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# Weed Management in Conservation Agriculture for Sustainability

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**SUMMARY**

Conservation agriculture (CA) is a production system that is based on minimum soil disturbance, maintenance of residue cover on the soil surface and crop diversification. It is a resource-saving agriculture practice that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment. In conservation agriculture, weeds expression, seed bank status, distribution, dispersal mechanisms, diversification, growing patterns and competition trends are complex and differ from conventional systems. The weed pressure increase in the early years of conservation agriculture implementation increased as a result of eliminating tillage as a weed control mechanism. Effective management of weed under CA is of prime importance for sustainable crop production.

## INTRODUCTION

Conservation agriculture (CA) can be defined as an effective approach to increase agricultural production sustainably with efficient use and conservation of natural resources. However, weed infestation particularly in the initial years, is one of the major challenges, as weeds severely affect crop growth, yield and income. On the contrary, no-till increases the number of annual weeds because of the accumulation of weed seeds on the upper soil surface (Nalewaja, 2003). No-till induced shifts of weed population particularly towards perennial weeds, thus creating a long-lasting weed problem (Streit et al. 2002). Small-seeded weeds that require light to break dormancy will likely become the dominant weed species in minimum and no-tillage systems. The behaviour of weeds and their interaction with crops under CA tend to be complex compared to conventional agriculture. Moreover, no-tillage induces a shift of weed population particularly towards perennial weeds, thus creating a long-lasting weed problem.CA requires a dedicated approach to control weeds during the initial years, after which maintaining weeds under this system becomes unwary.

### Weed dynamics in CA

Weeds are an agricultural pest and one of the major threats to the natural environment. Major weed invasions change the natural diversity and balance of ecological communities. Weeds are more persistent than native plants because of their morphological and physiological characteristics which heighten their survival ability. Under conservation agriculture, annual weed seeds remain in the upper surface of the soil (0-5cm) which emerges in 1-2 flushes. Furthermore, No-tillage enhances the shift of weed population, especially towards perennial weeds. Small-seeded weeds that require light to break dormancy will likely become the dominant weed species in minimum and no-tillage systems. So, different weeds have different responses under CA practices.

### Role of zero tillage and crop residues on weed suppression

Application of crop residues under zero tillage provides a favourable condition for greater weed suppression and reduced crop weed competition, enabling the crop for better utilization of available resources. Higher weed control efficiency can be achieved with zero tillage + residue application owing to the unavailability of conducive environments for germination of weed seeds due to less soil disturbance and light interruption by residue, and depletion of weed seed through seed predation (Mirsky et al. 2010 and Kumar et al. 2013). Crop residues on the surface of soil act as a layer of protective mulch, which helps in inhibiting surface weed seed germination. There is a decrease in the small-seeded weeds that require light to germinate due to prevention or lack of light by the residue cover on the soil surface. The decrease in weed infestation might be because seeds of some weeds that persist on or around the soil surface in presence of surface cover are either damaged due to environmental effects or destroyed by predators or pathogen attacks (Murphy, 2006). Residues affect weeds through changes in nutrient dynamics, which is dependent on the most frequently used tillage systems, C: N ratio of residues, soil type, and environment (Liebman and Mohler, 2001).

### Diversified crop rotations (cover crop/green manure/brown manure)

Crop rotation is considered the panacea for controlling several agricultural pests and is a proven weed management strategy. The inclusion of crop rotation in CA is a successful approach to reduce weed oppression. Weeds are normally crop-specific; changing a crop in a conventional system by coming in a prevalent sequence may reduce the chances of particular weed infestations and, thus, may reduce the weed pressure. Crop rotation breaks provide higher resistance to weed pressure due to the allelopathic potential of some crop residues. The allelopathic effect can cause weed seeds to remain in dormancy immediately. Different cover crops bring about different cultural practices, which can act as an important component for disrupting the growth period of weeds and, as such, preventing selection of the flora towards an increased abundance of problem species. The effect of cover crop effects on weeds largely depends upon cover crop species and their agronomic management, and weed community composition. Weed suppression is exerted partly through resource competition (for light, nutrients and water) during the cover crop growing cycle, and partly through physical and chemical effects that occur when cover-crop residues are left on the soil surface as a dead mulch or ploughed down and hence used as green manure. Interference with weeds, including competition, physical, and allelopathic effects, is generally higher when grasses or crucifers are used as cover crops than when legumes are used.

**Biological weed control**

Biological control of weed means controlling weeds their economic threshold level by using other living organisms such as predators (insects, mites), pathogens (fungi, bacteria, virus), deleterious *Rhizobacteria* (DRB), herbivorous fish (common carp, sunfish, white amur), animals (duck, geese, snails) and botanical agents (competitive plants, crops or weeds) which can be applied under specific growing condition. Biological weed control is a successful option for integration with other principles under CA.

**Chemical weed control**

Herbicides are used as an efficient tool to reduce the competitive ability of weeds against crops. Herbicides can control the weeds up to a certain time but further flushes of weeds pose new challenges to the farmers during the cropping season. The success of the chemical method depends on many factors; such as plants and their associated weeds, soil, climate, the basis of application. The time and dose of application are decided according to vegetation cover present in the field (Vargas and Wright, 2005). In conventional tillage systems, there are no crop residues on the soil surface when pre-emergence herbicides are applied, on the contrary, under CA practices there are residues on the surface and may interfere in herbicidal activity and reduce their effectiveness (Hartzler and Owen, 1997).The rate of application of herbicides are same for both conventional and conservation agriculture. However, farmers under CA must wait for a while to apply post-emergence herbicides as the crop establishment period is not uniform sometimes due to suppressive effects of cover crops or residue load of previous crop and different emergence pattern of weeds (Bajwa, 2014).

**CONCLUSION**

The sustainability of modern agriculture can be increased by the adoption of efficient and effective crop production technology. Conservation agriculture comes as a promising approach but weed control is a major constraint. Integration of different weed management strategies along with the present principles of CA can act as an effective modern tool, which will surely be a point of interest for adopters of CA.

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