

INSIGHTS INTO ORGANIC WEED MANAGEMENT IN AGRICULTURE

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ABSTRACT

Weeds pose a significant threat to agricultural production, causing nearly one-third of total losses attributed to pests. Certain crops, such as direct-seeded rice, may suffer complete yield loss due to weeds. While herbicidal weed management is effective and time-efficient, concerns over issues like resistance, pollution, and toxicity have led to a shift towards organic weed management. This holistic approach encompasses preventive, physical, cultural, biological, allelopathic, and organically derived herbicidal methods. Combining preventive measures, physical techniques like hand weeding and mulching, cultural practices, biological control, and allelopathy offers a comprehensive, synthetic herbicide-free strategy, suitable for diverse agricultural systems such as organic and natural farming, where weeds pose a significant hindrance to productivity.



INTRODUCTION

Management of weeds in all agro-ecosystems is imperative in order to sustain our crop productivity and to ensure food security as losses due to weeds accounts for about one-third of the total losses caused by agricultural pests. In certain cases, like in direct seeded rice (DSR), weeds can cause up to 100% yield loss. Among different weed management options, herbicidal based weed management is the very popular as it is quite effective in managing weeds and simultaneously saves considerable time and labour. But like other pesticides, over-reliance on herbicide has received criticism for different issues like:

- evolution of herbicide resistance in weeds
- weed species population shifts
- surface and groundwater water pollutions
- herbicide residues in food chain
- toxicity on non-target organisms

- risk in cropping systems

The increased concerns about side effects of herbicides have dominantly driven the focus on organic weed management. Organic weed management is basically a multi-hammer approach that is basically a multiple weed suppression tactics that are individually weak but cumulatively strong. Thus it is just opposite to chemical weed management option that relies on single hammer approach. Organic weed management consists of various preventive, physical, cultural or ecological, biological, allelopathic and organically derived chemical-based approach to tackle weeds.

WEED SCOUTING

It is an important step in any type of weed management. Understanding type of weed populations present in a field, their growth stage, and infestation severity is very important as it is the basis of any type of decision taking related to weed management. Many weed species are only effectively controlled when they are small, so timely scouting finds small, susceptible weed seedlings present in a field. Additionally early identification of new species, provides opportunity to control them before they move within the field or to other fields. Weed scouting should not be limited to the current growing season, but throughout the year preferably conducted twice during each growing season, once following planting but prior to the first weeding and then just prior to harvest. (Vangessel, 2019)

For start of successful weed management strategy, following steps are essential:

1. Walk a zig-zag pattern through the field, stopping at least 5 times at widely-separated points along the way.
2. While walking through the field, identify all weed species present and record the growth stage of each weed.
3. If the weeds appear to be concentrated in specific areas of the field, draw a map of the field and mark their locations.
4. At each field stop, determine the number of weeds present
5. After taking data on their degree of dominance, take decision on which methods can be incorporated in managing them.

PREVENTIVE APPROACH OF ORGANIC WEED MANAGEMENT

There is a saying that 'Prevention is better than cure'. Preventive options consist of a number of tactics like at the time of sowing, use weed free certified crop seeds, well decomposed FYM and compost; during the growing season, use of clean (weed seed free) irrigation water, keep the irrigation channel and bunds free of weed infestation; at the time of harvest, use clean harvest and grain transporting equipment

etc. Other than this, impose strict quarantine law, stale seed bed, use clean farm machinery and farm animal etc needed to be ensured.

PHYSICAL METHODS OF ORGANIC WEED MANAGEMENT

Physical method of weed management is the combination of mechanical and manual method of weed management. Hand weeding is the most common method of organic weed management. It effectively controls annual weeds with upright and erect growth and not suitable for weeds growing horizontally prostrate & rosette as they may get cut off at the base on pulling by hands and may rejuvenate later. Hand hoeing is a post-planting intercultural operation, require less manpower than hand weeding. It is effective more against annual weeds than against perennial weeds. Tillage also effectively controls perennial weeds. Mulching exclude sunlight from reaching to soil by covering it and to germinating weeds, whose photosynthesis inhibited causing them to die. They also work as effective barrier to weed emergence. It is very effective against most annual weeds and some perennial weeds such as *Cynodon dactylon*, *Sorghum halepense*. Other physical method of weed management are cheeling and digging, flooding, burning, flaming, mowing and slashing etc.

CULTURAL/ECOLOGICAL METHODS OF ORGANIC WEED MANAGEMENT

Cultural or ecological method is based on the principle 'a good crop is the best weed killer'. It relies on crops competitiveness and management practices which gives the crop more favourable environment. Strategies like selecting weed competitive crop types, varieties, modifying sowing time and method that favours crop over weeds, adjusting seed rate, crop rotation, use of trap and catch crops, following cropping patten that discourage weed emergence, irrigation timing and methods, modifying fertilizer application rate, method, time that stimulate crops over weeds, summer fallowing etc are the different strategies that need to be considered in organic weed management.

BIOLOGICAL METHODS OF ORGANIC WEED MANAGEMENT

It relies on the natural law of homeostasis, that is check and balance. It focuses on managing a organism (weeds) using another living organism up to a population density lower than what naturally occurs in the absence of the employed organism. This method is not suitable in crop land situation, but can be used in non-crop situation. Various insects and beneficial micro-organism can be used in biologically managing weeds.

Bio agents	Target organism
Insects	
<i>Zygogramma bicolorata</i>	<i>Parthenism hysterophorus</i>
<i>Crocidosema lantana, Teleonnemia scrupulosa</i>	<i>Lantana camara</i>
<i>Neochetina eichhornea, N. Bruchi</i>	<i>Eichhornea crassipes</i>
<i>Agasides hygrophilla</i>	<i>Alternanthera philoxaroides</i>
<i>Crytobagus singularis, Paulinia acuminata</i>	<i>Salvinia molesta</i>
Microorganisms	
<i>Phyophthora palmivora</i> (Devine)	<i>Morreria odorata</i> (Strangler vine) in citrus
<i>Colletotrichum gleosporoides</i> f.sp. <i>aeschynomene</i> (Collego)	<i>Aeschynomene virginica</i> (northern joint vetch) in rice and soybean
<i>Colletotrichum gleosporoides</i> f.sp. <i>Cuscuttae</i> (LUBAO 11)	<i>Cuscutta</i> sp. (Dodder)
<i>Cercospora rodmanii</i> (ABG 5003)	<i>Eichhornea crassipes</i> (water hyacinth)

(Ravisankar et al.,2017)

ORGANICALLY DERIVED HERBICIDE BASED WEED MANAGEMENT

Organically derived herbicides can be a very potential tool in organic weed management. They are obtained from natural sources, so can be used in organic farming as well. But the main problem of these type of compound is that, most of them are non-selective, which restricts its use in crop land situation, but can be applied in non-crop situation. These need to be applied, either prior to crop emergence or transplanting, or post-directed application in established crops to assure the herbicides do not injure the crop plant. In general, these contact herbicides control broadleaf weeds better than grasses, and annual weeds better than perennial weeds. These herbicides destroy the plant's waxy cuticle and cell walls causing desiccation and rapid wilting. Example of some organically derived herbicides along with time of application is given as below:

Organically derived herbicides	Time of application
Corn gluten meal	Pre emergence
Mustard seed meal	Pre emergence
Vinegar (5, 10, 15 and 20% acetic acid) like Weed Pharm® (20% Acetic Acid)	Post emergence
Clove oil (Matratec®, and Matran®, 50% Clove Oil)	Post emergence
D-limonene (GreenMatch® 55% d-limonene)	Post emergence
Caprylic/capric acid (Suppress®)	Post emergence
Eugenol (Weed Slayer®)	Post emergence

(Webber, 2012; www.extension.colostate.edu)

ORGANIC WEED MANAGEMENT USING ALLELOPATHY

Allelopathy is based on the fact that plants produce many secondary bi-products which released in the the surrounding environment either via leaching or exudation or through decomposition of residue. These compounds have the ability to possess negative or positive impact on growth of other plants. For example- Some crops, such as Rye, Sunflower, Buckwheat, Black mustard etc can be used for controlling different weeds via allelopathy. Several allelochemicals like gallic acids, protocateuic acid, syringic acid, benzoic acid, dhurrin, sorgoleone etc present in sorghum water extract (sorgaab). Similarly, chlorogenic acid, isochlorogenic acid, scopolin etc present in Sunflower water extract. They can be used as foliar spray for managing weeds. Allelopathy may be employed for weed control in field crops by combining cropping, intercropping, surface mulch, soil incorporation of plant residues, allelopathic aqueous extracts etc. (Arif et al.,2015)

ORGANIC PARASITIC WEED MANAGEMENT

Parasitic weeds are special kind of crop bound weeds which depend on crops directly for survival during their partial life time or complete life time. A number of options available for managing the parasitic weeds.

Parasitic weeds	Management strategy
<i>Cuscuta spp</i>	i) Crop rotation with wheat,barley, oats or with winter pulses like gram lentil etc. ii) Tolerant variety like for lucerne, ‘T9’; for green gram, ‘M2’; for linseed, ‘Garima’ iii) Soil solarization
<i>Orobanche spp</i>	i) Crop rotation with non-host crop like wheat, barley, chickpea ii) Trap crop like Pepper for <i>O.cernua</i> , Linseed for <i>O .ramosa</i> ; Catch crop like Toria. iii) Soil solarization iv) Tolerant varieties like ‘F-402’ of Fababean .
<i>Striga spp</i>	i) Crop rotation with soybean, cowpea, cotton, sunflower; intercropping of sorghum with desmodium and napier grass on border (Push and pull strategy), ; green manuring with sunnhemp etc ii) Minimum or Zero tillage iii) Soil solarization

ORGANIC WEED MANAGEMENT FOR AQUATIC WEEDS

Aquatic weeds are one of the major hindrances in fishery, they decrease the value of wetlands, harbour a number of disease-causing vectors etc. A number of options available for managing them organically like, mechanical methods consisting of chaining and dredging, netting, mowing etc; biological methods use of Grass carp (*Ctenopharyngodon idella*), Snails (belonging to genera *Marisa* and *Pamacea*), Ducks, Manatees. Insects (*Neochetina eichhorniae* for *Eichhornia crassipes*) etc can be done.

CONCLUSION

Organic weed management is indeed a potential alternative to chemical weed management, if implemented properly. Integrated application of different organic weed management tactics may provide better result rather than relying on any of individual option. More intensive research and developments are needed in area of biological control and allelopathy mediated weed control to expand their use and effective field applicability. Further, in recent future, exploiting latest options/concepts like ‘weed suppressive soil’, robotics assisted welders can be a way forward in this field.

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