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Weed Management in Organic Farming

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Abstract--- *Weeds are one of the key obstacles for sustaining the productivity of the crop. Weeds fight with crops for soil moisture, nutrients, space, and solar radiation; and decrease the quality and yield of produce. In addition, they also act as an alternative host for disease-causing microorganisms and insect-pests. Problems with weeds vary in various seasons, crops, management practices, and agro-ecological conditions. Various methods of weed control in field crops are used with varying degrees of success, including preventive, chemical biological, cultural, mechanical and biotechnological approaches. Chemical intervention in organic farming systems is not permitted because of the lack of research on non-chemical weed management options has made weeds serious trouble in organic farming. It is important to understand that weeds will never be eliminated under an organic scheme, but will only be managed. In organic systems, weed control focuses on management techniques that are designed to prevent weeds, as well as crop production that is large enough to out-compete weeds and reduce the availability of weed resources. In organic farming, the main target of weed management is to bring about substantial yield improvement of the crop and to decrease the degree of direct control inputs.*

Index Terms--- *Weeds, solar radiation, weed management, organic farming.*

I. INTRODUCTION

In increasing the productivity of crops, weeds are the main biological limit. One of the main limitations of world agricultural production is the adverse occurrence of unwanted crops, also known as weeds. Weeds are organisms that are highly successful and competitive[1]. Maximum kind of weeds show the rapid growth of seedlings and the ability to reproduce when they are young, especially when they endure stress. Weeds are plants that cause social and economic harm to farmers under certain conditions. In the agro-ecological sense, weeds are a product of human inter-specific selection since the start of cropping, influencing the soil and the whole environment[2]. The selection process is continuous and depends on the practices implemented by the farmer. The widespread use of chemical herbicides has resulted in significant changes in weed flora in plant fields, including those of dominant species as well as biotypes of other species that have become resistant to widely used chemical herbicides. Compared to most plant species, weeds grow rapidly and many species flourish under a wide range of conditions[2], [3]. They can withstand a wide range of adverse environmental conditions, such as drought and compaction of the soil.

Weeds can scavenge and compete for resources and respond to favourable growing conditions quickly. Weeds are found in all types of farms: livestock/pasture; crops (vegetables); and perennial crops (soft fruits, top fruits, etc.)[4]. Though, it is the cropping sectors (vegetables and seed crops) where weeds engage a big proportion of a farmer's

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management time: weeds seldom dominate even in poorly managed pastures, but in plant systems, if no efforts are made to control weeds, they can quickly take over. Weeds are a special class of pest that severely restricts the production of the major crops to any magnitude[5]. These compete with the crops for all the inputs which are given for the growth of crop and play a significant role in reducing the crop's productivity. The vegetables are more susceptible to the weeds and care must be taken at an appropriate time to manage these unwanted plants[6]. Now a few days, due to public knowledge of organic farming, the farmers are increasingly moving to organic farming, without using any chemical inputs, from their style of farming practices. The vegetables are major crops that are raised by organic methods. Since brinjal is a more profitable and popular vegetable that the public consumes and this plant is more resistant to organic cultivation[2], [5], [7]. In addition, herbicides alone contribute more than 50 percent of global sales of pesticides than other agrochemicals and have taken a lot of incomes of farmers. Therefore, the need to sustain a healthy and sustainable ecosystem, there is a need for non-chemical approaches for weed management in crops. Weed management should require the use of many techniques and methods in organic vegetable production systems, all with the aim of achieving economically appropriate crop yields and weed control[8]. Growers need to have access to nutrients, water and light to grow weeds. The cultural practices used in the production of vegetables also give the opportunity to crop to gain that advantage. Despite the severe threat weeds pose to organic crop production, the research on weed management in organic farming has so far received relatively little attention, an issue that is often addressed from a reductionist perspective[9]. The aim of this paper is to outline the reasons for organic farming to tackle weed management.

II. INTEGRATED WEED MANAGEMENT

Integrated weed management is characterized in a variety of ways, but at its core, it is the concept of using several different weed management tools to control weeds in an integrated way[10]. One way of conceptualizing integrated weed control is to combine the four weed management sciences/means: chemistry, physics, ecology and biology[10], [11].

- Chemical weed management is conquered by synthetic herbicides, but there are also "natural" (eobiotic) herbicides.
- Physical weed management strategies include mechanical techniques such as tillage and hoeing and thermal techniques such as fire weeding.
- Ecological weed management uses interactions between species to achieve weed control, e.g., allelopathy, crop weed competition, and crop rotations.
- Biological weed management uses plant biology understanding, for example, germination to manage weeds.

Therefore, integrated weed management is the process of using all four sciences to achieve the best weed management in a system-wide or integrated fashion. Therefore, it is also essential in organics, and increasingly in mainstream farming, to integrate weed management with all other farm activities to create "integrated farm

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management" such as other tillage systems, soil management, disease, and pest management, etc.[10].

However, the use of synthetic herbicides (and pesticides) has been banned by organics. While the number of natural (eobiotic) herbicides based on fatty acids extracted from plant oils is very low, they only contact herbicides and have no complete impact so that their effectiveness is restricted[12]. In addition, its use is also "restricted" under the requirements for organic certification, i.e. they can only be used in a small number of specific situations and cannot be used as the main form of weed management. Chemical weed control in organics, the opposite of mainstream agriculture, is therefore quite limited[9], [10]. Therefore, organic integrated weed management is dominated by physical, ecological and biological tools

III. PREVENTIVE METHODS

Cultural weed control

In this context, the use of any methods that specifically improve crop productivity against weeds, i.e. methods used during a crop growing process, is referred to as cultural weed management. In any case, cultural methods are effective if, to the advantage of the former, they are able to maximize the development difference between crop and weed[8]. In this regard, the use of crop transplants instead of seeds is an additional tool available to the farmer, which is particularly important in vegetable crops which are often poor opponents against weeds. Over the years, cultural influence has been one of the most commonly used weed control methods. Over the past 50 years, the advent of selective, effective and inexpensive herbicides has moved focus away from cultural control[9], [13], [14]. Cultural weed control options include growing crop productivity, crop rotation, delayed or early seeding, irrigation, green manure, and cover crop inclusion, and intercropping.

Crop Competition

To control weed growth, the most efficient way is to have highly competitive crops. It is less likely that a vigorously growing crop will be adversely affected by weed pressure. Crops that are well suited to their areas of planting are often good competitors because since they will tend to engage a site quickly[15]. Creating conditions where the intended crop can quickly gain dominance is imperative. Using high-quality, well-adjusted planting tools, vigorous seed, adapted varieties, good soil drainage, optimum soil fertility, and proper soil preparation and tilth will usually result in rapid, vigorous crop growth[16]. Competitive crops such as horse gram (Dliches uniforms), soybean (Glycine max), cowpea (Vigna Sinensis) and sweet potato (Ipomea batata) are shifting the competition from crop weeds to favour of crops[17], [18]. Such crops are growing rapidly and producing early canopy resulting in better weed shading.

Condition and fertility of the soil

It is important to rely on the soil's biological activity as the main source of fertility and favorable physical soil structure in an organic system. The key to growing healthy, high-yielding organic crops is an active and diverse soil microbial population[19]. Successful management of organic fertility should feed the soil ecosystem on a long-term basis, rather than just feeding the plants. An incredible source of plant

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nutrients and water holding capacity is organic soil matter[20]. Soil testing may be useful, but only if the results for an organic system is properly interpreted.

Careful attention to the balance of main nutrients can often reduce problems with weeds and increase crop growth. The inappropriately finished compost or improper application of manure is a mutual mistake made by many organic farmers. This can throw off the stability of certain nutrients in the soil and microbial life and can increase the growth of weeds[5], [18], [20]. Some changes in soil fertility, such as gypsum, may increase the tilt and looseness of the soil. This enhances the success of mechanical cultivation operations, but it also appears to reduce the pressure from certain species of weed favored by tight, hard soils[20].

Allelopathy

Using companion or rotational crops, mulching with the plant residues, applying plant extracts or including allopathic potential in crop cultivars by means of plant improvement techniques, allopath could be used to conquer weeds[21]. Some species of plants compete with each other by releasing chemicals from their roots that inhibit other plants ' development. This "allelopathy" is one of the most powerful plant control strategies of nature. Allelopathic crops comprise barley, annual ryegrass, rye, buckwheat, sorghum, oats, corn, red clover, alfalfa and sunflower[22]. In particularly weedy fields, selecting allelopathic crops can be beneficial with a reduction in the overall weed pressure.

As mentioned earlier numerous crops, some of which can be used as cover crops have been shown to release allopathic compounds in soil, many of which have been characterized chemically[21], [22]. In the case of the crop: weed interactions, it is difficult to obtain absolute evidence of allelopathy occurring in the field, primarily because it is difficult to separate allelopathic effects from resource rivalry and further biotic effects. In addition, the release and production of allelochemicals are largely dependent on environmental conditions, generally higher when plants are under pressure, such as extreme temperatures, soil nutrient shortage, drought and high incidence of pests;[23] the amount and concentration of chemicals that a species may produce may also differ accordingly.

Mulching

Mulching or covering the surface of the soil can reduce weed problems by preventing germination of weed seeds or by suppressing the growth of new seedlings. Mulches are usually ground cover, loose inorganic or organic matter particles spread over the soil, and sheets of natural or artificial materials laid on the surface of the soil[24]. Living mulch is a dense stand of low-growing species that were developed before or after the crop. Living mulches sometimes referred to as the cover crops, but they grow concurrently with the plant at least part of the time. Typically, cover crops are killed before the establishment of the crop[25]. Living mulches are well well-matched for use in perennial crops like fruit where self-reseeding is a benefit. However, rising mulch along the planted row can depress crop growth even in developed apple and apricot orchards.

Also, natural (inorganic and organic) and non-living artificial mulches are used for also agricultural and non-agricultural weed control. These mulches may be divided into different categories depending on their shape: particulate mulches (e.g. grass clippings, straw and hay, industrial crop waste, leaf moulds, coffee grounds, shredded and chipped wood or bark, dry fruit shells, sawdust, crushed rock and gravel) or sheet mulches (e.g. geotextiles, black, clear and colored polythene, paper, carpets, and needle punched fabrics)[25]–[27]. Such mulches control weeds by inhibiting the

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germination of light seeds, decreasing weed growth by partially or totally absorbing light-dark mulches, physically interfering with the growth of weed seedling and solar heating – clear plastic mulches. Non-living mulches can also protect the soil from the erosion of wind and water, help to sustain soil moisture, add organic matter to the soil, nutrient leaching, rise or reduce rainfall penetration and soil oxygen content[26].

Mechanical weed control

Mechanical weed control is India's oldest and most popular method. Not only is it safe for the environment, but it is also safe for the user as well. It is very effective in controlling weeds. The best practice could be mechanical weeding between the rows with finger weeded during early growth accompanied by hand weeding[12]. Mechanical control of weeds includes tillage as well as weeds cutting and pulling and is probably the oldest tool for weed management. Like numerous other non-chemical choices,[28] the acceptability and availability of herbicides have abstracted attention from mechanical weed management research, hampering the development of technology in this field.

The goal of early mechanical weed control is to establish as broad a crop-to-weed size discrepancy as possible as early as possible so that the most productive row cultivation can be achieved[28], [29]. Generally, weed stress will not expose the crop if crop plants are larger and more vigorous than the weeds. Effective early weed control is therefore absolutely essential until weeds pose a significant threat to the plant.

Tillage

Mechanical weed management is conducted to monitor weeds through pre-plant and post-plant tillage. Tillage of the pre-plant usually takes place in two phases, namely primary tillage and secondary tillage[11]. Post-plant tillage is done in row crops to suppress weeds and is more popularly referred to as row cultivation. Tillage is for not only controls weeds, but it also breaks the soil top preparing the seedbed, facilitating uniform and rapid germination and penetration of root, rises soil aeration and rainfall penetration, and for specific crops (furrows, raised beds, etc.). provides the required soil-surface topography[30].

Weed control in crop lines, crop residue management issues, and climate dependence are major challenges to tillage weed control. [31]nowadays, more focus has been given to the negative effects of traditional tillage in the form of soil structure degradation and soil erosion and more hope has been given to the reduced tillage or no-tillage.

Reduction in tillage, however, would cause 40-80 percent of weed seeds to accumulate in the top 0-5 cm soil surface, resulting in more weeds than traditional tillage[32]. However, perennial weeds are well known and becoming troublesome. As a result, farmers are forced to go to weed control for herbicide use. However, by incorporating other non-chemical means like crop rotation or cover cropping this exacerbated condition can be effectively managed[30], [32]. In addition to primary tillage, secondary tillage such as harrowing, row cultivation, etc. also affects the seed bank of weed and the composition of species. Many weeds need a flash of red-light micro-seconds to germinate. Night tillage can help to significantly reduce the germination of weeds. Covering the tillage tools to prevent light from reaching the soil was reported to reduce the development of weeds by 70%[30].

Cultivation

For organic vegetable activities, cultivation is probably the most extensively used method of weed control. Burial works best on minor weeds, while bigger weeds are well controlled by the devastation of the root-shoot connection and

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by cutting, slicing or turned the soil to remove the interaction of root system with the soil[33]. Cultivation is active against nearly all weeds, except for some parasitic forms like dodder. Effective cultivation should target areas of weed growth specifically and accurately, thus requiring good soil preparation and bed shaping. Cultivation requires comparatively dry soil; subsequent irrigation should be long deferred to avoid re-rooting of the weeds[34]. The cultivation goal is to cut weeds as close as possible to the seed line without damaging the crop. In most cases, on more than 80% of the surface, precision cultivation may take care of the weeds. The residual weeds have to be removed by hand or by other mechanical means from the seed line. Removing weeds by hands while they are small is easier.

The correct timing of cultivation depends on the speed of the weed growth: in spring a period of 2-3 weeks is about right; in winter it may be appropriate to have longer periods between cultivations[28], [32], [34]. The grower's training and experience are important factors for successful cultivation. Weeds that compete with the cropped primary in the crop cycle may be more harmful to crop yields than weeds which are later found. Weeding in the late season can damage the root system of the plant or assassinate fruits or flowers, which can reduce yields[8]. Clearly, crops in the late season must be balanced against the potential for yield loss to minimize weed seed production.

Thermal weed control

Many methods have been created to manage the weeds using heat. These include hot water, flame, steam, infrared, microwave, ultraviolet radiation, freezing, and electrocution[35]. Heating results in protein coagulation and protoplasm bursting due to expansion, killing the tissue. Use dry ice and liquid nitrogen, weeds can also be destroyed by exposure to low temperatures, e.g. by exposing underwater weeds to low air temperatures by removing the water from a lake or pond or by freezing weeds on terrestrial[35], [36]. In comparison to chemical methods, there are several benefits of using heat to suppress weeds. The risks of chemical waste run-off, chemical spray drift and rinses are eliminated.

Weeds cannot develop resistance with chemicals as much as they can. Beneficial soil microorganisms are not damaged because of the minimal penetration of the soil. An all-weather, water can be used as there is nothing to blow away or wash off.[5], [9] Lastly, in non-chemical applications, the public perceives less risk, especially in high-profile areas for instance parks, sports fields, and playgrounds. There are several benefits of thermal weed control solutions[37]. They generally don't disturb buried seeds, leave dead biomass on the surface of the soil, which provides protection against erosion and loss of moisture, and may kill some pathogens and pests, and most importantly do not contaminate the environment with the synthetic herbicides[35]. The recently developed aquaculture vegetation control system uses hot water. The new technology uses a process in which water under low pressure is superheated on demand and then pumped to an application delivery system through a heat-resistant hose. Once applied to the ground surface, this superheated water can remove unwanted vegetation[24], [35]. The water's extreme heat quickly breaks down the plant's molecular structure killing it on contact.

Biological Weed Control

The biological control agent is existing in nature. However, there is a risk that biological control agents may invade crop plants and may not be so in another field as a plant considered a weed in one location. Biological control with phytophagous insects can be a convenient option for perennial habitats, mainly with a physically constant stand of a single weedy species, for example, non-agricultural system and rangelands[38].

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However, in cultivated plants, classical biological control has several limitations. Some biotic agents are also vulnerable to sudden and/or drastic changes resulting from crop rotation, crop harvesting, tillage, and land fallowing[4], [7]. Furthermore, it may not be possible to achieve an acceptable level of weed control during the grave period of weed interference if the required level of insect population is not achieved and maintained during this period.

Bio-herbicide: Bio-herbicides is the biological control agents that are used to suppress weeds in similar ways to synthetic herbicides. The active element in bio-herbicide is a living organism and is applied in modest amounts of proposals[39]. The most widely used microorganism is fungus and its prefaces are spores or mycelia fragments; in this case, it is also considered a mycoherbicide. Reducing weed growth and productivity may be enough to minimize losses in crop yields. Another method to decrease the amount of chemical herbicides usage is to associate them with the plant pathogens[40].

IV. CONCLUSION

Weeds should be managed at an acceptable level in organic farming systems, taking into account both their positive and negative aspects and should not simply be viewed as goals for elimination. With the tremendous advances in the control of organic/nonchemical weeds, made by organic farmers, scientists and growers and the ever-growing array of machinery, organic/nonchemical and high-tech and low-tech weed management can be exceptional, even exceeding herbicides. As integrated organic weed management is not simple or straightforward, it returns the knowledge and skills of weed management from the biochemist to growers and farmers, putting weed management back in the hands of its original practitioners. The upcoming future is clear: herbicides are failing, therefore organic/nonchemical integrated weed management is the only viable, sustainable solution. In organic farming, an ideal approach to weed management should include modifying the cropping system to reduce the emergence of weeds.

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