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ABSTRACT BOOK

INNOVATIVE CROPPING AND FARMING SYSTEMS FOR HIGH QUALITY FOOD PRODUCTION SYSTEMS

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Dealing with Climate Risk for Maize Production on Infertile Soils in Semi-Arid Southern Africa

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Abstract: Rainfed maize production on nutrient-poor soils that predominate semi-arid southern Africa is risky. Climate change is predicted to increase this risk with frequent and prolonged droughts and higher temperatures. Farmers can reduce the risk of crop failure and improve crop production by synchronising nutrient supply with crop demands. To achieve that, knowledge of the effects of available management options in terms of planting dates, tillage, mulching and fertility amendments across different seasons on crop yields is invaluable. We quantified crop productivity and soil N dynamics combining experimental and modelling approaches to test the hypothesis that planting early improves yields if it coincides with a mineral N flush at the season start but leads to crop failure with a false season start. We conducted a three-year experiment on a sandy soil in semi-arid southern Zimbabwe to test the effects of tillage (animal-drawn plough and ripping), mulch (0% and 100% residues) and fertility amendments (mineral fertiliser at 0, 20 and 40kg N/ha, 5 t/ha manure only and 5 t/ha manure + 20 kg N/ha) on maize yields and seasonal N mineralisation. The grain yields and N mineralisation were used to test the performance of a calibrated APSIM model. Following successful model testing, grain yields and daily mineralised N were simulated over a 30-year period (1984–2015) and compared across seven planting date scenarios (biweekly intervals from 1 November up to 15 January and variable planting after cumulative rainfall in three days exceeded 20 mm). The experiment revealed that plough tillage stimulated N mineralisation, resulting in higher N uptake compared with ripper tillage. When mulch was added, however, mineralisation was slowed down resulting in low N uptake and reduced yield. The N recovery efficiency of maize was highly variable by season, reflecting the uncertainty complicating farmers' decision making. In the simulation experiment, early planting yielded best, resulting in food self-sufficiency in 50–90% of the cases and relatively low risk of crop failure (<40%). Grain yield penalties due to a false start followed the trend: ripper + mulch>plough+ mulch>ripper (no mulch) across the fertility treatments. The occurrence of the mineral N flush with the first rains depended on the mulch and fertility amendment. Its coincidence with planting resulted in average yield benefits of 712, 452, 382 and 210 kg/ha for 1-Nov, 15-Nov, 30-Nov, variable planting respectively. We conclude that in the short-term, minimum soil disturbance and mulching reduced soil mineral N availability and maize yields. Strategic application of agronomic management practices such as early planting in combination with reduced tillage, mulch and fertility amendments is critical to reduce the risk of crop failure and maximize yields in the risky environment of semi-arid southern Africa.

Keywords: conservation agriculture, household maize grain requirement, N stress, planting date strategy

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Cover Crop Productivity in Contrasting Growing Conditions and Influence on the Subsequent Crop

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Abstract: In arable systems, cover crops provide multiple ecosystem services involved in soil protection and fertility. They can efficiently compete against weeds, control erosion or recycle nutrients. The supply of these services is however largely dependent on cover crop growth as most of the services are related to biomass production. The choice of a cover crop adapted to the growing conditions is thus essential. Growing mixtures instead of sole crops is expected to be a way to overcome variable growing conditions and to insure high biomass production.

Different field trials have been conducted from 2013 to 2016 in Nyon, Switzerland to assess cover crop biomass production and stability, and their influence on the following crop. Indian mustard, field pea, black oat and phacelia were sown as sole crops and in mixtures with different diversity levels (2, 3 and 4 species). A mixture of 11 species (50% of legumes and 50% of other species) was also tested. Biomass production was assessed about three months after seeding, just before the seeding of the next main crop, in two 0.5 m × 0.5 m quadrats. For each cover crop, a risk of failure, e.g. the probability of producing less than 3 t/ha (minimal biomass allowing to provide the services expected from cover crops), was estimated. Weed pressure was appraised by weed biomass in quadrats. The yield of the following main crop, here winter wheat, was determined after harvesting with a combine harvester, at wheat maturity, in summer.

Sole crops showed very contrasting performance according to the growing conditions. Pea was the most productive in low yielding conditions with 2 t/ha while other sole crops produced only 0.5 t/ha. Pea was barely more productive in high yielding conditions, reaching only 3 t/ha when cover crop average was 6 t/ha. By contrast, mustard and oat showed high production potential in these conditions, exceeding 7 t/ha. Pea should thus be favoured when the growing conditions are clearly identified as limiting (low N availability), while oat or mustard should be chosen in favourable conditions. However, in general, conditions are hardly predictable. Our results showed that mixtures should be preferred as they were adapted to a wider range of environments than sole crops, performing well regardless of the conditions and resulting in a lower risk of failure than sole crops. The 11-species mixture revealed that generally 4 to 5 species are sufficient to insure a good performance regardless of the conditions. Regarding cover crop effect on the following crop, we evidenced the importance of high biomass production for efficient weed control and positive influence on crop yield in no till treatments.

Our results showed that cover crop mixtures rather than sole crops should be chosen as they insure high biomass production and thus a good supply of ecosystem services. In addition, cover crop cultivation, even for a short period, proved to be paramount to the maintenance of grain yield and soil fertility on the long term, especially in reduced tillage systems.

Keywords: Sole crops, mixture, biomass, weeds, wheat