6 Summary

Flower-visiting insects in oilseed rape and accompanying vegetation were mapped on the trial fields of the Federal Biological Research Centre for Agriculture and Forestry (BBA) near Dahnsdorf, state of Brandenburg, in spring and early summer in 1998 and 1999. In that relatively short period of study, the surprisingly high numbers of 94 bee species and 48 hoverfly species were found. Many species are ecologically demanding and faunistically remarkable. One bee was found parasitised by the rare Strepsiptera *Halictoxenos arnoldi*, which was found for the first time in Brandenburg.

Bees and hoverflies were unevenly spread over the various habitat structures. A comparison of species identity among various habitats according to the SOERENSEN index, however, showed great fauna similarity in the crucifer stands in the trial fields (identity of species of 65 %). The highest degree of species similarity (69 %) was found between transgenic oilseed rape and conventional oilseed rape sown in a strip surrounding the transgenic crop. The fact that largely the same species were found on flowers of rapeseed and on flowers of other cruciferous plants increases the probability of pollen transfer from genetically modified oilseed rape to related plants. The dominance spectra of flower-visiting bees were also largely similar in transgenic and in conventional oilseed rape. Differences in the dominance sequence were found in comparison with cruciferous plants in the habitat islands. These were attributed to the late flowering of these plants, compared to the rapeseed.

We were able to show in mark-recapture experiments with bumblebees and solitary bees that the same individuals were visiting flowers of transgenic oilseed rape and later flowers of other cruciferous plants. An analysis of a bumblebee's pollen loads showed that pollen of transgenic rape was transported as expected. A honeybee's potential of pollen transfer from oilseed rape to weeds was seen as rather weak, in spite of the high individual density, because of the bees' marked preference for one flower. Apart from bees and hoverflies, many other insects, including

ladybirds, March flies and sawflies, were observed to visit flowers and transfer pollen.

Transport of rapeseed pollen depends both on insects and on wind. Examination of pollen traps showed a close link between weather and pollen amounts transported from rape fields by wind. Pollen concentration in the air rapidly decreased with distance from the rape field. At 10 m distance, the concentration was only 4.5 % (1998) or 37 % (1999) of the concentration measured at the edge of the field, the level depending on temperature and rainfall.

Seed of cruciferous plants were harvested and sown out, and emerging seedlings were treated with glufosinate herbicide. Only a few plants of sarepta mustard survived the treatment. In 64 of the surviving plants, the *pat* gene was detected on the molecular genetic level. Some hybrid plants were also characterised cytogenetically and phaenotypically. With 0.26 %, the rate of out-crossing of transgenic oilseed rape to sarepta mustard was surprisingly high, particularly when compared to the out-crossing rate of transgenic rape to conventional rape in the catch crop seed, which was up to 0.15 % and 0.32 % in the same trial site.

The degree of out-crossing does not only depend on the pollen concentration in the air, but also on other factors, such as weather and abundance and behaviour of flower-visiting insects. The low number of hybrids (6 plants) in 1999 was attributed to the relatively wet and cold weather during rape flowering in that year, which allowed pollen transport only over short ranges resulting in a high probability of self-fertilisation in rape plants. In 1998, warm and dry weather during rape flowering allowed farther pollen transport, leading to a higher probability of cross-fertilisation and a markedly higher number of sarepta mustard hybrids (58 plants). It cannot be definitely said whether hybrids were the result of wind or insect-carried pollen, because dry and warm weather has also decisive influence on the activity of bees and other flower-visiting insects.

One F_1 hybrid was cultivated up to seed ripeness, and 43 seeds extremely heterogeneous in size, colour and surface structure were harvested. Six F_2 plants developed, and two of them were found to carry the herbicide resistance gene. The

emergence of F_2 plants proved that the hybrids stemming from out-crossing of transgenic rape to sarepta mustard are partly fertile.

Because of the great number of flower-visiting insect species and the specific behaviour of the species, these are not only visiting oilseed rape, but also related plants flowering in the neighbourhood and at the same time. This leads to pollen transfer and out-crossing. Field releases of transgenic oilseed rape should therefore be carefully monitored, in particular with an eye to the out-crossing incidence (development of hybrid plants) and the behaviour of hybrid plants in natural or semi-natural plant communities.

Results of our study of out-crossing of herbicide resistance indicated a high potential of transfer to sarepta mustard. *Brassica juncea* seems therefore suitable for use in a model of risk assessment of out-crossing of transgenic oilseed rape. The model of risk assessment should be integrated in the monitoring already during field release trials.