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Role of integrated weed management in conservation Agriculture System: A Review

Uday Pal Singh, Ankush Kamboj, Satender Kumar and Paras Kamboj

Abstract
Farmers usually use tillage equipment to improve the soil structure and to control weeds. But they actually damage the soil structure and reduced soil fertility by doing this again and again. In conservation agricultural systems, however, tillage is reduced or totally eliminated. The use of conservation agriculture (CA) is widely increasing in the world due to several advantages, such as conserving the soil and water resources, reconstructing the soil's fertility, protecting the soil from erosion, and reducing labor needs. Adoption of any appropriate physical, biological or chemical weed management strategy to the existing cultural weed management of conservation agriculture fulfils the multiple approach of integrated weed management (IWM). IWM is valuable to conservation agriculture; as it assists in the management of weed problems and non- availability of some weed control options. Thus, this review article discusses integrated weed management in relation to conservation agriculture and environmental sustainability.

Keywords: Integrated weed management, Conservation Agriculture, Environment

Introduction
The decline in crop productivity due to the presence of weeds has justified the need to manage weed infestation. In the past many years, several weed control strategies have been tested and employed. Tillage, whose main objective is to provide favorable soil condition for crops, functions as mechanical weed control technique since weeds are uprooted and buried into the soil in this land preparation practice. More so, repeated tillage operations have been found useful in controlling perennial weeds due to its ability to reduce the energy reserve in perennial crop through the destruction of their storage organs and propagules. Tillage involves mechanical manipulation of the soil and plant residues. It is an inseperable part of traditional agricultural production practices (Farooq & Siddique, 2015) [16]. In addition to its weed control attribute, intensive tillage loosens the soil, improves the release of soil nutrients for crop growth, and modifies the circulation of water and air within the soil (Hosseini *et al*., 2016) [21]. Tillage affects soil properties such as temperature, moisture content, bulk density, porosity and infiltration which affect crops performance (Adebisi *et al*., 2016) [1].

However, tillage is also a factor responsible for land degradation. Intensive tillage may worsen the soil through carbon loss and erosion resulting from excessive break down of soil aggregates. Tillage alters the water holding capacity of the soil and leads to drought conditions in none or less plastic soils (Singh *et al*., 2016) [30]. The frequent use of heavy machinery for tillage releases greenhouse gas to environment and sometimes compact the soil. To rectify environmental problems of conventional tillage, conservation agriculture which stresses the minimal disturbance of the soil among other components has emerged as a popular practice in some countries. In the 21st century, conservation agriculture is practiced on 154 million hectares (Singh *et al*., 2015) [31], with annual expansion of about 7 million hectares (Friedrich *et al*., 2012) [17].

Ever since the introduction of herbicides in developed countries, the major strategy was chemicalweed control. The use of herbicides has fetched dividends for many years, but the repercussions started appearing only in recent years. This is the situation in developed countries. The higher prices of crude oil that has always been imported into these countries made the herbicide costly apart from the knowledge and skill needed in using them. Hence the major strategy in these countries is to integrate the already available non-chemical methods with herbicide.

It is observed that today's weed of minor importance assumes importance gradually and becomesa major weed of minor regional or national concern tomorrow. The fact lies in that diverted towards it.

The control measures contemplated are mainly for that weed is an isolated way ignoring the whole system. This is undoubtedly be a remedy from that weed, but not a panacea for all. It rather indirectly encourages other minor weeds to grow and proliferate more in the forthcoming years. Again the world, the chances of discovery of a new range of weed control, persistence and residual hazards (Chittapur *et. al*., 1997).

What does the IWM component contribute to

- Development of weed species abundance to reduce interference with crop.
- Dominance of a species in the composition of existing weed flora.
- Substitution of a species in the composition of existing weed flora.
- Enhanced profitability
- Change in succession of species.
- Improvement of overall pest management at the farm level.
- Social acceptance of practices those are appropriate to stake holders.

Table 1: The methods of weed control compared

Methods	Usual duration of effect	Energy requirement	Impact
Quarantine	Long	Very low	Prevents future weedproblems.
Habitat management	Medium to long	Varies	Improves cropgrowth.
Farm hygiene	Medium to long	Varies	Reduces need for and cost of other weedcontrol methods.
Mulches	Shorts	High	Reduces germination ofweeds.
Cultivation	Short	High	Rapid knockdown ofweeds
Mowing	Short	High	Reduce height ofweeds.

Material and methods

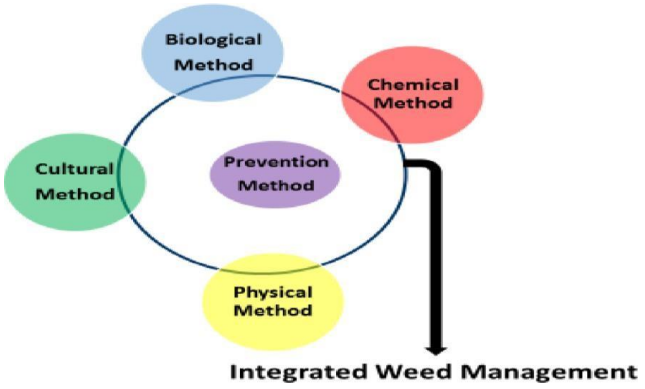

Fig 1: Interception of ring by more than a method brings about IWM

Preventive weed management method: Seed of weeds mixing with crop is a major factor responsible for the spreading of weeds. The use of crop seeds and equipment that are totally free from weed seeds, isolation of imported animals, scouting for new weeds and deterrence of the seed production by weeds on the field are examples of preventive measures (Monaco *et al*., 2002) [28]. These are indirect method of weed control, main objective is to reduce the number of weed plants emerging with crop.

- **Use clean wheat seed free from weed seeds**: Seed of weeds mixing with crop is a major factor responsible for the spreading of weeds. Drill box surveys revealed that many of the farmer's wheat seeds contain weed seeds particularly *Phalaris minor*. Farmer should use cleaned seed or certified seed.

Cultural weed control method: Cultural weed control involves the manipulation of farm practices to the advantage of crop growth at the expense of weeds. Some of the agronomic strategies like tillage, sowing time, sowing methods, competitive crop cultivars, higher crop density, closer spacing, irrigation, fertilization, crop rotation are come in cultural weed control method.

- **Sowing time:** Sowing should be adjust in such manner that it is unfavorable for weed seed germination. Early sowing of wheat (last week of October) reduce the *Phalaris minor* infestation as compared to late sowing. In early sown wheat temperature is not suitable for *Phalaris minor*.
- **Crop rotation:** Crop rotation is an important component of integrated weed management. Under monoculture weed infestation is increased. Crop having different seeding and maturity time can break the life cycle of weeds. The main purpose forrotating crops is to deplete the soil weed seed bank. Crop rotation has been found a very effective cultural practice in breaking the association of problematic weeds like *P. minor* in wheat. A survey sown that resistance of isoproturon in *Phalaris minor* was observed in 67% of fields under rice-wheat rotations. Rotating the wheat field crop like sunflower, sugarcane or berseem helps in decrease the population oh *Phalaris minor*.
- **Mulching:** Mulching provide soil cover when crop is not present or during planting season. Mulching reduce the light from reaching the soil surface to inhibit weed germination. Use of organic mulch (live/green mulch or crop/plant residue) is desired, although there are non-living mulch materials such as plastic widely used in different cropping systems.

Physical weed control method: Physical weed control involves the use of force, heat or some other physical forms of energy to break, cut off, destroy, burn or severely injure weeds (Swarbrick & Mercado, 1987) [32]. Hand weeding, mechanical weeding are the example of physical weed control method. It involves mowing, grazing, mulching, tilling, burning.

Biological weed control method: Biological control is the use of natural enemies to reduce the impact of weeds and weed count. It encompasses the use of organisms and

biologically based products (Ehi- Eromosele *et al*., 2013) [13]. Use of Bio-herbicides which are phytopathogenic, microorganisms or microbial phytotoxins, applied in similar ways to conventional herbicides (Boyetchko & Peng, 2004) [8].

Chemical weed control method: Chemical weed control is the use of synthetic chemical to kill the weeds or reduce the growth of weeds. Based on herbicide movement in plants, there are systemic and non-systemic (contact) herbicides Based on time of application, herbicide could be pre-emergence or post-emergence. Selectivity of herbicide is depends on their compatibility withcrop and the type of weed they control. Herbicides can be an important and effective method of any weed control program. On other side, herbicide resistance is also be an issue with some species. More use of herbicide can also pollute the environment. However, the adoption of chemical weed control is challenged by availability of herbicide, cost of herbicides (Kughur, 2012) [23].

Integrated Weed Management

Considering the diversity of weed problems, no single method of weed control, viz. cultural, mechanical or chemical could provide the desired level of weed control efficiency under CA. Therefore, a combination of different weed management strategies should be evaluated forwidening the weed control spectrum and efficacy for sustainable crop production. Integrated weed management system is basically an integration of effective, dependable and workable weed management practices that can be used economically by the producers as a part of sound farm management system. This approach takes into account the need to increase agricultural production, reduce economic losses, risk to human health and potential damage to flora and fauna, besides improving the safety and quality of the environment. Integrated weed management system is not meant for replacing selective, safe and efficient herbicides but is a sound strategy to encourage judicious use of herbicides along with other safe, effective, economical and eco- friendly control measures. The use of clean crop seeds and seeders and field sanitation (weed- free irrigation canals and bunds) should be integrated for effective weed management. Combining good agronomic practices, timeliness of operations, fertilizer and water management and retaining crop residues on the soil surface improve the weed control efficiency of applied herbicides and competitiveness against weeds. Approaches such as stale seedbed practice, uniform and dense crop establishment, use of cover crops and crop residues as mulch, crop rotations, and practices for enhanced crop competitiveness with a combination of pre- and post- emergence herbicides should be integrated to develop sustainable and effective weed management strategies under CA systems.

Advantages of IWM

- IWM is considered a more practical approach more effective in the long run since combination of methods will take care of weeds in totality and prevents seed production of weeds and enrichment of soil seed bank.
- It will reduce the chance of occurrence of weed flora shift, herbicide resistance weeds, etc in the eco system.
- It may to some extent be complementary to integrated pest management through continuous control of weeds, which cause many insect pests and diseases to harbor upon them.
- It will generate higher net return in the long run particularly under higher cropping intensity.
- It is much useful under high cropping intensity.

Disadvantages of IWM

- IWM mutually compatible, supportive to each other and matching the diversity of weed species is not easy.
- An IWM will not be uniformly applicable to all crops across locations.
- IWM is highly site-specific and cropping system-specific based on host of factors concerning soil, crops, climate and production practices adopted.
- It is more of a concept and as such not a method of weed control in pure sense. Its efficiency may vary based on fluctuation in the efficiency of weed control methods integrated over time and space.

Conclusion

Advancement for measures such as CA that prevent human induced soil degradation is allowable. The adoption of CA attenuates erosion and some other associated challenges of tillage. However, emergence of different weed challenges in CA requires that its inbred weed management component (cover crop, crop residue mulching and crop rotation) be convoluted with other weed management strategies without negotiate its principles. Acceptance of any compatible physical, biological or chemical weed management strategy to the existing cultural weed management of CA fulfils the multiple tactics of integrated weed management IWM. The reduced weed management options in CA tend to increase reliance on herbicide which could cause water contamination, weed resistance, weed flora shift, and herbicide carryover. IWM checks overreliance on herbicide. Hence, embracing IWM in CA assists its sustainability and enhances the environment protection focus.

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