3. Effects of weeds in maize production

Maize is very sensitive to weed competition during the critical period between the V3 (leaf stages based on the number of leaves i.e. collar of 3rd leaf visible 16-23 days) on the corn plant and the V8 stages (collar of 8th leaf visible 31-38 days). Before the V3 stage, weeds are usually important only if they are larger than the maize or if the crop is 6suffering from water stress. Maize needs a period between the V3 and V8 stages when few weeds are present. From the V8 stage to maturity, the crop usually reduces the sunlight reaching the weeds enough to provide good weed control. In the later part of the cycle, weeds are important mainly if water or nutrient stress is a problem, or if a very aggressive weed overtops the maize and shades it, or if the weed has some allelopathic effect. In addition, some weeds make harvesting difficult, and thus increase production costs. Some weed species are more damage than others. This can be because the weeds are very effective competitors for water or nutrients.

Two types of approaches are utilized in most competition studies between weeds and maize (Rajcan and Swanton, 2001). Determination of the critical competition period between the crop and the weeds; and, evaluation of the threshold above which weed infestation becomes detrimental to the crop. Hall *et al*. (1992) defined the 3-leaf and 14-leaf stages of plant development as the critical period for weed control in maize. Grain yield in maize can be increased by increasing the number of hoeing's, even though differences are not always significant (Bezerra *et al*., 1995). Maximum leaf area of maize was noted in those treatments where weeds were controlled the experiment was done by Khan *et al*. (2002) Maize at V8 under good, fair, poor, and no weed control. If there were no subsequent weeding, respective yields would be approximately 100%, 75%, 25%, and 8% of potential. In the no-weeding treatment, even if weeds were controlled from this stage on, the crop would already have suffered irreversible damage (note the reduced plant size and early leaf senescence). Weed species differ in their response to management practices because they have different life cycles, nutrient requirements and modes of reproduction (Martin & Pol, 2007).

3.1. Soil moisture competition

Competition for water in a crop– weed situation has been defined as an increase in water stress of the crop due to the presence of weeds (Thomas and Allison, 1975). Water stress during vegetative dry matter (DM) accumulation can limit the height, vegetative biomass (Denmead and Shaw, 1960 and Stewart *et al*., 1975) and rate of leaf appearance, but not necessarily the yield. In general, plant species are more vulnerable to moisture stress during reproductive rather than during early vegetative stages of development. Plants exposed to water stress for a limited time (i.e., several hours) respond by a reduction in the transpiration rate through a lowering of the leaf water potential and closing of stomata. Stomata closing will affect the rate of leaf photosynthesis, which may influence the grain yield.

Under weedy conditions, maize will develop water stress symptoms (i.e., lower leaf water potential, reduced leaf stomata conductance, reduced leaf photosynthesis) earlier than when grown in the absence of weeds (Young *et al*, 1984 and Tollenaar *et al*., 1997). During vegetative growth, weeds and maize may not show signs of competition for water (i.e., no decrease in vegetative DM accumulation), but the DM distribution (i.e., root/shoot ratio) of both weeds and crop would be altered. Maize grown together with weeds may have a less developed root system compared to maize grown under weed-free conditions (Kasperbauer and Karlen, 1994). Maize grow together with weeds may have a less developed root system compared to maize grow under weed free conditions, thus the more limiting factor in uptake during reproductive DM accumulation may be less developed root system, rather than water availability per se. another possibility is that exudates of weed roots may contain toxins that can inhabits the root growth of maize.

Water is the most common limitation to maize production in the tropics. Drought during the crop establishment stage can kill young plants, reducing the plant density. The main effect of drought in the vegetative period is to reduce leaf growth, so the crop intercepts less sunlight. Around flowering (from about two weeks before silking to two weeks after silking), maize is very sensitive to moisture stress. Grain yield can be seriously affected if drought occurs during this period. During the grain-filling period, the main effect of drought is to reduce kernel size. In general, maize needs at least 500-700 mm of well- distributed rainfall during the growing season. Even that amount of rain may not be enough, however, if the moisture cannot be stored in the soil because dimethenamid are acid amide herbicides, also known as chloroacetamide herbicides. The acid amide herbicides have much more activity on grass weeds, such as crabgrass (*Digitaria sanguinalis* [L.] Scop.), barnyardgrass (*Echinochloa crus-galli* [L.] Beauv.), and broadleaf signal grass (*Urochloa platyphylla* [Munroex C. Wright]). Tank-mixing these herbicides with organic matter.

4.4.3. Post-emergence Herbicides

Herbicides applied after corn and weed emergence are known as post-emergence herbicides. They usually have foliar activity on emerged weeds with a good crop safety if applied as directed on the label. Post-emergence herbicides can be broadcast-applied on crop and weeds or with the equipment that directs the herbicide to weeds and minimizes exposure of the crop. Foliar-applied post-emergence herbicides do have a requirement for rainfall after application. In fact, a certain time is required after application of post-emergence herbicides that should be free from rainfall or overhead irrigation to avoid washing the chemicals of the plant and leaf surface. For example, time until herbicides are rainfast for 2, 4-D is 1 h, glyphosate 1-4 h depending on glyphosate formulation, and glufosinate 4 h. Several post-emergence herbicides have been registered for weed control in corn. Wide-scale adoption of glyphosate-resistant corn has resulted in heavy reliance on glyphosate for weed control for many years in Midwestern United States.

Multiple glyphosate applications are relied upon for weed management in glyphosate-resistant corn, which comprise approximately 60 % of the corn hectares in the USA. In addition, more than 90 % of the soybean hectares are planted with glyphosate-resistant cultivars, placing extreme selection pressure for glyphosate resistance in weeds. Although corn and soybean are commonly rotated in North Central and Midwestern USA, corn for seed production is continually grown on the same land without rotation with other crops. The hydroxyphenylpyruvate dioxygenase (HPPD)-inhibiting herbicides, such as mesotrione, tembotrione, topramezone, and isoxaflutole, are important herbicides for control of broadleaf weeds in grain and seed corn. Atrazine has been in use since 1958 and is applied on several million hectares in the USA and several other counties. Atrazine is the base for the weed control program in corn in the USA. It is widely used because of its low cost, control of a broad spectrum of broadleaf weeds, flexible application timing, such as pre-emergence or Post-emergence, and compatibility to mix with several other herbicides.

important to review literature on the effects of individual CA principles before weed dynamics under CA are studied. Mulching appeared to suppress weeds, resulting in low overall biomass. The mulching effect on weed suppression was more pronounced in the ripping and planting basin options. Under some fertilization treatments such as cowpea–maize and maize–cowpea rotations subjected to low fertilizer rates, mulching suppressed the weed emergence by between 40% and 60%.

This is in contrast to findings by Mashingaidze *et al.* (2012) who, working with sorghum and cowpea, found that mulching significantly increased weed density, as a result of probable improvements in the soil micro-environment. At Domboshawa, however, while similar processes may have promoted weed seed germination, mulch most likely smothered the germinated seedlings across the treatments, such that at quantification, only surviving individuals were accounted for. Another reason for lower seed populations under mulch could be due to seed-rot linked to excessive soil moisture experienced during the early part of both seasons. Flash floods were experienced during the months of December and January in 2011–2014, leading to excessive water logging, particularly under the basin option.

Differences in species diversity were also apparent in mulched *versus* no-mulch treatments. For example, regardless of fertility treatments, a Shannon–Wiener diversity index of 2.1 was measured for basins under mulch *versus* 2.8 for basins where no mulch was applied, although the same herbaceous annual, *G. parviflora*, continued to dominate. The same trends were observed for the ripping option. Under conventional tillage, while mulching appeared not to have significantly influenced ($p < 0.05$) weed diversity (mean 2.5), species richness was lower under mulched plots. Crop rotation is considered as a “panacea” as for controlling several insect pests, diseases and weeds under crop field ecosystems so for maintaining soil health and sustained crop production. It is highly effective against parasitic weeds such as *Striga hermonthica/asiatica* (mainly in sorghum and maize). Any material that blocks light will suppress or prevent growth of weeds. Layers of organic mulches municipal yard waste, hay can be used for control of annual weeds (Makus *et al.*,1994). Thicker layers provide good results. Organic mulches break down over time, and original thickness can typically reduce by 60 percent after one years. Cover crops can be grown

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