Genetically modified maize: Factors affecting cross-pollination and coexistence

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Maize is worldwide one of the most important crops in terms of area grown and yield. Cross-pollination is a natural process occurring in maize. With the introduction of commercial cultivation of genetically modified (GM) crops in the year 1996, there have been concerns about the possible cross-pollination between GM and non-GM maize. According to maize biology, with about 95% cross-pollination, adventitious presence can arise through many pathways. These include cross-pollination between adjacent fields, seed dispersal from volunteers and mechanical transfer at sowing, harvesting, transport and storage operations. A central point of the European agricultural policy is that farmers should be able to use the agricultural system of their choice. To achieve this policy, recommendations and guidelines have been released. This includes field management strategies to reduce the level of cross-pollination. To date no field trials were conducted with the aim to compare the effect of two different gap crops between the donor and the recipient field on cross-pollination rate. Moreover no field trials were conducted to investigate the effects of GM seed admixture on the non-GM seed harvest product.

Three chapters (Chapter 2 to 4) describe the conducted field experiments to ensure the coexistence of farming systems with and without the use of GM crops.

Field trials described in the second chapter were to investigate the consequences of GM seed admixture on the non-GM harvest product. We determined the effect of maturity group on the level of cross-pollination and we compared the visual detection with the detection method using qPCR. The results of the field trials showed that the GM output is equal to the GM input. The standard deviations observed depend on the location, the flowering time which determine the pollen concurrence and weather condition which determine the viability of pollen. By the admixture of seeds with different maturity groups, the GM output was lower than the GM input. In addition, we showed that the visual detection differed from the detection using qPCR. The qPCR was more variable due to uncertainties by the quantification using maize flour as Certified Reference Material.

The objective of the third chapter was to verify appropriate separation distances for ensuring coexistence between GM and non-GM maize production fields and to analyse the extent of cross-pollination into donor-facing field edges of maize recipient plots. Moreover, the effect of different gap crops (wet vs. dry microclimatic conditions) on the cross-pollination rate between two adjacent maize fields has been investigated. Though the cross-pollination rates varied between the years, it is shown that the cross-pollination rate is highest at border rows facing the donor (edge effect) and decreases rapidly with increasing distance from the donor field. The common assumption that pollen mediated gene flow follow a leptokurtic function could not be confirmed by our results. The vertical pollen transport over distance was more dependent on strong and predominant wind conditions than on different thermal conditions induced by different gap crops.

Chapter four was undertaken to investigate whether the level of cross-pollination is correlated with the flowering time on the one hand and with climatic conditions on the other hand using

data from two cross-pollination field experiments over two years. No clearly defined correlation was found between the flowering time, weather conditions and the cross-pollination rate.