.95**	0.73 n.s.

Although visible PHSP under laboratory conditions was very high, germination capacity of seeds at harvest ranged from 97 to 99 % (not shown). Hidden, non visible PHSP as it might occur and then spoil seed quality and germination capacity was therefore obviously not directly correlated with high PHSP levels from the laboratory test.

Summing up, a high correlation of SD and PHSP was found over 10 to 13 weeks after flowering corresponding to three weeks to one week before harvesting, more or less independently from the incubation time. The identification of varieties with low or high PHSP, or high and low SD, respectively, was possible even without counting of seeds but only by rating the level of sprouting.

Generally, there seems to be a higher risk of PHSP if low-dormancy varieties are grown. This result has to be qualified by several points. First, the rapid test for PHSP depicts an extreme scenario under artificial conditions in the laboratory and can be different from PHSP under field conditions; PHSP was never observed to the same extent in the field. Second, the high germination capacity of seeds at full maturity shows that there was no hidden PHSP. Third, the low-dormancy variety Express was widely grown in Germany around 10 years ago, but relevant problems with PHSP have not been a topic of discussion among breeders and farmers of this variety. Therefore, breeding low-dormancy varieties seems to show more advantages than disadvantages. Nevertheless, it has to be observed whether or not low dormancy varieties tend to higher PHSP under field conditions. The test is very simple and fast and can be done without special equipment and experience by farmers. The results of the study enable breeders and farmers to analyse the SD potential of a variety early before harvest. The test and its results could be further improved and strengthened by taking samples at other sampling times, by varying the number of pods included in the analysis and by varying incubation time.

Conclusion

There does not seem to be a high and relevant risk of PHSP if using low-dormancy varieties though the risk is indeed increased. The short and simple rapid test which was developed can be easily used for prediction of SD by farmers. The mode of post-harvest tillage may then be adapted if varieties with low PHSP potential indicate high disposition to SD; i.e. the soil should be left untilled for several weeks after harvest. Screening large numbers of varieties for low or high dormancy seems possible by the pre-harvest sprouting test.

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