*General Article*_____ *Chapter – 5*

INTEGRATED WEED MANAGEMENT IN TOMATO

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Abstract

Weeds account for 45 percent of the yearly loss of agricultural produce, even higher than crop losses caused by pests (30 %) andpathogens (20 %). In tomatoes, weed competition leads to a 32.5% yield loss (Oerke*et al*., 1994). If not controlled, weeds may cause yield loss of up to 80%. Hence, it is necessary to control the weed species in the field to avoid crop competition and yield loss. In tomatoes, after six to eight weeks of transplanting, weed competition would be found to be high, competing with tomato for space, light, nutrients, and water. These weed species sometimes act as hosts for pests and diseases, which may lead to tomato yield loss. In this regard, Integrated weed management (IWM) systems must be adopted to prevent crop loss due to weeds. IWM is the combined use of weed control measures like preventive methods, cultural methods, mechanical methods, and chemical methods to control weeds.

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Introduction

The term "Integrated Weed Management (IWM)" refers to using several weed control methods to control weeds. This is an excellent approach since any weeds that arenot managed in one way can be controlled by another. Adopting integrated weed management helps reduce problems like shifting weed species and developingherbicide resistance in weeds. An Integrated Weed Management system is effective for the long-term maintenance of natural resources, elevating agricultural productivity with less adverse environmental impact and providing sufficient income to the farmers.

Losses In Tomato Yield

In tomatoes, economic yield loss was found to be nearly 80% if not controlled. The problem of weeds in this crop is more diversified and intensified than the field crops because it has earlysluggish growth, higher nutrition, and water requirement, abundant use of farmyard manure, repeated tillage, broader spacing, and restricted crop canopy during the critical period of crop, and weed competition.The critical crop weed competition in tomatoes occurs between 30 and 45 days after transplanting. As a fast-growing vegetable, it can effectively suppress weeds by shading. It is closely planted, so the weeds and stubbles should be removed during land preparation. Weaver *et al*. (1987) has reported that an increase in the nightshade population in tomato field reduced the transpiration rate and stomatal conductance and reduced the tomato crop yield

Weed Flora in Tomato

Most of the weeds are season-specific since a particular weed seed requires a specific temperature for its germination; thus, weed communities like barnyard grass/ cockspur grass (*Echinochloa crus-galli),* wild spinach *(Chenopodium album),*knotgrass/ pigweed*(Polygonumaviculare), Amaranthus sp.,* little hogweed/parsley *(Portulacaoleracea),* and *Solanumnigrum* are dominant weed species in transplanted tomatoes. Early emergence grass weeds include *Avena sp., Aloepecurusmyosuroides*,*Lolium sp*., are common in direct-seeded tomato crop. Parasitic weed *Cuscuta sp.,* can also be a problem.

Table 1. The commonly growing weed flora in tomato are furnished below:

S.NO.	SCIENTIFIC NAME	ENGLISH NAME	HABITAT
1	*Chenopodium album*	Lamb squatters	Rabi annual
2	*Cyperusrotundus*	Purple nutsedge	Kharif annual
3	*Lathyrusaphaca*	Meadow pea	Rabi annual
4	*Echinochloacolonum*	Banyard grass	Kharif annual
5	*Solanum nigrum* (under greenhouse conditions)	Black nightshade	Perennial, Rabi, Non cropped

*Cyperusrotundus*is a perennial weed that can regenerate even if the aerial parts are removed before the seed set. Its vegetative part may penetrate 5-7 feet deep in the soil seeds of *Lathyrus sp.*and remain viable for longer periods varying from 1-15 years.

Losses Caused by Weeds

Weeds drastically hamper tomato growth and productionas they are potentially competing for space, solar energy, nutrients, and water. Weeds increase the cost of production. In order to remove the weeds, tillage operation is done, which costs 30% of the total expenditure for crop production. In case of severe infestation, more laborers will be required for hand weeding. Weeds can cause tomatoes to be spindly, poorly developed, shaped, undersized, and have low-quality fruits. The virus diseases-spotted wilt is carried by insect vectors that live on weeds in fields and along field borders. Weeds also reduce the flow of canals by 50% or more when submerged. It induces seepage and waterlogging around the ditches. The root of *Cyprus rotundus* secretes phytotoxic substances (allelochemicals) which reduces the seed germination and causes grade losses in terms of yield.

Dissemination of Weed Seeds

Irrigation water acts as an agent in weed seed dissemination for weeds like *Echinochloa crus-galli, Amaranthus sp., Chenopodium album*. Nuts of *Cyperusrotundus* are transported long distances through farm machinery.

Principles of Weed Control

Weeds have a range of techniques that enable them to thrive. To successfully control weeds, one must acquire knowledge about the following principles: the Life cycle of the weeds, the mode of reproduction of weeds, soil texture and moisture, farm practices, habitat and location, and weed management measures.

Methods of Weed Control

The nature of weed competition is determined by the magnitude of the infestation, length of the infestation's period, crop plants' competing ability, type of weed species, and climatic conditions. Integrated weed management with supplementary hoeing at the right stage may help to reduce the load of herbicides. Various methods are used to control weeds. They are discussed below.

Preventive Weed Management

It refers to the restriction of entry and establishment of weeds in the field. It also includes farm hygiene. Frequent shallow cultivation is recommended to control weeds.

- Use clean or weed-free seed
- Examine the roots to ensure that nutsedge is absent during transplanting
- Prevent the entry of reproductive organs of weed into crop site
- Do not permit the livestock to move from infected to clean areas.
- Do not use undecomposed dung or FYM
- Clean the equipment after each use
- Keep the banks of irrigation or drainage channels weed-free

- Identify the weeds in the growth stage of seedling
- Higher population per unit area, proper crop rotation, and proper placement of fertilizers prevent the successful establishment of weeds

Mechanical or Physical Methods

Mechanical or physical method of weed control is the use of specific tools and implements o remove the weeds from the cropped area. Hand weeding is usually done with weeding tools like hand-hoe in arable crops and by spades in plantation crops. This method also includes destroying weeds and weed seeds by flooding and burning. This is used to do away with the extensive unwanted green vegetation, dispose ofdry tops of matured weeds and eradicate green weed growth. *Burning* is the cheapest method of eliminating mature unwanted vegetation from non-cropped areas. *Flaming* is also practiced to reduce the weed numbers by 60-85% by exposing the weeds to a very high temperature of 1000^0C by the flames emanating from burning liquid petroleum gas. *Flooding* causes suffocation by reducing the oxygen availability for plant growth and preventing photosynthesis. Flooding is mainly used to control perennial weeds. Besides imparting chemical weedicides, manual weeding at least once is carried out at30 days after transplanting.

Agronomic or Cultural Methods

The cultural method aids in reducing the weed population butdoes not provide complete weed control in tomato fields.The common cultural methods amenable toweed management in tomatoesare discussed below.

Soil solarization and soil fumigation

It is considered a non-hazardous and non-chemical method of weed control. Soil temperature can be easily increased to the lethal point by covering it with a transparent polyethylene sheet. Soil solarisation for 45 days in May with transparent polythene film (0.1- 0.2 mm) is more effective.Soilsolarization builds the soil temperature slightly above 40° C and thus has an excellent effect on weed seeds. It was effective in controlling broad-leaved weeds. Treating the soil with fumigants like Methyl bromide would kill certain weed seeds.

Off-Season Tillage or Summer Fallowing

Summer fallowing is a very effective method to reduce weed infestation. In India, the farmers have used the hot months of April, May, and June to expose the underground parts of perennial and obnoxious weeds to the scorching summer sun to kill them. Deep plowing should open the fields immediately after harvesting intercrops and left in cloddy condition. During this process, care should be taken to avoid any water leaks from the irrigation channels. Summer fallowing cannot be followed in light soil due to fear of erosion.

Mulching

In a standing crop, the purpose of mulching next to moisture conservation is the suppression of annual weeds. Effective weed control depends on the right choice and prudent use of mulching material. Mulching with a black polyethylene sheet suppresses

seed germination and further reduces the growth of weeds by excluding sunlight. Water hyacinth mulch results in increased tomato yield by 91%. Nutrient paper mulching inhibits the growth of broad-leaved weeds in tomato. According to Teiteh*et al*. (2010), mulching using dried grasses has proven to be the best weed control method and enhances tomato growth and yield. This study also suggests combining mulching and weeding followed by herbicide application of either pendimethalin 2L or 3L/ha or post-emergence application of glyphosate (2 L/ha) were found to be very effective in controlling weeds and enhanced plant growth and development.

Mulching

Soil solarization

Crop Selection

The crop selection influences the crop-weed competition i.e., the crops having tall stature with rapid growth rates are more competitive. Transplanted tomato is intermediate in stature, and direct-seeded tomato is considered non-competitive.Intomato, cover cropping with rye, hairy vetch, and crimson clover is beneficial insuppressing weeds, increasing the soil organic matter,reducingsoil erosion, andimproving soil structure. It also restricts the infestation of certain pests and the incidence of some disease occurrence.

Planting geometry and sowing time

Manipulation of crop canopy helps in maintaining crop-weed balance. Weed growth is always suppressed with narrow spacing due to the availability of low light to the weeds at ground level because of the dense crop canopy. A change in plant population and plant arrangement suppresses the weeds.The seeds of particular weed species germinate at their peak emergence period. Delay in planting or sowing time in combination can be useful in managing weeds.

Crop rotation

It can manage the weeds which dominate in a particular cropping system. Adjusting befitted trap and catch crops in crop rotation can reduce the intensity of parasitic weeds. Avoid the succeeding crops of *Apiaceae* (celery and carrots) and tomato. The crop rotations are as follows:

Temperate region	Tomato – cereal-fallow Melon – beans – spinach-tomato Potato – beans-Cole crops – tomato-carrot
Tropical region	Tomato- okra- green bean

Intercropping

Intercropping controls the weed population by providing more shade to the crop than the monocropping system. The effect of special intercrop arrangement on weed suppression is potentially more complex. In temperate regions, tomato is intercropped with cole crops, and in tropical regions tomato is intercropped with pigeon pea.

Irrigation Schedule

Under furrow irrigation systems, indry furrows generally, low weed intensity is noticed than in irrigated furrows. Weed intensity is usually lower in drip irrigation than in furrow irrigation systems. Pre-sowing irrigation encourages the weed seeds to germinate, which are later destroyed by repeated ploughings.

Stale Seedbed Technique

A stale seedbed is prepared 2-3 weeks before attaining maximum weed-seed germination near the soil surface. Emerged weeds are destroyed either with shallow tillage or by sprayinga herbicide that leaves any residues. In light-textured soils, the herbicide treatment is risky for tomato. Metham sodium is highly effective against *Solanumnigrum*.Precaution should be made to leach out any fumigant residues in the soil. Generally, planting tomato plants is advocatedonly after 20 days of fumigation.

Nutrient Management

Weed growth is also increased by vigorous fertilizer application. Hence, fertilizer placement and timing must be altered to increase the viability of nutrients to the crop and not the weeds.The fertilizer should be applied in bands in crop rows and not by broadcasting. The time of fertilizer application may also be altered to tilt the crop-weed competition in favor of crop plants.

Chemical Control Methods

The best approach to minimize weeds is to use chemical weedicides along with other integrated weed control measures.Most herbicides are effective in perennial weed control.The efficacy of herbicides can be enhanced by combining two herbicides having different weed-control spectra and by adding a non-ionic surfactant or adjuvant.Kumar *et al.* (2015) reported that integrated usage of hand weeding onthe 30^{th} and 60^{th} day after transplanting, followed by applyingPendimethalin 1 kg a.i/ha, was effective in weed control with good crop yield.Pendimethalin@ 3.3 l/ha, Fluchloralin @ 2 lit/ha, or Metalachlor 2 l/ha are the commonly employed pre-emergence herbicidesin tomato. Besides, hand weeding at 30 days after transplanting is advocated.

HERBICIDE	DOSE (kg a.i./ha)	TREATMENT PERIOD
Ethalfluralin	0.8-1.7	Pre-planting
Metribuzin	0.10-0.35	Pre/Post emergence
Oxifluorfen	0.24-0.48	Pre-planting
Pendimethalin	1.32-1.65	Pre-plant application
Rimsulfuron	7.5-15(g / ha)	Post-emergence
Trifluralin	0.59-1.44	Pre-plant application

Conclusion

Weeds are the major problem in crop production, and single-individual management methods do not provide sufficient long-term weed management; instead, it leads to the development of resistance. Hence, to attain better crop yield without yield loss, integrated weed management (IWM) is the potential weed management system to control weed populations to a manageable level; it will also reduce the environmental impact of using the herbicide alone to control weeds and it increases the cropping system sustainability. Integrated weed management approaches like mulching, solarization, soil fumigation, adjusting planting date, sowing time and spacing, irrigation management, nutrient management, proper drainage facility, flaming, flooding, and crop rotation are used in an integrated manner to effectively control the weed species in tomato in an eco-friendly manner.

Reference

Bose, T. K., Kabir, J., Maity, T. K., Parthasarathy. V. andSom, M. G. 2002.Vegetable crops (Volume 1), BhubaniMitra publications, Calcutta, Page no: 37, 60-62.

Kumar, A.,Manuja, S., Singh, J. and Chaudhary, R. 2015. Integrated weed management in tomato (*Lycopersiconesculentum* Mill) under the dry temperate climate of the western Himalayas. *Journal Crop and Weed* 11(1): 165-167.

Oerke, E. C., Dehne, H. W., Schonbeck, F. and Weber, A. 1994. Crop production and crop protection: Estimated losses inmajor food and cash crops. Elsevier, Amsterdam, The Netherlands. Pp. 808.

Rana. M. K, Fundamentals Of Vegetable Production. 2011. New India publishing agency, New Delhi, Pp: 484-526

Teiteh, R., J. C. Norman, and C. A. Amoatey. 2010. Studies on weed management of tomato (*Solanumlycopersicum* L.). *Journal of Horticultural Science* 9: 126-132.

Weaver, Susan E., Nancy Smits, and Chin S. Tan. 1987. Estimating yield losses of tomatoes (*Lycopersiconesculentum*) caused by nightshade (*Solanumspp.*) interference. *Weed Science* 35(2): 163-168.