

ORGANIC WEED MANAGEMENT IN VEGETABLE CROPS

Abstract

Most of the vegetables are annuals in nature. Short duration of the vegetables is vulnerable for weed's competition for sunlight, water and nutrients. In vegetables, 70 to 80 percent of yield loss was recorded due to weeds. This hinderance for vegetable growth makes the weed management an essential thing in vegetable cultivation. Dependence on herbicides for weed control has become easy and immediate solution for weed control in vegetable crop cultivation. But continuous use of herbicides not only pose environmental issues but also pose health related issues. Conventional weed management practices aim at total eradication of weeds but the organic method focuses on management of weeds rather than eradication. Some of the weeds may improves the performance of main crop by acting as a trap crop for pests, that will be best utilized in organic method. The systematic organic approach to reduce the weed competition can be seen in this chapter.

Key words: Weed management, environmental issue, systematic organic approach

Author

Dr. V. Divyabharathi
Institute of Agriculture
TNAU, Kumulur
Trichy, Tamil Nadu, India.

Dr. A. Vijayprabhakar
Institute of Agriculture
TNAU, Kumulur
Trichy, Tamil Nadu, India.

Dr. S. D. Sivakumar
Institute of Agriculture
TNAU, Kumulur
Trichy, Tamil Nadu, India.

I. INTRODUCTION

Majority of the vegetables are slow developing during the initial developmental stage. This propensity makes them weak against weed competition, which contrarily affects the yield and quality parameters. In vegetables, weeds caused 70 to 80 percent yield decrease (Rana *et al.*, 2011). Manual method is commonly adopted to control weeds in vegetables cultivation. Lack of accessibility of labours at right time, hike in wages and abnormal climate conditions limits the efficiency of manual weeding and influences the yield of the crop (Chacko *et al.*, 2021). Chemical weed control is an easy and ready source to deal with the present circumstance. Reliance on herbicides alone for weed management is not advisable as it influences the environment and induces resistance in weed species. Rather, organic means of weed management serves as a cost-effective and reliable method that can be adopted for sound weed management practices in vegetable crops.

II. WEED COMPETITION - CROP GROWTH

Sustainable production of food materials has become a challenging task in today's agriculture with increased demand for food and limited resource availability. Weeds are the major biotic constrain that limits the production in agriculture. Without proper management yield loss and input loss by weeds cannot be controlled. Apart from competition with inputs supplied, most of the weeds serves as a shelter for various pest and diseases. It is very difficult to assess the yield loss due to single weed and hence it is estimated as cumulative loss by the effect of all weeds. Compared to pest and diseases, the loss created by the weeds are proved to be more.

Easy establishment and faster growth of weeds gain advantage over the vegetable crops. Phytochemicals released by some weed species adversely affects the germination, root and shoot development in vegetable crops. The seed germination in tomato was inhibited by *Cyperus rotundus*, *C. dactylon* etc. The root exudated of *Cyperus* sp. inhibited the cowpea growth and development. The range of yield loss in crops depends largely the nature of weed growth, intensity and critical period of weed competition along with the climatic conditions. Impact of crop- weed competition on yield of certain vegetables are listed in Table 1.

On an average, weeds deprive 47 percentage of Nitrogen, 42 percentage of Phosphorous, 50 percentage of Potassium, 39 percentage of Calcium and 24 percentage of Magnesium. The weed competition is perpetually severe in the early stages of a crop than at later stages. Generally, if a crop is of 100 days duration the initial 35 days after sowing should be maintained in a weed-free condition. Weed-free condition may not be maintained throughout the crop period, as it will entail unnecessary expenditure without a balanced increase in yield.

III. CROP-WEED COMPETITION: CRITICAL PERIOD

The critical period for crop weed competition may be defined as the specific interval of crop life cycle during which weeds competition for nutrients and other resources should be managed to avoid reduction of yield. Knowledge about critical time for weed control helps to make right choice of weed control method to avoid over usage of herbicides. Unlike fruit crops vegetables are particularly having sensitivity towards the weed competition. If vegetable crops are failed to keep weed free in initial stages of growth yield will be lost

heavily. Critical period for weed competition varies between vegetable to vegetable (Table 2.).

IV. WEED MANAGEMENT

The combination of prevention, eradication and control of weeds to manage weed population in cropping environment is weed management. Weeds can be controlled broadly by two methods *viz.*, preventive and curative methods.

Preventive Method

Prevention of new weed introduction and spread in an entirely new environment is preventive method of weed control. Knowledge about weed dissemination method is highly essential for this method of weed control. The following methodologies can be adopted to prevent spread of weeds.

- 1. Weed-Free Clean Seeds:** Crop seeds contaminated with weed seeds serves as a prominent source for weed spread. Identifying the mixed weed seed in a crop seed is highly difficult. For instance, mixture of amaranthus seeds with wild amaranth and cruciferous vegetable seeds with *Argemone Mexicana* are difficult to identify and separate. Hence, certified seed sources should be used for cultivation purposes.
- 2. Clean Implements:** Operating implements at various fields may harbour weed seeds also bulbs, rhizomes, tubers in hidden sides. Care must be taken before entailing cultivator, seed drill, harrows etc. in cultivation fields. After every usage implement must be cleaned to ensure weed seed contamination. This measure will prevent weed spread to certain extent.
- 3. Canal and Irrigation Channel Maintenance:** Canals and irrigation channels are the prominent factor in every field. Most of the crop cultivation depends on canal irrigation and flood irrigation. Weeds along the path of canal and channels may also spread weeds seeds through running water.
- 4. Well Decomposed Manure Usage:** Weed seeds have better viability compared to crop seeds. Seeds of *Convolvulus arvensis* will remain viable upto 5 years. Seeds of *Cynodon* and *Cyperus* will remain viable for 2-5 years. In most of the manure cow dung is the major part. Cow dungs will be heaped for decomposition but not for longer period. The temperature rise during decomposition is not sufficient to destroy weed seeds. Well rotten manures are highly suitable for weed free cultivation practices.

V. MANAGEMENT OF CULTIVATION PRACTICES:

- 1. Crop Rotation:** Mixed cropping and crop rotation for longer period to increase soil fertility is often followed in organic cultivation practices. Crop rotation is one of the important steps in organic weed management. Certain weed species will retain in a particular field on monocropping. When different crops are used in rotation, weed germination and growth will be disturbed. Weeds tend to grow and survive with the crops that requires similar conditions for their growth and development. Monoculture of a vegetable for a longer period of time enhances weed mass and creates a conducive

condition for their survival. Diversifying the crops will disturb the establishment of weed species.

2. **Cover Crops:** Rapid growing and dense mat forming ground covering crops are cover crops. This imposes restriction over weed emergence and growth. Cover crops are not generally grown for yield but only to provide agroecological services at field and farm level (Thorup-Kristensen *et al.*, 2012). Some cover crops are capable of reducing the weed density during their life cycle and even after their diminution by exuding allelopathic compounds. Cruciferous crops contain glucosinolate compounds that can manage weeds in subsequent crops. Residues of rape seed crop (*Brassica napus* L.) when incorporated into the field before planting potatoes the weed density reduced by 73–85% and the weed biomass diminished by 50–96% also reduced the weed density along with biomass in green pea production (Robacer *et al.*, 2016). In addition to weed suppression it also improves soil structure, enhances soil fertility, prevents soil erosion and act as an alternate host for pests thereby reduces pest damage to main crop.
3. **Intercropping:** Like cover crops planting intercrops also occupies the space between vegetables so that weed population can be managed
4. **Soil Solarization:** During summer solar radiation is trapped using 25 -50 mm polyethene sheet (LDPE) covered over moist soil. The soil temperature would be increased over 8-10⁰ C when compared to non-covered soils and the weed seeds along with soil borne pest would be eradicated. Water retention capacity of heavy soil serves best compared to light soil. Solarization upto 4-6 weeks gives a satisfactory control over weeds but for perennial weeds like *Cyperus* sp. this method won't work efficiently. Fumigation, a similar kind of process using chemicals also serves the similar purpose. But the residual effect of those chemicals in crops are lethal.
5. **Mulching:** Mulches are excellent source that provide triplet benefit to the crops. Mulching reduces the evaporation of soil moisture, prevents infiltration of excess water and smothers obnoxious weeds. Mulching can be distinguished major into three types *viz.*,
 - Organic mulches
 - Inorganic mulches
 - Combined mulch (Both)
 - **Organic Mulching:** Organic mulches are plant derived products used to reduce weeds also conserves moisture content. It includes straw materials of crops, plant debris, husk, fronds of coconut, arecanut, dry leaves, dry weeds before flowering, wood chips *etc.* Plants that trail over the ground can be planted densely to cover the soil can also be used as live mulches. It can be planted either before or after crop establishment. These kinds of mulches should be carefully chosen to avoid competition with crop of economic importance. Besides weed management ground covers will enhance soil structure, increases fertility and reduces pest.
 - **Inorganic Mulches:** Apart from farm waste and other derived products plastic materials can be used for mulching. In plastic ecofriendly biodegradable mulches are highly suitable for organic vegetables production. These mulches are photosensitive

and will be degraded when exposed to sunlight for 30 to 60 consecutive days. Those photodegraded pieces will be easily decomposed by microbes. Reusable black polyethene mulches can be used but after its validity disposal becomes major menace. For small scale production reusable cloth mulches can be used.

- **Stale Seed Bed:** Cleansing the field out of weeds prior to crop cultivation will reduce the weed population also the frequency of occurring. Seed beds are created and irrigated copiously to induce weed germination. The germinated seeds are eliminated manually or mechanically or with flame. Most weed seeds are present on the top soil of 5 cm and SSB method targets those top soil weed seeds. This method provides enough space for crop to cross vegetative stage without much intervention by weeds. Once the crop covers the space, shade will depress the weed seed germination and growth. In vegetables like cucumber SSB preparation 10 – 30 days before seed sowing increased the yield (Singh *et al.*, 2009). Combination of SSB and polyethene mulch reported effective management of purple nut sedge in bhendi according to Ameena *et al.* (2013).
- **Irrigation Management:** Time and method of water application decides crop growth as well as weed growth. Flood irrigation favors weed rather than crop. Water applied in drops directly in the root zone enhances the effectiveness of water utilization by crop. Drip irrigation is beneficial for effective weed management. In rainfed crop cultivation mixed cropping, intercrop and mulching aids in weed management.
- **Manure AND Compost:** Method of application and type fertilizer used decides the weed population in cultivation land. Usage of improperly decomposed organic manure facilitates spread of weed seeds in cultivable area. Broadcasting of manures or fertilizers supplements nutrient to crop also weeds. Use of leguminous crops instead of nitrogenous chemical fertilizer reduces weed and residue deposition. Split application of manure also favours weed management.

VI. MECHANICAL WEED MANAGEMENT

Weeds are removed physically by mechanical methods (Tools/implements). It is one of the oldest but effective method of weed management. Mechanical weed control is a laborious and time-consuming process.

1. **Tillage:** tilling of cultivable land uproots the weeds and enhances the porosity of soil. Deep ploughing buries the weeds deeper in the soil. Pulverized soil provides ideal soil texture for crop cultivation. But frequent tillage affects soil structure and least favorable for crop cultivation. Tilling is not suitable for orchards.
2. **Blind Tillage:** it is followed either before crop cultivation or when the crop is in early stage. Different types harrows (spike tooth harrow, spring – time harrows, rotary hoe cultivator, wheel hoe, Blade- harrow, horse hoe) are used in this method to enhance yield of the crop.
3. **Ploughing:** it is followed for burying all types of weeds before cultivation. Deep summer ploughing exposes weed seeds to direct sunlight also harmful microbes facilitates natural sterilization of soil.

4. **Harrowing:** useful in removal of small weeds. When the soil is free from obstacles it serves better for destruction of root system. Disturbing the roots of shallow roots enhances desiccation thus weed dies before it generates new roots.

VII. FLAME WEEDING

This method is a thermal based one that kills weeds by heat. The heat disrupts the cell membrane leading to death or delayed growth. In case of fallow lands burning of weeds is also followed. Flaming is done before crop emergence and early part of crop growth. Advanced form of flame weeding is infrared weeders. In which burners heat metal or ceramic surface to generate infrared rays that targets the weeds specifically.

VIII. BIOLOGICAL METHOD

Biological method of weed management is a slow but effective method that controls weeds in steady manner.

Allelopathy

Allelopathy refers to a plant's direct or indirect chemical impact on the germination, growth or development of nearby plants. It is commonly regarded as a biological control method. Both crop and weed species are capable of this. Crops like barley, rye, oats, sorghum and sudan are allelopathic. In vegetables very few shows allelopathic effect on other crops includes carrot, radish and horseradish. The allelopathic property of crops can be directly used for vegetable crops to control obnoxious weeds. Using crops having this property as intercrop saves space also reduces weeds. Instead of direct involvement of crops allelochemicals can be used to control weeds.

Table 1: Weed impacted yield loss in different vegetable crops

Crop	Yield loss	Reference
Bhendi	40 -80 %	Patel <i>et al.</i> , (2017)
Bottle gourd	40%	Dash and Mishra (2014)
Brinjal	30 -35 %	Syriac and Geetha (2007)
Cabbage	45 – 80 %	Akshatha <i>et al.</i> (2018)
Carrot	90 %	Singh <i>et al.</i> (2017)
Chilli	60 -70 %	Khan <i>et al.</i> (2012)
Garlic	94.8 %	Sanjay <i>et al.</i> (2019)
Onion	40 -80 %	Channapagoudar and Biradar (2007)
Potato	52%	Singh <i>et al.</i> (2005)
Radish	86 %	Singh <i>et al.</i> (2009)
Tomato	92-95%	Bakht and Khan (2014)

Table 2: Crop rotation pattern

S. No.	Crop Rotation
1.	Pepper – onion – winter cereal
2.	Melon – beans – spinach – tomato
3.	Tomato – cereals – fallow
4.	Lettuce – tomato – cauliflower

5.	Potato – beans – Cole crops – tomato – carrots
6.	Melon – artichoke – beans – red beet – wheat – Cole crops
7.	Tomato – okra – green bean
8.	Sweet potato – maize – mung bean
S. No.	Mixed cropping
1.	Lettuce + carrot
2.	Cole crops + leeks /onion/ celery/ tomato
3.	Maize + beans/ soybean
4.	Maize + beans + squash
5.	Tomato + pigeon pea
6.	Sugar cane + onion/tomato

Table 3: Critical period of crop weed competition in vegetables

Crops	Critical period of crop-weed competition
Bhendi	2-4 weeks after emergence
Brinjal	20-60 days after sowing
Cabbage	2-4 weeks after emergence
Carrot	3-6 weeks after emergence
Cauliflower	0-30 days after sowing
Chilli	30 – 45 days after transplanting
Cucumber	4 weeks after sowing
Lettuce	3 weeks after planting
Onion	The whole season
Peas	30 -60 days after planting
Potato	15-45 days after planting
Radish	25-30 days after sowing
Squash	Early planting competes better
Tomato	6 weeks after planting
Turnip	15-20 days after sowing

Table 5: Intercropping sequence

Main crop	Intercrop
Bhendi	Beetroot, Peas and Knol khol
Capsicum	Beetroot, Peas and Knol khol
Cabbage	Radish, Methi, Turnip and Palak
Cauliflower	Palak and Radish
Cauliflower	Tomato
Tomato	French beans and onion

Table 6: List of allelochemicals and targeted weeds

S. No.	Allelochemical	Target plants	Reference
1.	Juglone (Black Walnut)	Horseweed, hairy fleabane, purslane and morning glory.	Khamare <i>et al.</i> (2022)
2.	1,8 - cineol (Eucalyptus)	Common amaranth and little hogweed	
3.	Ailanthone (Tree of heaven)	Common amaranth, garden cress, foxtail, barnyard grass, and corn.	
4.	M-tyrosine (Fescue grass)	Rape plant, crab grass, white clover and dandeline	
5.	Sorgaleone (Sorghum)	Common amaranthus, Indian jointvetch	
6.	Parthenin (Parthenium)	Amaranthus, senna	
7.	Lantadene A & B (Lantana)	Water hyacinth, wild oat, beetroot	
8.	Sarmentine (Long Pepper)	Wild mustard, horse weed	
9.	Nimbolide B (Neem)	Lettuce, alfalfa	

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