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Role of resource conservation technologies in biotic stress management

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ARTICLE ID: 019

Introduction:

Resource conservation technologies (RCTs) are the methods that increase the proficiency of the resources or the inputs that we deploy for increasing the productivity of land, labour, capital and other agricultural inputs. The idea of the RCT is to obtain of acceptable profit levels along with higher production levels while simultaneously preserving the climate (FAO, 2007). Practices like zero tillage/minimum tillage, mulching and residue, surface seeding, inter-cropping, skip furrow irrigation, live fences and vegetative barriers, water harvesting and supplemental irrigation management. Resource conservation technologies are often confused with Conservation agriculture (CA) which is quite distinct. RCT are the practices (use of new varieties, reduced tillage practices, land levelling practices) that enhance the productivity, in other case CA is the process of retaining surface crop residues with no tillage, use of bed and furrow method for crop planting, precision land levelling to improve the resource management. So basically, conservation agriculture consists three components, such retention of crop residues on the soil surface, minimum soil movement and advantageous crop rotations. RCTs, not only have proved to be energy and input efficient, but were also addressing the issues such as climate and soil health, it has been practiced over an area of 100 M ha worldwide across a variety of climatic, soil and geographic zones (Derpsch and Friedrich, 2009; Saharawat et al., 2010; Ramesh et al., 2016).

Zero tillage / minimum tillage:

Zero tillage otherwise called as no-till farming is a method of growing crops with minimum or no disturbance to the soil through tillage and reduces the erosion rates. Minimum tillage or conservation tillage lowers the pest population by enhancing the numbers of their natural

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enemies. According to a study by Stinner and House (1990) on 51 arthropod pest species of the world revealed that there is a reduction in the damage caused by the 43% of pests and vice versa for 28% of the species the rest 29% of the species remained unaffected. Increased generalist bio-control agents like ground beetles, rove beetles, and spiders in the crop residues due to the availability of the alternative prey in the absence of the obligatory prey (Soane et al., 2012; Tamburini et al., 2016). Examples like delayed infestation by overwintered Colorado potato beetle adults in zero till tomato plots, lowered populations of season populations of immature stages and summer adults of Colorado potato beetle when compared to the conventionally tilled plots resulted in the reduced insecticide applications to keep beetle populations below economic thresholds (Zehnder and Linduska, 1987). Similarly, according to All and Gallaher, 1976 infestation by the European corn borer was doubly reduced in zero tillage field than the on conventional tillage plots. Nevertheless, pest suppression by zero or reduced tillage is not granted but always depends on both phenological and ecological aspects of both crop and their associated pests.

Mulching

The impact of mulching has always been less appreciated when it comes to reduction of pests and disease control. Decrease in insect pest population and disease transmission in mulched crops may be driven by several mechanisms (Prasifka et al., 2006; Szendrei et al., 2009; Szendrei et al., 2010). Mulching disables the capacity of pests to seek their host plants and to move in between them (Andow, 1991; Costello and Altieri, 1995; Finch and Kienegger, 1997; Vidal, 1997) and increasing the searching time enabling them to spend more energy to find the appropriate hosts when they are covered up with mulch (Adamczewska-Sowinska et al., 2009; Szendrei et al., 2010). Furthermore, mulching increases natural enemy plenitude and enhances natural control (Sheehan, 1986; Russell, 1989). Moreover, the physico-chemical properties of the mulch may add in limiting the population of insect pests and other. Striped cucumber beetle (*Acalymma vittatum* F) infesting zucchini plants, was significantly lower in plots intercropped with sunhemp, *Crotalaria juncea* L (Hinds and Hooks, 2013). Soybean grown with alfalfa live mulch (LM) has an increased natural enemy population and decreased *Aphis glycines* Matsumura (Schmidt et al., 2007).

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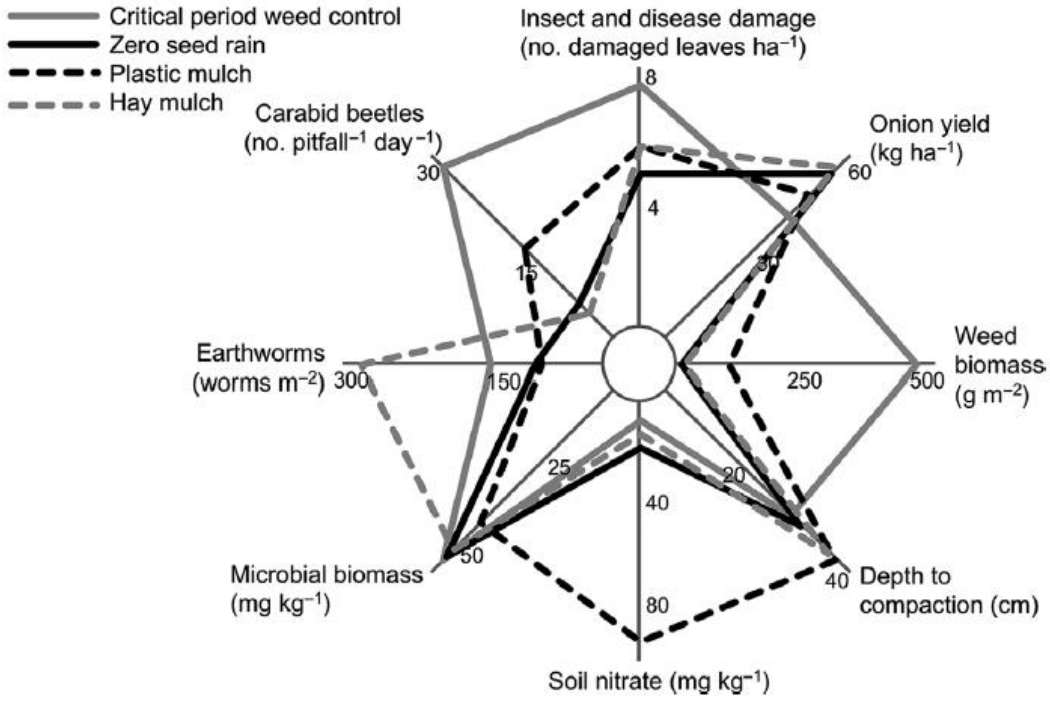

Figure 1 Effects of mulching in an onion agro-ecosystem at the Rogers Farm, University of Maine, USA. Figure created from results of Brown & Gallandt (2018) and Alyokhin et al., 2019.

Organic soil amendments:

A variety of crop systems have considerably proved that plants grown on organically amended soils become less susceptible to infestation by pests and diseases by gaining either antibiotic or antixenotic properties (Alyokhin and Gross, 2013). *Brassica juncea* seed meal showed the most pronounced positive effect when added to non-pasteurized soil, which could completely prevent the infection of apple seedlings by *Rhizoctonia solani* AG-5. Ebaa (2015). Use of canola meal (1%) and pennycress seed powder (0.5%) reduced soybean cyst nematode (SCN), *Heterodera glycines* population density by 70% and 54%, respectively reported by Zane et al. 2014.

Cover Crop /Trap crop:

Cover crops pose a significant role in the integrated pest management (IPM) plan, as they are compatible with other practices that support beneficial organisms. Planting perennials like bug banks, fence rows and pollinator strips act as a refuge crop providing both food and shelter when the cover crops terminates and also before the establishment of the cash crop. Intercropping with the trap crops also encourage natural enemy habitat and also provide

nectar and pollen to natural enemies. Increased pest population densities of diamondback moth were observed in a mono-cropping system when compared to the diversified cropping systems, Broad et al. (2008). In contrast higher population densities of cabbage worm were observed in mixed broccoli intercropping system, Hooks and Johnson (2002). Few pests may respond more strongly to homogeneous systems than to mixed cropping resource concentration‖ hypothesis. So, a successful cover/trap crop treatment is a result of both on cropping diversification and its timing (Broad et al., 2008).

Synthetic fertilizers

It is no surprise that synthetic fertilizers affect insect pest populations Nitrogen being the most essential element for the crop growth, also encourages the pest densities when used in excess amounts (Malik et al., 2009; Buckland et al., 2013). According to Malik et al. (2009) population densities of onion thrips doubled when supplemented with 200 kg N/ ha compared with 50–150 kg N/ ha.

Conclusion:

A rapid demand for the healthy and pesticide free food worldwide, has led to adapt sustainable crop production strategies. The wide scale adoption of such practices is hampered by serious pest management challenges. Many cultural practices (planting of resistant varieties, timely planting, irrigation and fertilizer management) adapted by the farmers so far played a good role in the pest management. By adapting a more comprehensive approach of control strategies such as integration of cover crops, crop rotation and reduced tillage, organic soil amendments, live mulching with other pest control tactics such as narrow rows, fertilizer application methods and reduced pesticide dosages. A complex agroecosystem can be sustained by less disturbed soils creates an environment that is less conducive to outbreaks of herbivorous insect pests.

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