Seed eaters on our fields – how many rapeseeds are consumed by what creatures?

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Abstract

Many seeds of oilseed rape (Brassica napus L.) are lost during harvesting and can survive for a long time in soil. This can lead to problems with oilseed rape volunteers in following crops. However, seed predation could contribute to the reduction of oilseed rape volunteers. A field trial was conducted to identify groups of seed eaters and to quantify seed predation (oilseed rape, wheat and weed seeds) under different tillage treatments in the year 2010. Exclusion cages with different mesh widths were used to exclude, respectively, no animals (ALL), birds (EXB) and all vertebrates (EXV). Seed consumption was higher when vertebrates had access to the seeds (ALL and EXB), as compared to only invertebrate access to seeds (EXV). Main seed predators were probably mice. Seeds of the crops oilseed rape and wheat (more than 90 % predation in both) were clearly preferred in comparison to weed seeds. The impact of tillage treatment on seed predation was low in the standing crop winter wheat. By trend, seed predation was lowest in the chisel plough treatment. After the harvest of winter wheat, oilseed rape seed consumption was highest in the no-till treatment (67 %) compared to the mouldboard plough treatment (15 %) or the chisel plough treatment (11 %).

Introduction

All methods of oilseed rape harvesting result in a huge number of seeds getting dropped onto the soil and entering the soil seed bank. The number of volunteers emerging from the soil seed bank frequently exceeds by two times the number of sown oilseed rape plants. Many details are known about the life cycle of oilseed rape volunteers, but the amount of seed predation is still an open question. Agricultural practices aimed at promoting seed predation could be useful to reduce the number of volunteers. For that reason, knowledge is necessary about both the species that consume oilseed rape seeds, and the extent to which seeds are consumed under different tillage methods.

The aim of the study was to develop and apply a method for determining groups of seed consuming species by exclusion cages. Furthermore, feeding preferences for oilseed rape seeds compared to five other seeds and the influence of tillage on seed predation were investigated.

Materials and methods

Seeds of two crops and four weeds were examined: oilseed rape (B. napus), wheat (Triticum aestivum L.), stickywilly (Galium aparine L.), field pennycress (Thlaspi arvense L.), lambsquarters (Chenopodium album L.), and common chickweed (Stellaria media (L.) Vill.). To prevent germination in the field, seeds were inactivated by autoclaving for 10 minutes at a temperature of 121 °C. Twenty-five seeds per species were glued to waterproof sandpaper (28 × 11.5 cm, grain size 80) with a repositionable and waterproof spray (Spray Mount). Seed cards were sprinkled with sand to avoid animals stepping into the glue (according to Westerman et al. 2003). Exclusion cages (ca. 39 × 26 × 13 cm) with mesh sizes of 25 mm and 6.3 mm were constructed and put over the seed cards to divide seed predators into groups:

- Seed card without exclusion cage: all animals have access (ALL)
- Seed card with exclusion cage (25 mm): birds are excluded (EXB)
- Seed card with exclusion cage (6.3 mm): all vertebrates are excluded (EXV)

The trial was conducted in a long-term tillage experiment at the experimental station Ihinger Hof of the University of Hohenheim (8.8 °C, 688 mm precipitation), SW Germany, in the year 2010. The tillage experiment was established in 1999 with a plot size of 18 x 50 m and four replications. Exclusion cages were placed in three of seven tillage treatments:

- inversion tillage by mouldboard plough (ca. 20 cm) plus stubble tillage
- non-inversion tillage by chisel-plough (18 cm) plus stubble tillage
- no tillage

One control cage per replication was installed to determine seed loss due to weather conditions. Control cages consisted of wire mesh with a mesh size of 1 mm and a closure head of mesh size 25 mm. Control cages were placed ca. 15 cm above soil surface with four steel tent pegs. The steel tent pegs were covered with insect glue to prevent predators from migrating into the cages. Seed cards were exposed to the field environment in four consecutive periods of 14 days each, three periods in standing winter wheat in June and July, and one period after harvesting in August/September on the (tilled) stubble.

Removed seeds were statistically evaluated with the procedure PROC MIXED of SAS. Data were transformed with the arcsin square-root transformation and analysed using multi-factorial analyses of variance.

Results

As an example, results of the second sampling period in standing winter wheat and results of the fourth sampling period after harvesting are shown. No seed loss due to weather conditions was reported in control cages in either sampling period. Therefore, seed removal was likely to be a consequence of the activity of animals in all predator groups.

Dominant predator groups and feeding preferences

Exclusion of vertebrates led to a decrease in seed consumption, thus vertebrates seemed to be the dominant seed predators in the standing crop (Fig. 1). After harvest, there were fewer differences between predator groups (data not shown).

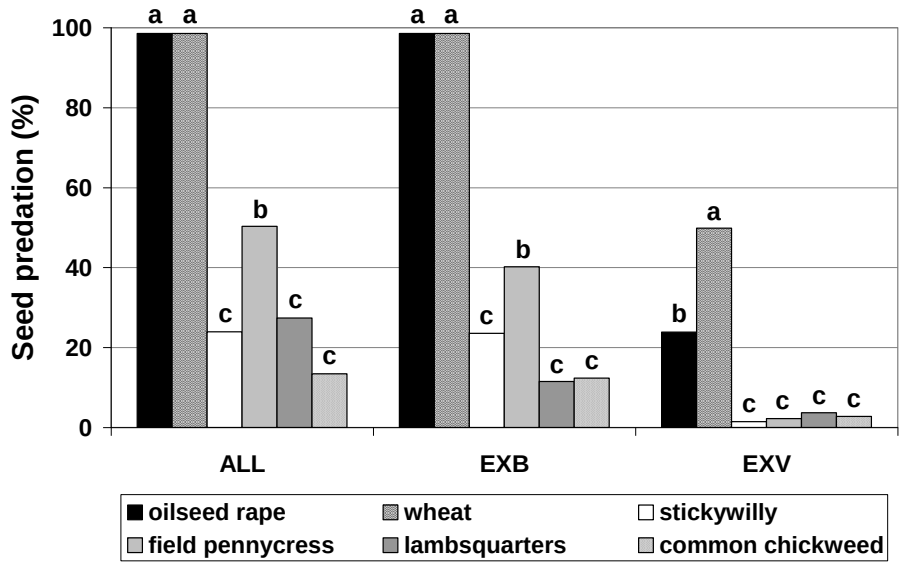

Fig. 1. Number of removed seeds (%) by predator groups (ALL: all animals, EXB: exclusion of birds, EXV: exclusion of vertebrates) after 14 days in the standing crop of winter wheat. Data back-transformed, significances related to transformed data, significant differences between species with different letters within predator groups, $P < 0.05$.

Crop seeds were clearly preferred by predators in comparison to weed seeds in all sampling periods. In the standing crop more than 90 % of the oilseed rape seeds and wheat seeds were consumed by the groups ALL and EXB, and more than 20 % by the group EXV, independent of tillage method.

Effect of tillage

Effect of tillage on seed predation was low in the standing crop, and the number of removed seeds was similar in the different tillage treatments (Fig. 2). By trend, seed consumption was lowest in the chisel plough treatment.

Among the invertebrates, slugs and ground beetles come into consideration as seed predators. Slime trails and slugs were found on seed cards. In all probability, slugs only consumed higher numbers of seeds in sampling periods with sufficient precipitation.

Crop seeds were considerably preferred in comparison to weed seeds. Feeding preferences are determined by the interactions of different factors like seed size, thickness of the seed coat and pericarp, surface finish of seeds, compounds in the seeds and individual feeding preferences of seed predators.

Effect of tillage

Effect of tillage on seed predation was low in the standing crop. Possibly, factors that affect predation were balanced in the different tillage treatments. Maybe the no-till treatment with higher crop residues compared to the mouldboard plough or chisel plough treatments was a suitable habitat for seed predators, but maybe also a favoured habitat for predators of seed predators (Cardina et al. 1996). Moreover, the mobility of seed predators plays an important role. It is very likely that mice consumed seeds from several seed cards in different tillage plots, and presumably, seed consumption was similar for all tillage treatments because of migrating mice.

After harvest, seed predation was significantly higher in the no-till treatment. Removal of cover could have led to change in the abundance of mice due to higher predation risk. Mice decrease their activity; they move shorter paths and walk less often (Tew & Macdonald 1993). It is likely that mice did not seek their food in different tillage plots.

Conclusion

Consumption of seeds from oilseed rape harvest losses can obviously be increased if the soil is not (immediately?) tilled, probably because 1. cover contributes to higher survival rates of seed predators, and 2. more food remains available on the soil surface. Thus, conservation tillage, and in particular no-till, shows additional advantages for farming.

References

Cardina, J., Norquay, H.M., Stinner, B.R., Mccartney, D.A. 1996. Postdispersal predation of velvetleaf (Abutilon theophrasti) seeds. Weed Science 44 (3): 534–539.

Tew, T.E., Macdonald, D.W. 1993. The effects of harvest on arable wood mice Apodemus sylvaticus. Biological Conservation 65 (3): 279–283.

Westerman, P.R., Hofman, A., Vet, L.E.M., van der Werf, W. 2003. Relative importance of vertebrates and invertebrates in epigeaic weed seed predation in organic cereal fields. Agriculture, Ecosystems & Environment 95 (2/3): 417–425.