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New approaches in management of weeds

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Introduction

Agriculture forms the backbone for our country. India has attained self-sufficiency in food grain production which was possible with the development and adoption of improved production technologies including weed management technologies. Weed science, as an integral part of agricultural production needs to evolve by undertaking research on complex problems through collaborations with multiple scientific disciplines. This means that weed science needs to move away from its mono-disciplinary perspective at targeting weeds, sometimes a single species, through the overreliance on few single herbicide mechanisms of action. Weed competition is one of the most important factors in limiting the yield of food grain crops. Competition between crop and weed begins when the supply of any of the growth factor is limiting and falls below the demand of both crop and weeds, when they grow in close proximity. Weeds having faster growth rate, accumulate large amount of biomass in a short period, which interferes with the growth of plants and ultimately affects the yield of the crop. Among the different weed species, grassy weeds pose greater competition. They have an extensive and fibrous root system. Similarly, sedges grow huge in number and cause serious competition for nutrients. The roots of the sedges also dominate the surface feeding zone and obstruct nutrient flow to crop roots. Weeds interferes with crop growing by competing for one or more growth limiting resources i.e. nutrients, water, space, light and carbon dioxide, because of the limited supply of these valuable elements, their association therefore, leads to competition for these elements for the survival. The success of weed management process is directly related to agricultural success as a whole. Improper management of weeds or if weeds are not controlled on proper time it leads to high reduction of crop yield and production cost also increases.

What is weed management?

Weed management is the application of certain principles and suitable methods that will improve the vigour and uniform stand of the crop and at the same discourages the invasion and growth of weeds. It encompasses all the aspects of prevention, eradication and control by regulated use, restricting invasion, suppression of growth, prevention of seed production and complete destruction of weeds.

Challenges in present weed management methods

- Herbicide Resistance
- Herbicide residue buildup
- Leaching
- Intercropping issues
- Labour shortage
- Biodiversity issues
- Ecology changes
- Effect on weed seed predators
- Weed seed bank

Therefore, there is a great need for a new weed management practices in modern agriculture based on ecological principles and non-conventional weed management approaches.

New approaches for management of weeds

Weed shift control

Rotate herbicides (different sites or modes of action). Rotate crops, particularly those with different life cycles (for example, winter annuals such as winter wheat, perennials such as alfalfa and summer annuals such as corn or soybeans). Clean equipment before leaving fields infested with or suspected to have resistant weeds.

Allelopathy

Allelopathy has emerged as a pragmatic approach to solve multiple issues in modern agriculture. Multiple approaches including crop rotation, cover crops, intercropping, mulching, crop residue

incorporation and water extracts application are being used to control weeds. Allelochemicals affect numerous physiological and biochemical processes in weeds like inhibit seed germination and nutrient uptake.

Herbicide Resistant (HR) crops

The most widely adopted modern tool for weed management in conjunction with herbicides. HR crops are generated with transgene technology or mutation breeding.

Strategies to develop herbicide resistant crops

i. Altered target site
ii. Enhanced metabolism
iii. Compartmentalization or sequestration
iv. Over expression of the target

Thermal weed control

Thermal weed control methods can be divided into
(a) Direct heating by hot water and hot foam and
(b) Indirect heating by electrocution

Hot water treatment is safe and has no side effects unlike flame weeding or radiation methods. The effectiveness of hot water treatment is greater on dense weed population because of its high ability to penetrate the plant canopy. The use of hot foam, as an alternative to hot water, is more energy efficient due to slowly foam disintegration and therefore the greater amount of heat transmittance to targeted weed plants

Weed control by electrocution

The practice of weed control via electric shock is called electrocution. The use of high-electric power and Electro- physical engineering to minimize chemical herbicides and eliminate undesirable plants effectively has started gained pace. In the future, this method may have utility, especially in organic vegetable and orchard farming systems

Bio- based herbicides

For organic farming management, where synthetic products are not allowed, non-synthetic botanical products are used for weed management. Improved extraction and purification procedures have facilitated the recovery and purification of potentially herbicidal metabolites. One of the main advantages of natural bioactive compounds is its rapid degradation in the environment. Generally, botanic based products have little or no selectivity and usually adequate efficacy only at very high doses compared those of synthetic herbicides.

Nano herbicides

- ✓ Exhausting Weed Seed Bank
- ✓ Degrading germination inhibitor
- ✓ Exhausting food reserve
- ✓ Slow release-season long weed control
- ✓ Rapid degradation of Herbicide residue

Weed management through nanosensors

Nanotechnology-based sensors are being used in precision agriculture for the accurate release of herbicide spray mixtures and precision control of herbicide applications. Nano-based biosensors could enable better and more efficient use of herbicides while maintaining environmental safety.

Precision weed control

Reduce the amount of chemical used to control the weeds by applying them to exactly where the weeds are located. Site-specific weed management (SSWM) has the potential to reduce herbicide use by 40- 60%. Site-specific weed management is the integration of machinery or equipment embedded with technologies that detect weeds growing in a crop so as to maximize the chance of successfully controlling the weed SSWM may be an option when weeds occur in patches of varying size, shape and density. It involves: variable rate technology, detection systems (Advanced sensor intensive technology and weed seeker).

Weed seeker

This method involves mounting the unit on a GPS guidance tractor. The spray nozzles are activated when the electronic signal detects weeds. Detect spray is an optoelectronic sensor that uses 646 nm and 850 nm reflectance to distinguish weeds from soil. Detect spray automatically sprays the weeds based on detection by the sensor. It reduced the usage of herbicides by 70%.

Automated weed cultivators

Automated cultivators were developed as intra-row cultivators in transplanted vegetable crops such as cabbage (*Brassica oleracea*) and celery (*Apium graveolens*). These cultivators use a variable-speed rotating, semicircle-shaped disc blade. A camera and computer-controlled guidance system adjust the rotational speed of the disc in real time so that the opening of the disc blade passes around the transplanted crop. The rotating cultivator results in 30–54%lesser weed densities than the standard cultivator.

Robotic weed management

Robotic weed management is a four-step process involving guidance, identification, precision weed removal, and mapping of weed species. The feasibility of a robotic weed control system depends upon accurate machine vision analyses, robotic efficiency and suitability, variable-rate-application technology, decision support system, and strength of weed-sensing tools. Automated weed control through robotics is considered a viable option for best integrated weed management in the future. Use of mechanical, chemical, thermal and electrical approaches is useful to remove weeds through robots.

Conclusion

Multiple weed control methods used at multiple spatiotemporal scales are necessary. New technologies offer promise to meet many of the challenges in weed control for organic production system. Any weed management practice that can reduce the pollution load on the environment brings the ecological harmony which in turn makes the system sustainable.