EFFICIENT WEED MANAGEMENT PRACTICES IN OILSEED CROPS

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Every crop is exposed to severe competition from weeds, oilseed crops are no exception. Most of these weeds are self-sown and they provide competition caused by their faster rate of growth in the initial stages of crop growth. Weed management is an important component of plant protection improving the production potential of crops. It includes management of the weeds in away that the crop sustains its production potential without being harmed by the weeds. Weeds are the plants that grow without human efforts and are not wanted. They grow in the fields where they compete with the crops for water, soil, nutrients, light and space, and thus reduce the crop yields. The damage on crops by weeds is invisible as compared to other pests. Most of the oilseed crops are cultivated in less productive eco-systems and weed control is not given due care in oilseed crops as one would do in other crops. Hence, oilseed crops experience greater reduction in crop yields due to weed infestation. Proper weed management is a pre-requisite for obtaining higher input efficiency. Weeds also act as alternate hosts that harbour insects, pests and diseases and other micro-organisms. Some weeds release into the soil inhibitors or poisonous substances that may be harmful to the crop plants, human beings and livestock. Weeds reduce the quality of marketable agricultural produce and render harvesting difficult, leading to increased expenditure on labour, equipment and chemicals for their removal.

Weed management is done through the mechanical, cultural and chemical means. Use of biological control methods in field crops is being considered, but still not much in use. Use of herbicides is an important method in the modern concept of weed-management technology. New hand-tools and implements have also been designed to assist in weed-mangement programme.

Yield losses and nutrient depletion

Weeds cause serious yield losses if they are not controlled fully and at the right time. The extent of yield loss in major oilseed crops is quite considerable and varies a lot (Table 1). The degree of yield reduction depends on number of factors such as weed flora, intensity, tillage and cultural practices, input use, soil and weather conditions etc. In many instances, the weed control practices followed by farmer are either incomplete or not applied on time resulting in loss of about 10-15% from the potential yield. Weed control as an input is as important as application of fertilizers. Apart from direct losses, weeds also deplete substantial quantities of nutrients from soil. Weeds accumulate greater concentrations of nutrients compared to many crops. Unchecked weed growth leads to huge quantity of nutrient loss (Table 2). It has been estimated that nutrients to the tune of 10:5:10 kg $NP_2O_5K_2O$/ha are believed to have been used up by weeds. A sound weed

management system is vital for preventing nutrient loss and for realizing higher input use efficiency. An understanding of nature of weed problem, weed flora and critical stages of crop weed competition will help in planning an effective weed management strategy.

The dominant weed flora observed in oilseed crops are Cyperus rotundus, Cynodm dactylon, Digitaria sangunalis, Panicum repens, Dactylactenium aegyptium, Amaranthus viridis, Azeratum conizoides, Euphorbia hirta, Phyllanthus spp. Portulaca olerasia, Eclipta alba, Chenopodium album, Parthenium hystarophorus, Celosia argentia, Legasca mallis and Trichodesma indicum, In crops like linseed and niger, Cuscuta chinensis is a serious problem.

Table 1: Extent of yield losses due to weeds in oilseed crops in India

Crop	No.of sites	No. of expts	Mean loss (%)
Soybean	21	50	55.2
Groundnut	18	24	62.7
Mustard	14	22	34.1
Sesame	5	6	55.9
Sunflower	4	5	33.8
Safflower	1	1	33.6
Linseed	4	5	53.2
Castor	-	-	19.4
Niger	-	-	34.6

Table 2: Nutrient depletion (kg/ha) by weeds in different oilseed crops

Crop	N	P	K
Groundnut	15-39	5-9	21-24
Rapeseed-mustard	13-22	3	12
Soybean	26-65	3-11	43-102
Linseed	32	3	13

Table-2: Critical period of crop weed competition in oilseed crops

Crop	Critical period, days
Groundnut	40-60
Sesamum	15-45
Sunflower	15-30
Niger & Safflower	15-45
Castor	30-60
Soybean	20-45
Rape seed-mustard	15-40
Linseed	20-45

Critical period of weed competition

It is well established fact that early weed competition is detrimental to crop yields and early weed control is necessary. Based on studies carried out at different centers, critical period for different crops during which the weeds are to be kept under control have been proposed (Table-3). Critical period threshold, however, is influenced by crop cultivars, agronomic practices, weed flora and density, pest and disease attack, environmental conditions etc. The effect of weed competition on crop yield varies greatly with location, species, duration of infestation, moisture, weed density and other factors One of the principles in crop-weed competition is that the plants establishing in the soil earlier try to smother another species of plant coming at later stage. This depends not only on the nature of weed and crop, on the environmental conditions and density of weeds, but also on the period for which weeds are associated with oilseeds crops. By keeping crop fields weed free from the initial 30-45 days by mechanical or chemical means, the productivity of oilseeds can be increased considerably.

Weed management methods and tools

In general the weeds are to be checked through prevention, eradication and control. Prevention involves procedures that inhibit or delay weed establishment in areas that are not already inhabited by them. These practices restrict the introduction, propagation and spread of weeds on a local or regional level. Success of a preventive programme varies with species and the amount of effort devoted to control. The prevention of a weed problem is usually easier and less costly than control or eradication. Wherever possible measures can be taken to minimize the risk of new weed introduction, although it is impossible to guard against such an invasion. History is replete with examples of introduced either deliberately or accidentally, of plant species which are some of our most troublesome weeds of the country today.

Eradication is the total elimination of a weed species from a field, area or a region. It is neither practical nor required in majority of the cases. It can only be attempted with highly risky weed species, that too in a small scale. Control practices reduce or suppress weeds. There are four general methods of weed control *viz*., physical, cultural, biological and chemical.

Physical methods of weed control

Hand pulling and hoeing are the most common forms of weed control in the country, in all the crops, including oilseed crops. A variety of hand and animal-drawn implements have been used with varied success. These methods are most effective on annual or simple perennial plants that are not able to sprout from roots or other vegetative organs . Their success is dependant on crop growth stages, row spacing, soil and climatic conditions of the area. A wet soil surface not only delays weed removal but also offer uprooted weed plants a chance for re-establishment. Intercultivation by animal-drawn implements is ideally done during the early stages of crop growth and in broad space crops. Best results are reported in crops (castor and safflower) which are grown under

dryland conditions and under conserved soil moisture. Though physical methods (manual and mechanical) are very effective, they have certain limitations such as unavailability of labour during peak period and high labour cost, unfavorable environment.

Tillage

A major benefit of tillage is prevention of and suppression of weeds. Repeated tillage may also deplete weeds from the fields by diminishing seed and vegetative propagules in the soil. Repeated tillage may also exhaust carbohydrate reserves of perennial weeds, thus suppressing them. Deep summer tillage is frequently considered as good husbandry practice for controlling perennial weeds besides soil-borne diseases and pests.

Considerable degree of weed control could be obtained by irrigating the field to encourage germination of the weeds and subsequently killing them with a shallow tillage or by use of non-selective herbicides, before planting of the crop. This technique is popularly called as Stale seed bed is followed by several farmers and could be a very practical approach for minimizing weed seed reserves in the soil (Table 4).

Table 4: Effect of 'stale seed bed' on soybean yield at Sagar (MP) (2 year mean)

Planting	Weed biomass (kg/ha)	Seed yield (kg/ha)	
		Control	Hand weeded
M1-Sowing after onset of monsoon	3092	269	1202
M2-Sowing after killing first flush of weeds	1673	490	1266
M3-Sowing after killing two flushes of weeds	956	609	1179

Jain and Tiwari (1995)

Cultural methods of weed control

Cultural methods of weed suppression often occur during the normal process of crop production. These practices include weed prevention, crop rotation, crop competition, cover crops and harvesting operations.

Weed prevention

The prevention of a weed problem is usually easier and less costly than control or eradication attempts that follow weed introductions, because weeds are most tenacious and difficult to control after they become established. Following measures merit consideration: Preventive measures include use of 'clean' (weed seed-free) crop seed for planting; use of organic manures only after thorough decomposition to kill weed seeds; clean harvesters and tillage implements before moving to non-weed infested area; avoiding transportation or use of soil from weed infested area; inspecting nursery stock or transplanting seed and vegetative propagules of weeds; removing weeds that are near irrigation ditches, fence rows, right-of-way and other non-crop land; preventing reproduction of weeds; use of weed seed screens to filter irrigation water; restricting

live stock movement in to non-weed infested area prevents weed multiplication.

Other practices used to prevent potential weed problem at the state, regional or the national level are the weed laws, seed laws and quarantines. In the absence of strict quarantine laws a large number of weeds (including some exotic) have been introduced each year into the country through import of food grains. Of late, however, stringent laws have been enacted and food/grain movements are closely watched at International ports.

Crop rotation

Certain weed species are often associated with particular crop and the population of such weeds usually increases when that crop is grown on the same field continuously for several seasons. This is because some environment or cultural conditions that favour crop production also tend to favour the weeds. Crop rotation has a definite role in the control of parasitic weeds. In fact it is the only effective method available for controlling them, as all other methods including chemical methods are ineffective. Broomrapes (*Orabanche* sp.) in mustard and field dodder (*Cuscuta* sp.) in niger and linseed are the upcoming parasitic weed problems in oilseed crops, where crop rotation with suitable non-host plants can be ideally practiced.

Cultural practices that shift the balance of competition towards the crop usually will disfavour weed occurrence and improve crop yields. Factors that improve competitiveness include:

- Selection of well adapted crop cultivars
- Optimum planting date
- Optimum planting geometry
- Selective stimulation of the crop (e.g. placement vs. broadcasting of fertilizer)
- Proper water management (drip vs. flood irrigation)
- Use of smother crops

Any practice that provides vigorous uniform crop establishment usually will assist in reducing weed prevalence .**Good crop is the best weed killer.** Some crops can suppress weed growth significantly through their ability to grow faster because they are planted at high density. Such crops are called smother crops. They include foxtail millet, barley, sunflower, soybean, cowpea etc. Often these crops are solid seeded or planted in very closely spaced rows. They also may be used in rotations or mixtures with other crops.

Intercropping

Growing of intercrops and cover crops will help in minimizing weed infestation. Early growing and quick canopy forming crops such as cowpea, soybean etc. are the ideal choices. Sometimes a crop is used as a living mulch to suppress weeds during initial stages of crop growth which are mechanically buried or terminated chemically to reduce competition to the main crop.

Mulching and soil solarization

Mulching is an age –old practice for moderating soil temperature, conserving soil moisture and for controlling weed growth. Despite several advantages, mulching is not very popular. Solar heating of the soil by mulching the bare soil with thin transparent PE films during hot summer months, immediately before planting of the crop can effect excellent control of weeds, nematodes and soil-borne pathogens. This technique is popularly called as Soil solarization, the method results in enhanced soil temperature by 8-12 ^{0}C which is believed to be lethal to soil-borne pests. The method has shown excellent activity against a wide variety of weeds in soybean, sunflower and groundnut (Table 5). The cost of treatment, which is otherwise, high could be drastically reduced of PE by re-use or by treating the field in parts.Polythene mulching in groundnut has been attributed as one of the major improved cultivation practices for enhanced productivity in China. Initially, the PE films are laid on soil and groundnut seeds are dibbled in the holes made in the PE films. This method enables good initial crop growth in an otherwise cold environment and later helps in checking weed growth and evaporation of water. This technique may find favour with farmers of NE region where groundnut grown in rice follow often suffer from low temperature.

Table 5: Effect of soil solarization on seed yield of groundnut and soybean

Crop	Seed yield (kg/ha)		
	SS	NS-Control	Weed free
Groundnut	2875	910	2910
Groundnut	2064	468	2126
Soybean	716	408	-
Soybean	1690	700	1600*
Soybean	2145	965	2070*

* 2 hand weedings; SS- Soil solarization; NS- Non-solarization

Biological Control

It is the use of living organisms to lower the population levels or competitive ability of a weed species so that it is no longer an economic problem. Several important weed problems (all in non-crop situation) have been successfully solved through the use of biocontrol agent (mostly insects).Alien weeds are controlled through introduction of biocontrol agent. This approach is not suitable for controlling weeds in annual crops where weed flora is composed of several weeds and quick results are expected.

Mycoherbicides

Plant pathogens could be used to control weeds effectively in biological control program. The native pathogens are artificially applied at very high inoculum levels so that the weeds succumb. Several mycoherbicides such as ‘Collego’ (*Colletotrichum gleosporides*), ‘Devine’ (*Phytophthora palmivora*) have been commercialized for weed control in rice and citrus, respectively. The use of microorganisms in this manner is new

and presents an exciting opportunity for the expansion of weed control technology. Candidates for mycoherbicides must produce large amounts of easily collectable inoculum and be easily cultured in the laboratory; highly virulent to the weed; selective to desirable plant species; and safe to humans and animals.

Chemical control

Control of weeds through herbicides has become an integral part of modern agriculture in all developed countries of the world. Herbicides now lead all other pesticide groups in total acreage treated, amount consumed and total volume from sales (Figure 1). The overwhelming success of herbicides as tools for weed control is for the following reasons:

- Herbicides allow the control of weed where cultivation is difficult, for example within and between narrowly spaced crops.
- Herbicides reduce the number of tillage operations needed for crop establishment.
- Controlling weeds with chemicals often permits early planting
- Herbicides substantially reduce labour requirement, meaning more area under cultivation, and productive use of labour.
- Special weeds can only be controlled by herbicides.
- Herbicides offer efficient and economical control of weeds.
- Herbicides allow flexibility in the management system. Less resilience on crop rotation, tillage etc.
- Mechanical damage to crops can be reduced.

Herbicide use

Herbicides are often applied at various times during a growing season depending upon stage of crop and weed growth.

Pre-plant: Herbicide applications are made to soil before the crop is planted. Non-selective, non-residual herbicides (e.g.paraquat, glyphosate) can also be used to kill the existing vegetation. This is used as substitute for tillage.

Pre-emergence: Applications are made to the soil after the crop is sown, but before emergence of the crop or weeds.

Post-emergence: Treatments are applied to both crop and weeds after they have germinated from the soil. The exact time of application is dependent on a particular herbicide and growth stage of weeds and crop.

Integrated Weed Management (IWM)

Considering the diversity of weed problem, no single method of weed control, whether manual, mechanical or chemical could reach the desired level of efficiency under all situations. Recently the most promising single approach to weed control in cropland combines manual, cultural and mechanical methods with herbicides. Herbicides are

being used as a supplement at as low a rate as possible. On environmental grounds emphasis has been given to judicious combinations of cultural and chemical methods of weed control.

Integrated weed management, defined as the combination of two or more weed control methods at low input levels in order to reduce weed competition in a given cropping system below an economical threshold level. Integrated weed management system (IWM) is basically an integration of effective, dependable and workable weed management practices that can be used economically by the producers as a part of sound farm management system. IWM is effective in groundnut sunflower and soybean

Various methods of weed management have been used with different degree of success in different agro-ecological zones and productions system, which are as follows.

Groundnut

Groundnut is a major oilseed crop in the tropical world. Hot and humid weather prevailing during its cultivation period affords repeated flushes of grasses and broadleaf weeds through its entire growing season . In addition to competing with the crop, weeds in groundnut hinder its pegging, compete for underground space and make crop harvest cumbersome. The weedy crop produces fewer pods per plant and smaller peanuts.Since groundnut crop is grown on light soils, spike tooth harrowing and hoeing are practiced during early stages of crop growth. About four weeks after sowing is considered a critical stage for weeding groundnut. But once pegging in groundnut begins, no further physical method of weeding can be adopted for fear of damage to the pegs.

Weeds cause maximum damage (30-50% yield loss) to the groundnut crop up to 45 days after sowing. It is advisable to do one or two hand hoeing and weeding depending upon soil type and extent of weed infestation. The earthing up should also be taken up simultaneously with intercultural operations. Basic idea of earthing up is to promote easy penetration of pegs in soil and also to provide more area to spread. Application of herbicides accompanied by 1 or 2 hoeing was found to control the weeds effectively. The recommended herbicides for groundnut in India are Lasso (alachlor) @ 5 litres/ha or Butachlor @ 0.5 kg ai/ha as pre-emergence sprays within 2 days of sowing or Basalin (Fluchloralin @ 1 kg ai/ha) and a post-emergence weedicide Fusilade (Fluazifopbutyl) @ 0.25 kg ai/ha resulted in an yield increase of 71 and 50% respectively over unweeded check.

In maize-groundnut systems, during *kharif*, the maize grain yield with application of alachlor or atrazine resulted in similar yield as that of HW twice at 25 and 40 DAS. During *rab,i* application of metolachlor or pendimethalin @ 1.0 kg a.i./ha resulted similar pod yield of groundnut as that of hand weeding twice.

Field investigations carried out at UAS, Bangalore during 1995-96 resulted in significant reduction in weed count and weed dry weight even up to the harvest of groundnut due to solarization with transparent polyethylene. The transparent

polyethylene of 0.050 mm was superior than of 0.075 mm. Solarization for 45 days with transparent polyethylene caused maximum reduction in weeds. The black polyethylene did not help in suppressing weeds and was on par with control. Maximum pod yield was recorded by weed free check (21.26 q/ha) but on par with transparent polyethylene 0.050 mm for 45 days (2.064 q/ha)

Sunflower

Sunflower initially slow growing crop provides congenial conditions for abundant growth of weeds. Wide inter row space in sunflower is prone to weed infestation. Wet soil conditions due to frequent rains during *kharif* in vertisols do not permit mechanical weeding to create weed free conditions. Hence use of herbicides has become a necessary practice to reduce the weed menace during early growth stages of sunflower. However neither herbicides nor cultivations are adequate for consistent and acceptable weed control. Thus Integrated Weed Management is gaining importance in management of weeds for preventing losses and higher input efficiency in sunflower.

Experiments conducted at DOR-ICRISAT farm in vertisols during 2006-07 showed pre-emergence application of pendimethalin (1.0 Kg) in combination with interculturing at 21 DAS followed by hand weeding at 40 DAS was found to perform equally good as that of weed free treatment in registering low weed population, lesser weed dry matter, high weed control efficiency higher seed yield and nutrient uptake. Post- emergence herbicides such as imazethapyr at higher concentrations resulted in phtotoxic symptoms and hence should be used with caution.

In rice-sunflower cropping system, application of anilofos @ 0.4 kg/ha or butachlor @1.5 kg/ha or 2,4-DEE @ 1.0 kg/ha at 5 DAT was found equally effective in suppressing weed growth and increasing grain yield of rice. Application of herbicides and hand weeding to sunflower did not influence the weed control and growth in *kharif* rice. During *rabi*, application of oxyfluorfen @ 0.15 kg/ha and metolachlor @ 1.5 kg/ha to sunflower was effective in controlling weeds and resulted in similar yield to that of hand weeding (20 DAS). Application of herbicides and hand weeding in rice had no effect on weed growth of succeeding sunflower crop in *rabi.*

In maize-sunflower cropping system, application of atrazine @ 1.0 kg a.i./ha, alachlor @ 1.5 kg a.i./ha to maize and metolachlor or alachlor or pendimethalin @ 1.5 kg a.i./ha to sunflower significantly increased the grain/seed yield over unweeded control and found as good as IC at 25 DAS in maize and hand weeding at 20 and 40 DAS in sunflower.

Rapeseed and Mustard

Interculture at 20-25 days after sowing remove weeds and conserve soil moisture. Application of isoproturon (pre-emergence), oxadiazon @ 1.0 kg/ha resulted in equal seed yield as that from weed free plots.

At Ranchi, there was lower weed population and dry matter with herbicide application as compared to HW. Higher weed control efficiency was associated with oxadiazon @ 0.5 kg /ha and fluchloralin @ 1.0 kg /ha and these were comparable with HW. Further, in mustard, application of isoprotunon, oxadizon, trifluralion @0.5 kg a.i/ha as pre emergence spray reduced the weed problem

Post-emergence application of isoproturon (1.0 kg /ha) proved effective and economical herbicide in controlling weeds in wheat inter cropped with mustard / linseed. Isoproturon (post emergence) recorded an increase of 25% of wheat equivalent yield over control.

Soybean

At Kanpur, application of alachlor @ 1.0 kg /ha, fluchloralin @ 0.66 kg /ha, lactofen @ 0.13 kg/ha and metribuzen @ 0.3 kg a.i./ha in combination with one HW or IC provided broad spectrum weed control and resulted seed yield similar to two HW at 20-25 and 30-40 DAS. Application of fluchloralin, pendimethalin, butachlor all in liquid formulation @ 1.0 kg/ha and anilophos @ 0.5 kg /ha and butachlor @ 1.0 kg /ha in granular form were found to be as good as two HW.The post-emergence herbicides advocated are: Chlorimuron-ethyl (25 WP) 0.01 kg ai/ha, Imazethapyr (10 SL), 0.1 kg ai/ha, Quizalofop-ethyl (5 EC)0.05 kg ai/ha, Fenoxy prop-ethyl 0.07 kg ai/ha.

At Shillong, pre emergence application of oxadiazon @ 1.50 kg /ha + one HW and Butachlor @ 1.5 kg / ha + one HW and pendimethalin @ 0.75 kg /ha + HW at 40 DAS found best for suppressing the weeds and increasing the seed yield (AICRP, 1989-90).

Integrated weed management in soybean encompasses deep summer ploughing, cultivation before sowing, need based use of pre-plant incorporated or pre-emergence herbicides and interculture at 30 DAS for obtaining economic yields

Safflower

Normally weeds do not pose any serious problem in safflower except when frequent rains are received during the initial phases of crop growth or when seedbed preparation and tillage is improper. Safflower is very susceptible to weed competition during the rosette stage which lasts for about 25 to 35 days in peninsular India and 60 days or more in other parts with prolonged winter. Timely weeding and interculture during this period is a must for arresting weed growth and obtain full benefits from applied nutrients, rainfall and soil moisture. One or two HW and hoeings/harrowings at 25 to 35 and 45 to 50 DAS depending on the length of rosette period and the severity of weed infestation is enough for control of weeds.

Pre-plant incorporation of fluchloralin @ 1.25 kg /ha and pre-emergence application of oxadiazon @ 0.75 kg /ha or Diuron (0.85 kg a.i/ha) resulted in higher seed yield.

Castor

In rainfed areas, performing 2-3 intercultural operations with the help of bullock drawn blade harrows commencing from 25 days followed by one hand weeding can effectively check weed growth. Pre-plant incorporation of Fluchloralin or Trifluralin @ 1.0 kg /ha or Pre- emergence application of Alachlor or Metolachlor @ 1.0 kg /ha fb HW at 25 DAS was effective in reducing the weed population and increasing the castor seed yield in irrigated castor.

Linseed

Linseed crop should be free from weeds for the first 35 DAS. Application of oxadizon has effectively controlled weeds and resulted in seed yield comparable to HW.

At Jabalpur, maximum seed yield and net returns of of linseed grown under irrigation was obtained with pre-emergence application of oxadiazon 1 kg/ha, alachlor 2 kg/ha, oxyflourfen 0.2 kg/ha and pendimethalin 1 kg/ha. At Kanpur, application of pendimethalin @ 1.0 kg/ha fluchloralin @ 0.67 kg /ha and isoproturon @ 1.0 kg /ha was found effective in preventing weed competition in lentil + linseed intercropping.

Application of isoproturon @ 1kg/ha either with or without 2,4-D (sodium salt) @ 0.50 kg/ha as post-emergence at 35 DAS controlled weeds effectively.

Niger

The crop is grown by tribal farmers of M.P, Orissa, A.P, W.B, Maharahtra, Bihar under rainfed farming on soils of poor fertility and undulating topography. In niger the critical period of weed competition is 30 days. Weeds cause 35-60% yield reduction in niger. Pre-emergence application of pendimethalin 1 kg/ha or alachlor 1 kg ai/ha was found effective for weed control.

Cuscuta commonly known as “dodder” is an invasive, obnoxious parasitic weed that attaches itself to the stems and leaves of niger ad linseed crops.. It draws nutrients from the host plant for sustenance and provides a dense barrier that drastically retards growth and vigour of the host plant and reduces yield by 35-100 per cent.

Management of Cuscuta

Non chemical methods such as deep-ploughing, burning, use of Cuscuta free crop seed (sieving the niger seed before sowing eliminates the weed seed) , use of resistant crops/varieties, crop rotation and intercropping, mechanical weeding, etc., may be useful in preventing/reducing Cuscuta infestation. Cuscuta is one of very few weeds that can be controlled completely by rotating host crop with non-host crop. The shade from dense crop foliage suppresses Cuscuta sufficiently to control it almost completely. In arid areas, time of irrigation can be manipulated to help control Cuscuta. Because Cuscuta seeds

cannot germinate without moisture near the soil surface, period of Cuscuta control may be extended by delaying irrigation in certain crops such as alfalfa grown for seed production. Once Cuscuta is attached to the host plant, mechanical removal of the parts of the host bearing the Cuscuta will control the parasite. Herbicides like Chloropropham granules 4 kg/ha applied at 6 DAS and Pronamide 2 kg/ha at 20 DAS as post-emergence was found effective in controlling cuscuta in niger fields. Although several soil and foliage applied herbicides such as paraquat, 2,4-D, glyphosate, trifluralin, pendimethalin, ethofumesate, etc., are known to achieve moderate to good control of Cuscuta, most of which are either not available to the farmers or they can't be used selectively in rice-fallow cropping system. When pulses or oilseeds are sown, the standing rice crop precludes pre-emergence herbicide application; while extreme sensitivity of crop seedlings to foliage applied herbicides prohibit their use as post-emergence

Sesamum

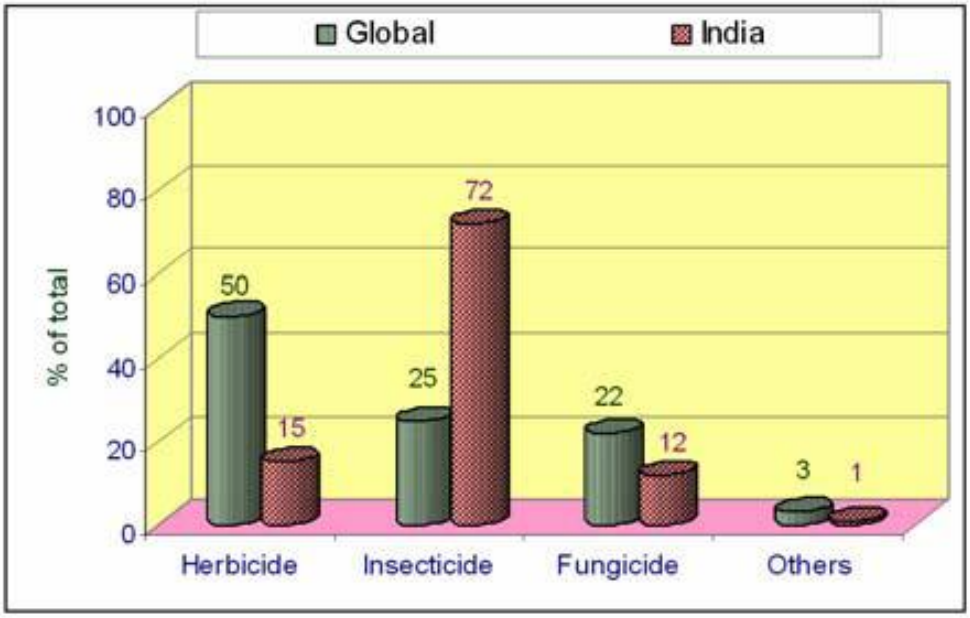
At Anand, there was decrease in weed growth and increase in seed yield with application of trifluralin @ 0.5, 0.75 and 1.0 kg /ha alone and lower doses integrated with HW at 30 DAS. Further, at Viswabharathi, pre emergence application of alachlor @ 1.0 kg / ha or fluchloralin @ 0.5 kg /ha fb one HW was found effective in controlling weeds.

Herbicides Vs Soil enzymes

When herbicides are applied to soils, they generally disturb the natural eco-system through their effects on soil microbial and enzymatic activities. Application of herbicides was found to have side effects on soil enzymes. Intensive use of herbicides without adequate knowledge on its effects on soil enzymes may have adverse impact on soil-bio-chemical processes and nutrient cycling. An attempt was made at DOR to assess the effects of applied herbicides on soil urease, phosphatase and dehydrogenase enzymes. Urease enzyme is involved in hydrolytic cleavage of urea to nitrogen and hence is one of the most important soil enzymes. .

Experiments conducted at DOR –ICRISAT farm during 2006-07 in *kharif* sunflower in vertisols resulted in significant inhibition of three soil enzymes with the application of pre and post emergence herbicides viz., Pendimethalin and Imazethapyr at higher doses alone (T1, T2) and in combination (T3) compared to control (T7 and T8). Application of lower doses of Pendimethalin 1.0 kg a.i/ha followed either by intercultivation at 20-25 DAS (T4) and hand weeding (T5) maintained favorably higher activity of soil enzymes similar to that of weed free situation (T7). A lower dose of pre-emergence application of herbicides followed by soil working was found to enhance the porosity of soils leading to improved aeration and higher microbial activity (Figure 2).

Fig. 1. Global and Indian Pesticide use scenario (% of total)



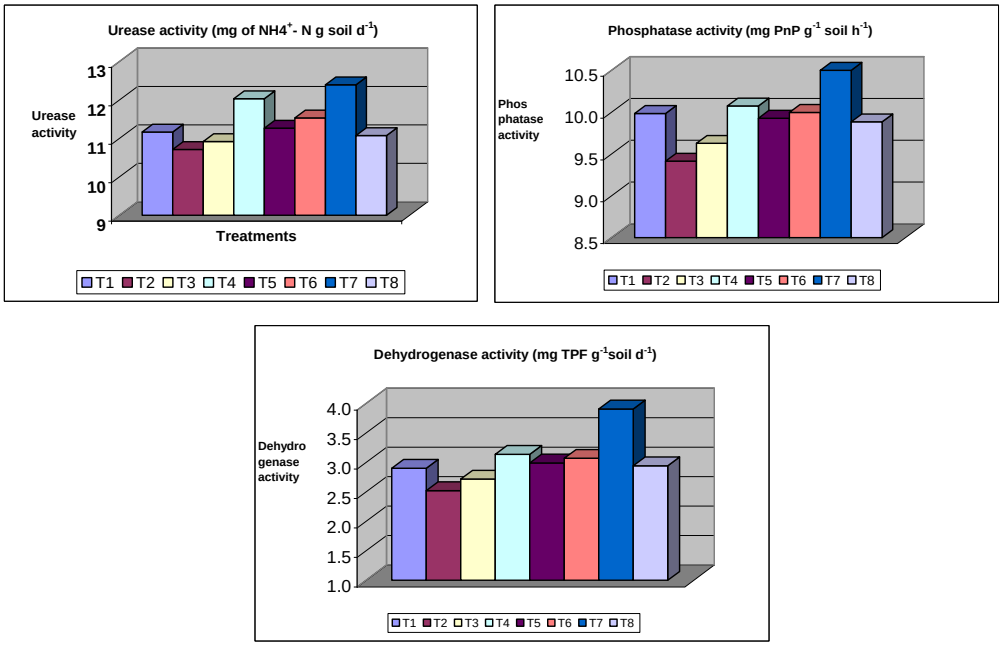


Figure 2: Activity of soil enzymes in *kharif* sunflower under different weed control treatments in vertisols