Genotype x management interaction for nutrient use efficiency (NUE) of maize varieties tested under different tillage and fertilization regimes

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Most varieties have been selected under high input conditions, including seed treatment, herbicide applications, as well as optimal levels of fast releasing fertilizers. Under organic farming nutrient release is dependent on the temperature and biological activity of the soil and its interaction with the declining residues from previous crops and applied quantity of farmyard manure. As a consequence it is not always possible to match nutrient release with crop demand over time. This effect is even more severe under conservation tillage. To promote conservation tillage in organic farming, it is necessary to identify cultivars that show high nutrient use efficiency (NUE) under these conditions. While there is substantial evidence that breeding for low N input conditions selection is more efficient under severe N stress than under high input conditions only few studies have been conducted to demonstrate the difference in selection gain between organic and inorganic fertilization or between different soil tillage management. The objectives of the study were (i) to quantify the NUE of maize (Zea mays L.) genotypes under different tillage regimes and fertilization levels, (ii) to compare the effect of slow releasing organic versus inorganic fertilizer, and (iii) determine genotype x management interaction.

We tested six maize varieties under conventional (CT) and reduced tillage (RT), applying five different fertilization regimes (unfertilized control, slurry with either 85 or 170 kg/ha total N, inorganic NPK fertilizer with either 85 or 170 kg/ha total N) with four replications in a split split plot design. Conventional tillage (CT) was carried out using a mouldboard plough tilling the upper 18-20 cm of the soil. The reduced (RT) tillage treatment was implemented with a stubble cleaner that inverted the top 5 cm. The field trials were carried out on two organically managed farms: one on loamy soil in Muri/AG, Switzerland in 2009 and the other one on silty loam (Luvisol) in Aesch/BL, Switzerland in 2010. Weed pressure, anthesis, plant height and chlorophyll content were assessed. At anthesis and silage harvest, dry matter content, dry matter yield (DMY), nitrogen (N), phosphorus (P) and potassium (K) concentration were determined as well as silage quality parameters including netto energy lactation (NEL).

The six different maize varieties tested in Muri 2009 and Aesch 2010 under different tillage and fertilization regimes had a significant effect on almost all traits. Tillage regime had no significant effect on DMY, although RT caused significant increases in weed scores, higher dry matter content and reduced chlorophyll content. Significant genotype x tillage x fertilization interaction were observed for weed incidence and NEL, but not for DMY. Significant variety x fertilization interaction was detected for P concentration. Significant variety x tillage x fertilization interactions were detected for N use efficiency (i.e., dry matter yield per kg Navailable), P use efficiency, and K use efficiency. We concluded that selection on dry matter yield can be performed under standard conditions (CT, NPK2), whereas selection on nutrient use efficiency is highly influenced by the management conditions resulting in the selection of different genotypes for different cultivation systems. In order to improve NUE, breeding and management should be optimized simultaneously.