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Review Article

Recent Trends and Techniques of Weed Management Practices in Organic Farming

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Abstract

Organic farmers cite weeds as the most significant production problem they encounter and total crop losses from weeds can occur under the organic system. Perennial weeds increase under organic husbandry. One analysis reveals the relative frequency of weeds in three years is 4050 to17320 m^2. Chemical intervention is not permitted for weed control purposes in organic farming systems the lack of research on non-chemical options for weed management has made weeds a serious problem in organic farming. It is important to understand that under an organic system weeds will never be eliminated but only managed. Weed control in organic systems focuses on management technique designed to prevent weeds, as well as the production of crop having vigorous enough to out-compete weeds and reduce the availability of resources to the weeds. The main target of weed management in organic farming is to reduce the degree of direct control inputs and to bring about substantial yield improvement of the crop.

Keywords: Weed Management; Organic Farming

Introduction

Weeds constitute a special class of pest which seriously limits the production of the major crops on any magnitude. These compete with the crops for all the inputs which are given for the crop growth and play a significant role in reducing the productivity of the crops. The vegetables are more sensitive to the weeds and care must be taken to manage these unwanted plants at appropriate time. Now a days, because of awareness among the public in respect of organic farming, the farmers are slowly switching over their type of farming practices viz., in to organic farming without using of any chemical inputs. The vegetables are prime crops which are cultivated by organic methods [1]. Since, brinjal is more remunerative and common vegetable consumed by the public and this crop is more prone for organic cultivation. Minimizing the losses due to weeds, choice of using chemical method of weed control which leads to adverse effects on the environment, crop produce and human health. Oruonye and Okrikata [2] posited that the synthetic agro chemical methods of crop enemies control have a lot of adverse ecological impact. Apart from that, herbicides alone contribute more than 50% of global pesticide sales than other agro chemicals and took lot of farmers income. Hence, the need to maintain a healthy and sustainable environment, there is a call for non-chemical approaches for weed management in crops.

Non-chemical weed management tool box

Preventive strategies

A sound prevention strategy is an essential component of an integrated weed management (IWM) strategy. The saying 'An ounce of prevention is better than a pound of cure' is indeed very applicable to weed management. Weeds prevention strategies aim at preventing: (i) initial introduction; (ii) infestation development; (iii) dispersal of weeds and their propagules. The formulation and practice of good weed prevention strategies may involve individual and group responsibilities as well as government-enacted laws to prevent the introduction and dissemination of weed propagules.

Knowledge of the economic threshold (the minimum weed density at which) Weed control is economically justified) and critical period of weed interference: when weeds must be controlled to obtain maximum yield is essential. A sound knowledge of weed population dynamics and how it is affected by different weed management strategies is important in developing an optimum crop management strategy.

Cultural control

Globally, cultural control has been one of the most widely used weed control options for centuries. The introduction of effective, selective and inexpensive herbicides has diverted emphasis away from cultural control during the past 50 years.

Cultural weed control options include: crop rotation, increasing the competitive ability of a crop, delayed or early seeding, flooding, inclusion of green manure and cover crops, and intercropping. The ability of crops to compete against weeds could be increased by selecting the right crops and cultivars, considering the weeds present as well as the climate, ensuring rapid and uniform crop emergence through proper seedbed preparation, and by using the right seed and seeding depth, increasing planting density and adapting planting patterns wherever possible to crowd out weeds, adequate and localized resource (water, fertilizer) application, and optimum management of the crop, including insect pest and disease management.

Practice	Effect
Tillage	Kills growing weeds; damages perennial roots and rhizomes; buries seeds too deeply to emerge; brings weed seeds to surface.
Post-planting cultivation	Removes weeds from the crop.
Stale seedbed	Flushes weeds from the soil before planting.
Organic fertility sources	Favor crops over faster-growing weeds due to slow release of nutrients.
Drip irrigation	Directs water to the crops rather than to weeds.
Mulch	Smothers weeds: delays emergence of weeds
Using transplants	Competitive advantage to crop
Competitive cultivars	Improves competitive ability of crop against weeds.
Increase plant density	Suppress weeds by shading
Rapid cleanup after harvest	Prevents seed set by residual weeds.
Cover crops	Suppress weeds, improves soil health

Cropping systems approach

Competitive crops

Competitive crops like horse gram (*Dliches uniflovos*), cowpea (*Vigna sinensi*), Soybean (*Glycine max*) and sweet potato (*Ipomea batata*) shift the crop weed competition in favour of crops. These crops grow quickly and produce canopy early resulting in better shading of weeds. Quick ground covering is the main reason for weed suppression. Even there are reports of reduction in umber of tubers per plant secondary sheets and above ground biomass of troublesome weed *Cyperus esculentus* due to effective light interception and shading by hem (*Cannabis sativa*).

Crops	Canopy spread (cm) 60 DAS	Weed dry weight (kg/ha)
Ground nut	40	3300
Soybean	50	2032
Green gram	43	2356
Cowpea	66	1630
Black gram	46	2250

Table 1: Total dry weight at harvest canopy spread as influenced by crop [3].

Intercropping

Intercropping suppresses weeded better than sole cropping and thus provides an opportunity to utilize crops themselves as tools of weed management. Smother crops reduce weed intensity by shading. Results of large number of experiments have indicated than much short duration pulses - green gram, cowpea and soybean effectively smothers weeds [4]. Horse gram also combines well and suppresses weeds.

Treatment	Weed weight (g/m^2)	Weed suppression (%)	Pigeon pea yield (kg/ha)
Pigeon pea weedy	113.9	-	1911
Pigeon pea + urd	90.4	20.7	2374
Pigeon pea + mung	88.6	22.2	2518
Pigeon pea + soybean	88.6	22.2	2266
Pigeon pea + cowpea	76.1	33.3	2349

Table 2: Effect of pigeon pea + pulse intercropping on weed growth and yield of pigeon pea [5].

Cover crops

Cover crops (velvet bean and cowpea) are grown for their various ecological benefits in an agro ecosystem, including weed suppression. They can be grown in rotation, during a fallow period, during an off-season winter period or simultaneously during part or all of the life cycle of a cash crop. Depending upon their specific objectives, they have been referred to as smother crops, green manure crops, living mulches, and catch crops, cover crops control weeds mainly by absorbing photo synthetically active radiation and by lowering the red: far-red ratio of transmitted light, which in turn influences the germination of light -requiring weed seeds. Allelochemicals, released by either the living cover crop or its dead residues, can also influence weed growth and weed seed germination.

Cover crops not only reduce weed growth during their life cycle but also lower weed pressure in subsequent corps by reducing soil-borne seed banks and the below-ground food reserves of perennial weeds, due to competition in the year when the cover crop was grown. In addition to a direct reduction in weed seed production due to competition for resources, it has also been suggested that cover crops can reduce the size of soil seed banks by increasing the activities of soil predators.

Allelopathic interactions

Allelopathy could be used to suppress weeds by using companion or rotational crops, mulching with plant residues, applying plant extracts or by incorporating allelopathic potential in crop cultivars using plant improvement techniques.

The potential of different weed/crop residues and plant products through their allelopathic effect was studied. Mulching of eucalyptus leaf litter registered the highest weed control efficiency of 62.0 and 51.8% at 20 and 40 DAS, respectively. The aqueous extracts as well as growing plants inhibit seed germination and seedling growth of *Abutilon theophrasti*, *Datura tramonium*, *Ipomoea* spp weeds. Soil incorporation of sunflower residues reduced the number of dicot weeds by 66%.

Treatments	C. album	C. didymus	A. fatua	P. minor	C. arvensis	Total Weeds
Pre-em.	21.75	15.50	8.00	5.00	3.75	59.50
25 DAS	19.50	20.25	8.50	10.00	2.50	71.50
Pre-em.+25 DAS	23.50	16.75	6.75	4.25	3.50	66.25
25+35 DAS	25.50	23.00	9.50	8.00	3.25	86.00
Pre-em.+25 +35 DAS.	24.25	13.25	7.75	4.75	4.25	63.25
Control	22.75	21.50	9.25	9.50	3.00	80.50

Table 3: Effect of Sunflower Plant water Extract (SWE) on weed population (per m^{-2}) [6].

Stale seedbed

Weeds have several requirements for germination including moisture, oxygen, temperature and light. By disturbing soil, weed seeds are often stimulated to break dormancy. This is generally observed as a flush of new seedlings following tillage.

In no tillage, weed germination will be more sporadic and extended over a long period of time. The land is, therefore, brought to fine tilth by repeated cultivation before the receipt of pre monsoon showers to provide favourable conditions before sowing of crops. This is known as 'stale seed bed'. This method has been extensively employed in cultivation of soybean in U.S.A. Generally, the effectiveness depends on occurrence of pre monsoon showers and if pre monsoon showers are not received crops and weeds sprout together resulting in higher weed intensity. Weed intensity is usually low in late sown crop than early sown crop because of stale bed effect.

Mulching

Covering or mulching the soil surface can reduce weed problems by preventing weed seed germination or by suppressing the growth of emerging seedlings. Mulches are generally ground cover, loose particles of organic or inorganic matter spread over soil, and sheets of artificial or natural materials laid on the soil surface.

Living mulches

A living mulch consists or a dense stand of low growing species established prior to or after the crop. A living mulch of *Portulaca oleracea* L. From seed broadcast before transplanting Brassica oleracea suppressed weeds without affecting crop yield. Living mulches are sometimes referred to as cover crops, but they grow at least part of the time simultaneously with the crop. Cover crops are generally killed off prior to crop establishment.

Living mulches are well suited to use in perennial crops such as fruit where self reseeding is an advantage. However, even in established apple and apricot orchards living mulch growing along the planted row may depress crop growth.

Non-living mulches

Both natural (organic or inorganic) and synthetic non-living mulches are used for weed control n agricultural as well as non-agricultural system (Bond and Grundy, 2001). Depending on the shape these mulches can be divided into various categories: sheet mulches (e.g. black, clear or coloured polythene, geotextiles, paper, needle-punched fabrics, and carpets) or particulate mulches (e.g. straw and hay, grass clippings, leaf mould, industrial crop waste, coffee grounds, dry fruit shells, shredded and chipped bark or wood, sawdust, crushed rock, and gravel). These mulches control weeds by inhibiting germination of light- requiring seeds, reducing weed growth by partially or completely absorbing light (dark mulches), solar heating (clear plastic mulches), and/or by physically interfering with weed seedling growth. Depending on the material used. Non-living mulches may also protect soil from wind and water erosion; add organic matter to soil; help conserve soil moisture; increase or decrease rainfall penetration, nutrient leaching and soil oxygen content.

Particle mulches

Loose materials like straw, bark and composted municipal green waste provide effective weed control but the depth of mulch needed to suppress weed emergence is likely to make transport costs prohibitive unless the material is produced on the farm. A3 cm layer of compost was needed to prevent the emergence of annual weeds. Weed control usually improves as the thickness of the organic mulch increases.

However, there were problems in laying the mulches, due to the wind lifting and tearing the sheeting. After cropping, lifting and disposal may be a problem with plastic and other durable mulches. Sheeting made from paper, non-woven natural fibers and degradable plastics have the advantage of breaking downs naturally, and can be incorporated into the soil after use.

Mechanical weed management

Mechanical weed control is the oldest and most common method popularly adopted in India. It is not only safe to the environment, but also safe to the user. It can control weeds very effectively. Mechanical weeding with finger weeder between the rows during early growth supplemented with hand weeding could be the best practice.

Mechanical weed control involves tillage as well as the cutting and pulling of weeds and is probably the oldest weed management tool. Like many other non-chemical options, the availability and acceptability of herbicides has diverted attention away from research on mechanical weed management, hampering technology development in this area.

Tillage practices

Mechanical weed management is carried out by pre-plant tillage and post-plant tillage to control weeds. Pre-plant tillage is usually conducted in two phases namely, primary tillage and the secondary tillage. Post- plant tillage is carried out to control weeds in row planted crops and is more popularly known as row cultivation.

Tillage not only controls weeds, it also breaks up the soil top prepare the seedbed, facilitating rapid and uniform germination and root penetration, increases soil aeration and rainfall penetration, and provides the soil-surface topography needed for specific crops (raised beds, furrows, etc). weed control in crop rows, problems in crop residue management, and weather dependency are major challenges for weed control by tillage.

Tillage influences the weed seed bank dynamics by physical mixing or by turning under the soil. Inversion tillage, such as mould board ploughing results in burial of large proportion of seeds in the tillage layer compared to non-inversion tillage such as chisel (Ball, 1992) weed seed burial deep fail to emerge resulting in low weed intensity in subsequent season following ploughing. Deep ploughing can also be effectively employed against perennial weed like *Cynodon dactylon* provided the rhizomes after tilling are collected and destroyed.

Soil depth (cm)	Total weed seed (%)	
	Ploughed	Chiseled
0 - 15	20	63
5 - 10	27	20
10 - 15	53	17

Table 4: *Influence of primary tillage on vertical distribution of total weed seeds in the soil [5].*

Nowadays, negative effects of conventional tillage in the form of soil erosion and loss of soil structure have received more attention and reduced tillage or no tillage have been viewed with more hope. However, reduction in tillage will allow accumulation of 40 - 80% of weed seeds in the top 0 - 5 cm soil layer resulting in more weed emergence compared to conventional tillage. In addition, perennial weeds establish well and become problematic. As a result, farmers are compelled to go for herbicide use to control weeds. However, this aggravated situation can be effectively managed by combining other non-chemical means such as cover cropping or crop rotation.

Apart from primary tillage, secondary tillage such as row cultivation, harrowing, etc. also influence weed seed bank and species composition. Light harrowing/blind tillage of soil with blade harrow after sowing of crops either before crop plants emergence or while they are in early stage of growth is a common practice employed to control weeds on soils that have tendency to form crust after irrigation or rain.

Night tillage

Many weeds require a flash of micro-seconds of red light in order to germinate. Night tillage may help to reduce weed germination to a significant extent. Weed seeds left on the soil surface germinate, which are lesser in number as compared to their active seed bank in soil. Some annual weeds, including *Chenopodium album* and Echinochloa spp. have been found to respond favorably to night tillage. Covering the tillage implements to prevent light reaching the soil has been reported to reduce weed emergence by 70% [7].

Weed control equipment

The new Infra-weeder weed control equipment uses infrared heat to kill undesired vegetation. Infra-weeder equipment uses a propane- fuelled ceramic heating element that develops temperatures up to 1800 degrees Fahrenheit (1000 degrees Celsius), which applies infrared radiation to weeds. Because of the high heat produced by this machine, it eliminates windborne weed seeds, bacteria, and moulds on the ground surface. In addition, the shielded heat element prevents heat from radiating upwards or sideways so vegetation can be controlled alongside desired species without harm. The most popular unit, the hand held Eliminator, runs four hours on a standard disposable propane torch cylinder.

Due to the nature of infrared heat application, a close proximity must be maintained between the heat element and the targets species, therefore it is restricted to use on relatively smooth surfaces. The use of infra-weeder equipment is slower than liquid herbicide application, and sometimes a second application is required in the case of mature weeds. This makes it an excellent addition to an existing chemical weed control program especially for sensitive areas such as near pools, patios, and areas where children play.

Thermal control

Several options for controlling weeds using heat have been developed. These include: fire, directed flaming, hot water, steam, microwave, infrared, ultraviolet radiation, electrocution and freezing. Heating results in the coagulation of proteins and bursting of protoplasm due to expansion, which kills the tissue. Weeds can also be killed by exposure to very low temperature, e.g. by exposing aquatic weeds to low air temperature by removing water from a pond or lake or by freezing terrestrial weeds using dry ice or liquid nitrogen.

There are several advantages of using heat as opposed to chemical means to control weeds. The risks of chemical spills spray drift, chemical run-off wastes, and rinses are eliminated. Weeds are not able to develop resistance as they can with chemicals. Beneficial microorganisms in the soil are not damaged due to minimal ground penetration. Heat can be used in all weather since there is nothing to wash off or blow away. The applicator is more comfortable because masks and goggles are not required. Finally, the public perceives less risk in non- chemical applications especially in high profile areas such as parks, playgrounds, and sports fields.

Thermal weed control options offer several advantages. They generally do not disturb buried seeds, leave dead biomass on the soil surface, which offers protection against erosion and moisture loss, and may kill some insect pests and pathogens and most importantly, do not pollute the environment with synthetic herbicides.

Hot water is employed by the recently developed aquacade vegetation control system. This new technology uses a process in which water is super heated on demand under low pressure and then pumped through a heat resistant hose to an application delivery system. This super-heated water when applied to the ground surface will eradicate unwelcome vegetation. The extreme heat of the water immediately breaks down the molecular structure in the plant killing it on contact. The Aquacide can be used in many applications including the line marking of playing fields, around public areas, between asphalt and curbs, as well as growth around fencing and poles.

Pneumatic weed control

An implement has been developed that injects compressed air into the soil to loosen and uproot small weeds on either side of the crop row. It has been used successfully in carrot, maize and sugar beet. These machines works best in dry soils. In a German prototype, air supplied to the hoe blade leg is blasted out through holes the sides of the hoe blade [8]. An operating depth of 15 mm and speed of 5-6 km/hr are suggested.

Lasers

Light in the form of lasers has been shown to inhibit the growth of water hyacinth (*Eichornia crassipes*). The treatment did not generally kill the weed but treated plants were smaller, propagated fewer daughter plants and covered less water surface than the untreated. More recently, the possibility of using a CO2 laser as a device for cutting down weeds has been demonstrated.

Ultraviolet light

The use of ultraviolet light for weed control has been patented but remains at an experimental stage.

Solarization

The search for new and improved method of weed management is continuous one. In 1976, Katan and his associates in Israel developed a non-hazardous and non-chemical method of soil distribution called soil solarization. This is a method of solar heating of soil by covering it with transparent polyethylene during summer.

The principal interest in soil solarization as a method of weed management is increasing due to its effect on soil seed reserve, which is main source of weed problem. Direct killing of weed seed in the soil by lethal soil temperature built under transparent polyethylene mulch is the main mechanism of reducing weed seed population and weed emergence. Soil solarization process increases the soil temperature by 18 - 12°C over the corresponding non- mulched soil. Weeds respond differently to the soil solarization treatment. The winter and summer annuals are susceptible to soil solarization but perennial weeds show differential response for solarization. Solarization is found to be highly effective in controlling parasitic weed like Orabanche unto 70 - 100 percent. There is scope for utilizing soil solarization as weed management method without any adverse effect on succeeding corps. Unlike other methods of weed management, soil solarization brings about control of soil borne fungi, bacteria and nematode and release of mineral nutrients. However, there are limitations of its applicability; soil solarization is a safe and effective method of pest control that may reduce the necessity of chemical application to soil.

Solarization (time in weeks)	15 days after film removal		30 days after film removal		45 days after film removal	
	Weed DM accumulation (gm^{-2})	Weed density (No./m^2)	Weed DM accumulation (gm^{-2})	Weed density (No./m^2)	Weed DM accumulation (gm^{-2})	Weed density (No./m^2)
0	11.9	1650.0	137.85	2449.99	316.44	1057.08
3	4.79	951.85	85.96	1685.18	245.67	861.67
6	2.07	570.37	54.89	1149.99	195.30	553.75
9	0.89	227.77	29.44	525.92	127.00	314.17

Table 5: Total weed dry matter accumulation and weed density in Carrot at 15, 30 and 45 days after the films had been removed.

Biological control

Biological control agent is available in nature. There is however, a fear of biological control agents attacking the crop plants and also a plant considered a weed in one place may not be so in another area. Biological control using phytophagous insects can be a very useful option for perennial ecosystems, particularly with a physically continuous stand of a single weedy species (e.g. rangelands or a non-agricultural system). However, classical biological control has several limitations in cultivated crops. Some biotic agents are also vulnerable to sudden and/or drastic changes that occur with crop harvesting, crop rotation, tillage, and fallowing of land. Moreover, achieving an acceptable level of weed control during the critical period of weed interference may not be possible if the necessary level of insect population during this period is not achieved and maintained. For these reasons, biological control using insects has not been very practical in annual cropping systems.

Some promising examples in Indian context include; control of *Eupatorium odorata* by leaf eating caterpillar, lantana by *Teleonemia scrupulosa, Salvinia molesta* (aquatic weed) by *Pablinia achminata* (grass hopper); water hyacinth by *Neochetine cichhornae* and *N. bruchi*; Parthenium by *Zygogramma bicolorata*. In aquatic weed control.

Bio agents of weeds

Weed	Bioagent	Reporting country	Kind of bio agent
Chondrilla juncea	*Puccinia chondrillina*	Australia	Plant pathogen
Cirsium arvense	*Septoria cirsi*	USA	Plant pathogen
Cyperus rotundus	*Bactra verutuana*	India, Pakistan	Shoot boring moth
Echinochloa spp	*Emmalocera sp.* *Tripos spp*	USA	Stem boring moth Shrimp
Eupatorium riparium	*Entyloma compositarum*	USA	Plant pathogen
Hydrilla verticillata	*Hydrellia pakistanae*	USA	Shoot fly
Orobanche cerna	*Sclerotinia sp.*	USA	Plant pathogen
Parthenium	*Zygogramma bicolorata*	India	Leaf eating cater pillar

Bio-herbicides

Bio-herbicides are biological control agents applied in similar ways of chemical herbicides to control weeds. The active ingredient in bio-herbicide is a living organism and it is applied in moderate doses of proposals. Most commonly the microorganism used is fungus and its prologues are spores or fragments of mycelia; in this case bio-herbicide is also called a myco-herbicide. Commercial bio-herbicides first appeared in the market in the USA in early 1980s with the release of product.

Devine in 1981 and in the next year, the release of the product collego. Inspire of considerable public research efforts and many promising candidate organisms only one bio herbicide Bio Mal has been recognized in Canada. Since then none of the products are currently commercially available for variety of reasons. Many of the constrains arise because of the desire to produce perfect analogues of chemical herbicide. This may well be unrealistic.

Reduction in growth and competitiveness of weeds may be sufficient to reduce crop yield losses. Another approach to reduce the amount of chemical herbicides use is to combine them with plant pathogens. For example, Mc Elwee and his associates observed that the herbicides ioxinil reacts with one of the defence mechanisms of bracken fern (*Pteridium aquilinum*) as response to invasion by the fungus *Ascochyte pteriodis* by reducing lignin production. This effect as one of the host resistance mechanism possibly accounts for the increased infection of the weed observed following the herbicidal treatment. This opens a new type of interaction between herbicide and bio- pesticide that could be exploited advantageously.

Mycoherbicides

Product	Pathogen	Weed controlled
De-vine	*Phytophthora palmivora*	Strangle vine
Collego	*Colletotrichum gloeosporioides*	Joint vetch
Bipolaris	*Bipolaris sorghicola*	Johnson grass
Biolophos	*Streptomyces hygroscopicus*	Non-Specific , general vegetation

Integration of non-chemical weed management options

An integrated weed management (IWM) strategy involves selection, integration and implementation of weed management options based on economic, ecological and social principles. Weedy species are not entirely our enemies, and therefore not only targets for elimination, nut represent part of an agro ecosystem with some positive attributes. They may benefit the crop by either diverting insect pests away or by supporting predators of harmful pests. There may also be some beneficial effects on associated non-crop communities (e.g. soil organisms including mycorrhizas) and the physical environment of the ecosystem.

A sound weed management plan should have a strategy to prevent the introduction and dissemination of weeds, enhance the ability of crops to compete with weeds, and combine a variety of weed management options to prevent weeds from adapting to any one of the control practice [9-12].

	Treatments	20 DAT	30 DAT	50 DAT
T_1	Application of paddy straw @ 3t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	6.34 (38.20)	7.15 (50.67)	6.15 (35.86)
T_2	*Azolla* as dual crop with rice and incorporation on 35 DAT using power weeder	6.51 (40.33)	7.30 (52.72)	7.66 (56.72)
T_3	Hand weeding twice on 15 DAT and 35 DAT	4.24 (16.00)	6.62 (43.33)	5.94 (33.33)
T_4	Conoweeder 3 times on 20, 30, 40 DAT	7.91 (60.52)	5.93 (34.67)	6.11 (35.33)
T_5	Mulching with biodegradable polyethylene sheet	6.14 (35.67)	6.77 (45.33)	7.25 (50.50)
T_6	Intercropping mesta (*Hibiscus cannabinus*) with rice as paired row and harvested as greens	7.48 (54.00)	8.82 (77.33)	10.02 (98.50)
T_7	Intercropping daincha (*Sesbania aculeata*) with rice as paired row cropping and incorporation on 35 DAT	7.02 (47.33)	7.54 (56.33)	6.38 (38.67)
T_8	Application of rice bran @ 2t ha^{-1} on 3 DAT + Hand weeding on 35 DAT	4.16 (15.33)	5.67 (31.67)	4.36 (17.00)
T_9	Hand weeding on 15 DAT followed by *Azolla* inoculation	4.23 (15.86)	6.26 (38.67)	6.90 (45.56)
T_{10}	Unweeded check	8.21 (65.33)	9.35 (87.00)	10.46 (107.33)

Table 6: Effect of different non-chemical weed management practices on total weed density (No.m^{-2}) in organic rice production [9].

Figures in parenthesis are original values. Data subjected to square root transformation.

Conclusion

There is the problem of farmers' acceptability of non-chemical technologies because of perceived ineffectiveness. Farmers' inability to evaluate the negative impact of synthetic chemicals on the environment and human health. Non-chemical weed control relies primarily on tillage and hand weeding, practices which are labor intensive and expensive. Lack of available labour, and high wage rates prohibit use of these techniques for agricultural production. Weeds at organic farming systems should be managed to some acceptable level, considering their positive as well as their negative attributes, and should not be simply considered as targets for elimination.

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