Maize production in living mulches in a humid temperate climate

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MAIZE PRODUCTION IN LIVING MULCHES IN A HUMID TEMPERATE CLIMATE

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SUMMARY

Growing maize in living mulches in conjunction with reduced tillage may alleviate or even eliminate the environmental problems associated with conventional maize cropping methods. According to the literature, living mulches may provide the following benefits: (i) reduced nitrate leaching hazard during the cool season, (ii) reduced runoff of nutrients and agrochemicals, (iii) reduced soil erosion, (iv) less structural damage by wheel traffic, (v) fewer herbicides, (vi) prevention of herbicide-resistant weed populations, (vii) enhanced earth worm biomass, and (viii) reduced infestation of maize with insects and diseases. However, living mulches and the main crop often compete for growth factors such as N and water. In the present study, dry matter and N yields as well as number of quality components (dry matter content, digestibility, concentrations of N and a number of minerals) of silage maize (*Zea mays* L.) in living or dead mulches of ryegrass (*Lolium multiflorum* Lam.) and white clover (*Trifolium repens* L.) were investigated. Furthermore, the accumulation of dry matter and N of maize as well as the seasonal patterns of some indicators of the N status of maize (whole plant concentrations of N and nitrate and leaf greenness) were monitored. Moreover, the temporal changes in the quantity of Nmin in the soil and its spatial distribution were studied. The conventional maize cropping system was the control. In addition, a maize cropping system in which the maize was planted into killed ryegrass stands was tested. Field experiments were conducted in the midlands of Switzerland near Zurich in 1990/91, 1991/92, and 1992/93 on a fertile sandy loam under high precipitation (about 1,000 mm per year). The maize was sown with a one-pass strip seeder tillage system into an autumn-ploughed, bare soil (= conventional cropping; **CC**), living (= living grass mulch; **LGM**) and dead (= glyphosate-killed dead grass mulch; **DGM**) Italian ryegrass, and living white clover (= living clover mulch; **LCM**). The living mulches were mechanically (= **LGM/Mech** and **LCM/Mech**) stunted, chemically killed (**LGM/Chem**), or chemically stunted (**LCM/Chem**). Depending on the year and cropping system, two to three N regimes were used. The N regimes were **N0** (= no addition of fertilizer N), **N110** (= 110 kg N ha^{-1}; N fertilizer plus soil Nmin to 90 cm depth at sowing), **N180** (= 180 kg N ha^{-1}; as N110 plus 70 kg ha^{-1} N fertilizer at the 4th leaf stage of maize), and **N250** (= 250 kg N ha^{-1}; as N110 plus 70 ha^{-1} kg N fertilizer at the 4th and the 6th leaf stages). Unless otherwise stated N fertilizer was applied to the maize rows.

Maize and cropping system yields

LGM systems: The LGM systems were tested during three cropping seasons (1990/91 to 1992/93) under two levels of N supply (N110, N250). N0 was used in 1991/92 and

1992/93. CC maize produced higher dry matter and N yields than did LGM maize, even though additional fertilizer N (on average 56 kg N ha^{-1}) was applied to the LGM plots to offset the low Nmin content of the soil at sowing. The LGM/Chem system was superior to the LGM/Mech system in terms of dry matter and N yields. The LGM systems were more responsive to N fertilization than was the CC system, indicating that N is more growth-limiting in the LGM systems than in the CC system. The total digestible dry matter yield of the LGM systems (grass cutting in spring plus silage maize) was similar or even higher than that of CC maize. It is desirable, however, to investigate the long-term yield stability of continuous LGM systems. The LGM systems showed a poorer N balance than the CC system. Uptake of N by the ryegrass and immobilization of N in decaying ryegrass residues may have contributed to this. The conclusion may be drawn that LGM systems for maize production have to be optimized, the aim being to increase the availability of N to the maize. As compared to broadcast applications, placement of N fertilizer in the maize rows increased the dry matter yield of maize under LGM/Mech by almost 20% (averaged across N110, N180, and N250). Thus, in living mulch systems, banding of N is an integral part of N fertilizer managem-ent. Maize produced under LGM/Mech tended to be less digestible (concentration of *in vitro* digestible organic matter) than maize grown under LGM/Chem and CC. With N110, maize in the LGM systems reached silage maturity later and had a lower harvest index (= cob dry weight/total shoot dry weight) than CC maize. Averaged across the years and N levels, however, silage maturity was reached at the same time. Whole plant N concentration of silage maize was highest under CC and lowest under the LGM/Mech system, irrespective of the level of N supply. With N110, whole plant concentrations of P and Mg were higher for LGM maize than for CC maize; increasing the N supply to N250 eliminated the differences among the cropping systems. There were no significant variations in the concentrations of Ca and K.

***DGM and LCM systems*:** The DGM system was tested during two cropping periods (1990/91 to 1991/92) under N110 and N250. Maize dry matter and N yields were similar to those under CC. However, these yields were reached with additional N fertilization at sowing (on average 54 kg N ha^{-1}). The LCM systems were tested in one cropping season (1992/93) under two N levels (N0, N110); maize dry matter and N yields were higher than those under the LGM systems with both N0 and N110. With N110, LCM/Chem was superior to LCM/Mech and almost equal to the CC system. It must be taken into account, however, that the LCM systems received additional N fertilizer (50 kg N ha^{-1}) in order to compensate for the low level of Nmin in the soil immediately before maize planting.