Weed Management

Introduction to Weed Management

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DEFINITION OF WEED

Weeds have been in the nature before man started cultivating crops. They were undoubtedly recognized as a problem since the beginning of civilization (Hay, 1974). Although, weeds were recognized individually in the ancient time near eastern civilization. But there is little evidence that a word or words existed for collective term 'weed'. Further, all plants were considered useful, but when any plant existed against the wishes of man considered weed. Weeds have no species of themselves, but the very name weed suggests useless and harmful plants that persistently grow where it is not desired. Whether a plant is considered weed depends not only on its characteristics and habit but also its relative position with reference to other plants and human beings. Thus, a plant of economic crops may also become a weed if it is found growing with other crops where it is not desired, *viz.* a plant of oat in the field of wheat. But for all practical purpose weeds referred undesirable, injurious, unsightly and trouble some plants which interfere with cultivated crops and affect human affairs.

Blatchley (1912) designated weed as a plant out of place or growing where it is not wanted. Georgia (1916) defined a weed as a plant growing where it is desired that some thing else shall grow. Alexander Nelson (1946) defined weed as those plants for which man has found no use and which in their evolution have developed such power of aggression, persistence or reproduction as to make them a menace to the best development of crop. According to Muenscher (1946) weeds are those plants with harmful or objectionable habits or characteristics, which grow where they are not wanted, usually in places where it is desired that something else should grow. Robins *et al*. (1942) termed those obnoxious plants as weeds which are unwanted, non useful, often prolific and persistent, interfere with agricultural operations, increase labour, add to costs and reduce yields. According to Herbort (1962) in the dictionary of ecology weed is a general term for any troublesome or otherwise undesirable plant, usually introduced, grows intent international cultivation. A weed is a plant growing out of place, where it is not wanted either because it is taking the place reserved for something else (The Encyclopedia Americana, 1962). Weeds are plants growing in places and at times when man wanted either some other plants to grow or no plants at all (NAS, 1971, Gupta and Lamba, 1978, Rao, 1983). A weed is plant growing where it is not desired (Anonymous, 1987).

Conversely various crop plants which grow as volunteers in other crop areas are rightly considered as weeds. Thus, it is clear that weed is a relative and anthropocentric concept rather than an absolute category. There are several remarkable characteristics that enable plants to become weeds, all being related to seeding and growth habits, as (i) many weeds are capable of growing under adverse conditions as they bear modified or reduced leaves and other aerial parts (ii) many weeds are able to thrive under conditions favorable or unfavorable for growth of crop plants,(iii) A great number of them ramify vegetatively even though they are prevented from seed production, (iv) Many, if not all, are able to form new plants from injured or cut portions, (v) and lastly many weeds are covered with spines, thorns, stiff hairs or sticky secretions and may contain substances of unpleasant odour or taste (Dutta and Banarjee, 1978).

Thus, those plants which interfere with human activity in crop and non-crop areas are considered weeds. Under certain circumstances, each species is a weed as such. All weeds are non-desirable plants but all non-desirable plants may not be weeds. Many plants commonly classified as weeds may be used for food or medicinal purpose, *viz*, *Portulaca oleracea* L. and

Mentha spicata L. are examples among a great many others. Furthermore, many weed plants growing in fallow areas serve to prevent soil erosion and to recycle mineral nutrients to the soil. Similarly, *Achyranthus aspera* growing in waste lands is not regarded as a weed. *Cynodon dactylon* is a worst weed of crop fields but is a desirable plant in lawns, range lands, and permanent bunds.

In natural habitat there are four types of plants: crop plants, wild plants, rouge plants, and weed plants. Crop plants are those which are intensely cultivated by man for his welfare. Wild plants are those which grow voluntarily in nature in an un-controlled way and do not interfere with man's activities. Rogues are off type economic crop plants in same crop fields. Weeds are those plants which are out of place, unwanted ,non-useful, often prolific and persistent, competitive, harmful, even poisonous which interfere with agricultural operation, increase labour, add to costs, reduce yields and detract from comforts of life (Crafts and Robbins, 1973).

COST TO SOCIETY FROM WEEDS

Very few realize the cost to society by weeds. Production of crops is largely a battle with weeds. More than one half of the cost of crop cultivation is because of weeds. Weeds occurring in crop fields compete them and reduce yield and quality of produce. Weeds flourish in aquatic systems, forestry, and non-cropped areas like road side , railway lines, air fields, water tanks, canals, rivers, uncultivated lands etc. and impair the quality and environment. Crop losses from weeds are generally much higher than we generally recognize. Because weeds are so common and so widespread, people do not fully appreciate their significance in terms of losses and cost of control. The whole system of weed control is so intermixed which separate account is difficult by any standard practice. As for example a farmer achieves weed control through a combination of methods, hand weeding, simple weeding machine and herbicides. Besides these land preparation, minimum tillage, growing competitive crops and varieties, intercropping, crop rotation, manipulation of planting date and plant population, fertility and water management indirectly help to control weeds Thus, it is difficult to separate out how much these weed control methods, particularly indirect method help to crop production and how much to weed control. The habitats grouped into crop fields, non-crop fields and aquatic environments.

A CROP FIELDS

Reduction in crop yields

The global loss of food production due to weeds was estimated to be 287 million tones per annum accounting for 11.5% of total world food production (Parker and Fryer, 1975). Out of total annual loss of agricultural produce from various pests in India, weeds account for 45%, insects 30%, diseases 20% and other pests 5%. The potential loss caused by weeds in different crops as reported in Indian literatures is summarized in **Table 1.**

In India, an estimated annual loss of agricultural production is more than Rs.6000 crores due to weeds. If we add the weed losses of the public parks, gardens, other recreation areas, high ways, rail roads, industrial plants, the aquatic problems of lakes, ponds, ditches and tide water areas and public health (hay fever, poisoning), the figures become unbelievable. Such losses due to weeds have not been accounted realistically in any country of the world.

Table 1: Mean potential loss caused due to weeds in some selected crops in India

Crop	No. of locations	No. of trials	Mean yield (kg/ha)		Mean loss (%)
			Weed-free	Weedy	
Rice (DSR)	22	28	3365	1151	64.0
Rice (PSR/PTR)	20	330	4549	2620	43.0
Wheat	23	63	3241	2226	31.6
Maize	13	18	4067	2056	48.8
Groundnut	20	31	2486	934	63.6
Soybean	21	54	1986	874	53.0
Mustard	12	20	1433	889	37.7
Linseed	4	9	1110	399	62.7
Sesamum	5	6	616	288	54.2
Sunflower	4	5	1659	1117	32.2
Pigeonpea	16	21	1573	774	46.7
Mungbean	7	13	963	516	46.3
Urdbean	15	18	1001	474	55.4
Chickpea	10	13	1545	767	48.1
Lentil	6	6	1709	755	58.8
Fieldpea	9	13	2094	1054	47.1
Cotton	12	18	1234	824	60.4
Sugarcane	8	9	93.1 *	64.4	34.4
Potato	7	10	18.3 *	12.8	29.0

* tonnes/ha, DSR (Direct Seed of Rice), PSR (Puddled Seeded Rice), PTR (Puddled Transplanted Rice).

Source: Yaduraju (2001, unpublished)

An environment favourable for crop growth and development is equally favourable for weeds growth. However, the weeds are crop specific and grow with particular crop as both weeds and crop have same cultural, soil and climatic requirement. If no restriction is imposed they compete with crop plants for nutrients, moisture, light, air, space and other factors in micro-environment, and result loss of crop yield. The loss in crop yield depends upon type of weed flora and its intensity. The extent of yield reduction varies from 15 to 100 per cent. The loss is more acute under moisture stress condition (dryland condition) as weeds comprise a

variety of plant types and out of that some are capable of flourish even in moisture stress condition than the crop plants.

Reduction in inputs and human efficiency

Besides reducing the crop yields weeds also reduce input and human efficiency. There are many indirect ways through which weeds increase the cost of production and thereby reduce the efficiency of all the inputs, machinery and manpower. For example, in weed infested fields operations like application of fertilizers, insecticides and irrigation become cumbersome. It is difficult to harvest the crops if weeds like wild safflower (*Carthamus oxycantha*), Canada thistle (*Circium arvense*), and cocklebur (*Xanthium strumarium*). Cowage (*Mucuna puriens*) annoy the harvest labour by causing itching. Bind weed (*Convolvulus arvensis*) and morning glories (*Ipomoea* spp) bind the crop plants together so well that harvesting of crops becomes time consuming. The weeds at harvest time also bring about excessive wear and tear of farm machines. The admixture of weed seeds to crop seeds add to the cost of separating weed seeds.

Increase protection costs from insects and diseases.

Weeds serve as an alternate host to number of pests. During crop season and off season these weeds harbour insect pests and disease organisms of crops and act as an alternate host. Later the specific pests and disease organisms migrate to main crops where they cause higher intensity damage than the weed free crop fields. The pests like carrot weevil, aphids, onion thrips harboured on wild carrot, wild mustard, rag weed and later attack on carrot, cabbage, cauliflower, radish, turnip and onion crops. The pathogen black stem rust harboured on grassy weeds and wild oat and later attack on wheat. Some important insect pests and diseases host weeds and crop affected are given in **Table 2**.

Table 2 : Weeds acting as Alternate Hosts of Crop Pests and Diseases *

Host Weed	**Insect-pest/disease Organism hosted**	**Crop affected**
Weeds Hosting Insect-pests		
Aeschynomene spp.	Grasshoppers (vectors of Colletotrichum)	Rice
Achyranthus spp.	Leaf eating caterpillars	Lucerne and maize
Brassica kaber	Aphids	Brassica crops and brinjal
B. kaber, Ipomoea spp., and Plantago spp.	Melon aphis	Melons, cucumbers, and squashes
Chenopodium album and Amaranthus and Datura spp.	Gram caterpillar	Redgram, cotton, okra, pea, tomato and brinjal

Host Weed	Insect-pest/disease Organism hosted	Crop affected
Weeds Hosting Insect-pests		
Chenopodium album	Stalk borer	Tomato, maize, lilies and asters
Crotolaria spp.	Hairy caterpillar	Castor
Digera arvensis and Amaranthus spp.	Catterpillars	Tobacco and cruciferous crops
Echinochloa, Panicum, and Zizania spp.	Stem borer	Rice
Kochia, Amaranthus, and Salvia spp.	Thrips	Onion
Trianthema, Solanum, and Chenopodium spp.	Greasy cutworm	Potato, chickpea and pea
Weeds Hosting Diseases		
Agropyron, Verticillum, and Portulaca spp.	Wilt	Tomato
Cynodon dactylon and Digitaria spp.	Sting nematode	Several vegetables
Commelina spp.	Certain viral diseases and parasitic nematodes	Banana
Daucus carota	Blight	Carrot
Leersia oryzoidee	Bacterial blight	Rice
Plantago & Verioica spp.	T.M.Virus	Tobacco and Tomato
Saccharum spontaneum	Downy mildew	Maize
Solanum and Physalis spp	Mosaic and cyst nematode	Solanaceous vegetables, tobacco and cocoa.

*(From: Deoderlein and Sites (1993); Ellis (1992); Hu & Nie (1989); Larson (1994); and others

Reduction in land value.

The land heavily infested with perennial weeds, e.g. *Cyperus rotundus, Saccaharum spontaneum, Circium arvense, Sorghum halepense* has reduced the sale value of land as they incur heavy expenditure to clear or to eradicate.

Impair health of men and animals

Some weeds are poisonous to animals and human beings as well. Weeds like *Trianthema spp, Astragalus lentiginosus* and *Astragalus pubentissimuer, Oxytropis sercea* cause abortion and congenial malformation in sheep and cattle. Similarly *Lupinus* spp is reported to cause crooked calf disease. Fresh green plant of *Phalaris tuberosa* causes death of cattle within hours of eating. Cattle feeding on *Sorghum halepense* during hot months of May and June develop tympani disease due to high concentration of HCN in this weed. However, with onset of monsoon, the plant makes vigorous growth due to which concentration of HCN comes down below the toxic level.

Some poisonous weeds like Mexican poppy *(Argemone mexicana*) seeds crushed with mustard seeds may lead to blindness and death to people if eaten along with oil. Weeds like *Mimosa pudica*, *Centipeda minima*, and *Datura strumarium* cause wounds, headache, sneezing, giddiness and vomiting. Carrot grass *(Parthenium hysterophorus*) is very harmful for the health of animals and human beings. It contains sesquiterpene lactones (Parthenin, hyenim and ambrosin etc.) which induce severe allergic, dermatitis and other symptoms (Williams, 1984).

In cattle due to parthenium contact, there is loss of hair, marked depigmentation of skin, development of lesions in mouth and intestine.

Loss in forestry and apiary

Weeds apart from effects on agriculture and horticulture also cause loss to forestry (Seth and Derbal, 1961). Lantana has already become a menace to forests of south (Griffithii, 1941) and in Himachal Pradesh (Chakravarty, 1963).

Poisoning of honey bees foraging on weeds, e.g.*Euphorbia geniculata* is a common occurrence. In flowering weeds compete with crops in attracting bees, interfere with pollution, and finally affect yield of crops.

Reduction in Quality of Produce

Contamination of weed seeds reduce the quality of produce in many ways such as wild rice in rice, wild oat in wheat, Argemone in mustard, wild onion in onion, weedy trash in hay and cotton, parasitic loranthus leaves in tea. The weed seeds with high moisture contents spoil the food grains during storage. Contaminated seeds are poorly accepted by consumers as well as offered lower price.

Presence of weeds like *Cleome viscosa, Paederia foetida, Brassica spp, Oxalis latifola* eaten by milch animals impart undesirable flavour in milk. The quality of wool or hide is reduced when grazing animals eat fruits of *Achyranthus aspera* and *Xanthium strumarium.*

Nutrient depletion

Indian soil is poor in nutrient status and because of this reason productivity of our most of crops is lower as compared to world's developing and developed countries. Further, weeds also remove much more amount of nutrients from soil than the crop plant if left uninterrupted. Work done on major nutrients nitrogen, phosphorus and potassium depletion by scientists in weedy crops are summarized in **Table 3.**

Table 3: Nutrient depletion by weeds in different crops:

Crop	N (kg/ha)	P (kg/ha)	K(kg/ha)	Reference
Rice(direct sown)	26	80	25.8	Singh & Sharma (1981)
Rice (direct sown puddle)	20.5	5.4	16.6	
Rice (transplanted)	10.9	2.6	9.8	
Wheat	23.5	2.2	28.8.	
Sorghum	39.5	15.0	31.7	Mani (1975)
Maize	59.0	10.0	59.0	Rajan and Sankaran (1974)
Groundnut (rainfed)	39.0	9.1	23.5	
Groundnut (irrigated)	14.7	4.6	20.7	Soundrarajan *et. al.* (1981)
Peas	29.7	5.4	-	Mani (1975)
Soybean	26.1	2.7	79.9	Maurya *et. al*. (1990)
Sugarcane	162	24	203	Gupta (1960)
Mungbean	120.4	15.9	119	Yadav *et. al*. (1985)

Moisture depletion

In general, for producing equal dry matter, weeds transpire more water than do crop plants (Table 4). Shahi (1978) determined the consumptive use of water for a common weed *Chenopodium album* as 550 mm against 479 mm for wheat. It was observed that weeds removed moisture upto 30 cm soil depth, while the major uptake of moisture by wheat was limited to 15 cm soil depth.

Table 4 : Transpiration co-efficient of certain Weeds and crop (After Kanitkar et al, 1960)

Plant Species	Transpiration co-efficient 'Q'	Plant Species	Transpiration Co-efficient 'Q'
WEEDS			
Amaranthus vridis	336	Tephrosia purpuria	1108
Cynodon Dactylon	813	Tribulus terrestris	221
Digitaria sanguinalis	696	Tridax procumbens	1402
Echinochloa colonum	674	Xanthium strumarium	331
Ischaemum pilosum	556	CROP	
Salsola kali var ternuifolia	542	Zea mays	352
		Sorghum vulgare	394

B. HARMFUL EFFECTS OF WEEDS IN NON-CROP SITUATIONS

Causes accident

Dense and moderately tall weeds obstructs the visibility of roads and hinders the speedy movement of vehicle and causes accidents. Weeds also conceal warning signs and markers and at sharp turns, chances of accident is more due to tall weeds.

Causes fire hazards

Dead weeds lying either in plantation crops, orchards, factories, houses, grazing lands, roads and railway sides subject to ignition by a spark, a carelessly torched cigarette, spark of fire from factory or rail engines cause serious fire hazards.

Deteriorates the beauty of public places aesthetic value

nfestation of weeds in lawns, gardens, air ports, parade grounds, deteriorates their beauty.

Causes pollution

The presence of weeds in non-cropped areas like courtyard, park, gardens, manure pits, threshing and drying yards attracts a number of insects, rodents, birds and reptiles which deteriorate the beauty of the areas as well as pollute the environment.

C. HARMFUL EFFECTS OF AQUATIC WEEDS

Reduce the movement of water

Weeds presence in channels, either irrigation or drainage and canal impede the movement of water. Restriction of water depends on infestation of weeds and it can go even upto 90 per cent and cause loss of water through seepage and floods. It reduces efficiency of canal, channels and drainage and rise of water level in these may result in upward movement of injurious salts and creation of inundated fallow land.

Increase transpiration of water

Weeds transpire more water than crop plants as well as evaporation alone from the open water surface. I dry land agriculture the actual evaporation from the weedy crop fields is much more than the evapotranspiration from a weed free crop field. In such an agri-system, during a dry spell the weedy crops exhibit moisture stress symptoms much earlier than a weed free crop.

Weeds affect water life

Weeds liberate CO_2 which when dissolved in water affect the fish life. Decomposition of weeds and their roots unaerobically result in production of toxic gases like H_2S, CH_4 and also increase the acidity which affect the growth of fish as well as cause death of fish due to inadequate oxygen in water bodies. Aquatic vegetation also upsets the equilibrium of physico-chemical qualities of water, causes imbalance in dissolved oxygen by preventing the gaseous exchange with the atmosphere and thereby affects the water living organisms.

Affect navigation

Aquatic weds causes hindrance to navigation especially like water hyacinth and alligator weed become impenetrable and prevent movement of boats and streamers.

Act as shelter for disease causing organisms

Aquatic weeds become a breeding place for mosquitoes in impounded water causing malaria, filariasis and encephalitis and these weeds act as primary vectors for disease causing organisms.

CLASSIFICATION OF WEEDS

There are more than 3,50000 plant species around the world, of which 30,000 have been recognized as weed species. Out of these weed species about 18000 cause serious loss to crops. These weed species often respond to common management technique because of similarity in life cycle, morphology, habitat, propagation and overall biology. These similarities enable us to generalise about the effectiveness or failure of a weed management practice against weeds as a class instead of individual weed species. Of course, while considering weeds in group even in their effective management method some weed species may escape which may result in shifting of weed flora to a particular site, the less dominant weed species may become dominant due to repeated use of same herbicide or method of weed management. Therefore, classification of weeds is required to understand the over all biology in general, and their management in particular.

Weeds are classified in many ways, but important classification are described for planning effective management techniques to manage weeds in crops and non crops situations.

CLASSIFICATION ACCORDING TO ASSOCIATION

Weeds present in crop fields differ in their soil and climatic requirements, cultural requirement, morphology, seed size and food habits. They have intense association with particular climate and crop, thereby they come in particular season and crop. Accordingly on the basis of association weeds are classified in three groups.

A. Season bound weeds: There are three seasons in a calendar year, monsoon, winter and summer. Accordingly, weeds grow in that particular season with disregard to crop species cultivated. There are weeds which are of perennial types but they are considered of particular season weed in which their major vegetative growth period is passed like *Sorghum halepense* is a summer perennial and *Circium arvense* is a winter perennial weed. Annual weeds which come in more than one season is called multi seasonal annual or multi annual weeds. Those weeds which complete their life within a season and propogate by seeds. They are of four types:

1. **Monsoon annuals (Kharif annuals)** : *Ammania baccifera, Sagittaria Sagittifolia, ludwigia, parviflora, Cyperus difforamis, Echinochloa crusgalli* etc.

2. **Winter annuals (Rabi annuals)**: *Chenopodiumalbum, phalaris minor, Avena fatua Spergula arvensis, Vicia hirsuta, Molilotus alba* etc.

3. **Summer annuals**: *Solanum nigrum, Portulaca oleracea, Argemone mexicana, Tephrosia purpurea* etc.

4. **Multi seasons annuals**: *Echinochoa colonum, Eclipta alba, Phyllanthus niruri* etc.

B. CROP BOUND WEEDS OR PARASITIC WEEDS.

Crop bound weeds are also called parasitic weeds. Such weeds are dependent on specific host crop as they get nutrition for their survival and growth from host crop. Accordingly weeds are classified as

1. **Total parasitic weeds**: These weeds are totally dependent on host plants as they take moisture, nutrients and food from host plants e.g. *Orabache* spp. It is usually parasitized tobacco, tomato, carrot, sarson etc..
2. **Semi parasitic weeds**: Those weeds are partly dependent on host plant and partly on their own are called semiparasitic weeds e.g. *Cascuta* spp like *Cuscuta reflexa* and *Cuscuta chinensis* and *Striga spp*. These weeds after germination of host crop seeds germinate and their radicles attach to the roots of host crops. After their germination they produce and synthesize food materials, but they take water and nutrients from the host crops.
3. **Non parasite weeds** : Those weeds which are not dependent on any other plants. These weeds germinate, take nutrients from soil and synthesis their food for themselves e.g. *Cyperus rotundus, Echinochloa spp, Phalaris minor, Chenopodium* album etc.

C. CROP ASSOCIATED WEEDS : The crop associated weeds, like crop bound weeds, are also crop specific, but for different reasons they may be associated with certain crops for one of the following causes.

i) **Need for specific microclimate** : Weeds like *Cichorium intybus* "chicory" and *Coronopus didymus*- "swine cress" require for their best growth shady, cool, and moist habitat which is amply available in crop like lucerne and berseem. Such weeds, therefore, are associated with these crops.

ii) **Mimicry**: *Oryza sativa* var fatua "wildrice" in paddy field and *Avena fatua* "wild oat" and *Phalaris minor* "canary grass" in small grain crops survive because of their similarity in morphology with the host crops. So is true of *Loranthus* in the tea gardens. This mechanism is called mimicry. A weed like wild oat tends to grow to the height of winter grains and adjusts its ripening time to the crop over a wide varietal range. This kind of mimicry is called phenotypic mimicry.

iii) **Contamination of crop seeds**: Weeds like oryza sativa var.fatua (wild rice) in rice, Phalaris minor (canary grass), *Avena ludiciana* (wild oat) and Convolvulus arvenlis (hiran khuri) in wheat , *Cichorium intybus* in berseem mature their seeds almost at the same height and time as that of respective crops. Seeds of these weeds are morphologically similar to associated crop seeds. Thus, they easily contaminate crop seeds at harvest time and can not separated out by any method.

IMPORTANT WEEDS REPORTED WITH RESPECTIVE CROPS ARE :

- **Paddy :** *Echinochloa colonum, Echinochloa crus-galli, Ischaemum rugosum, Cyperus rotundus, Cyperus iria, Digitaria sanguinalis, Eleusine indica, panicum repend, paspalum conjugatum.*
- **Wheat :** *Phalaris minor, Chenopodium album, Asphodelus, tenuifolius, Carthamus oxycantha, Convolvulus arvensis, Anagallis arvensis.*
- **Cotton :** *Cynodon dactylon, Echinochloa crus-galli, Eleusine indica, Digitaria spp, Cyperus rotundus, Digera arvensis, Corchorus spp, Leucas aspera.*
- **Jowar :** *Cynodon dactylon, Sorghum halepense, Dactyloctenium aegyptium, Eleusine indica, Cyperus rotundus, Solanum nigrum.*
- **Berseem** *: Chichorium intybus, Cuscuta reflexa, Digitaria spp.*
- **Rapeseed and Mustard :** *Chenopodiam.album, Spergula asvensis.*
- **Maize :** *Amaranthus spp, Cynodon dactylon, Eleusine indica, Digitaria spp, Eragrostis spp, Cyperus rotundus, Corchorus trilocularis, Digera arvensis, Phyllanthus niruri, Celosia argentea, Trianthema monogyna, Solanum nigrum, Commelina benghalensis.*
- **Sugarcane :** *Ageratum conyzoides, Sorghum halepense, Echinochloa colonum, Digitaria spp, Eleusine indica, Cyperus rotundus, Convolvulus arvensis, Amaranthus viridis, Digera arvensis*
- **Soybean :** *Cyperus rotundus, Cyperus iria, Phyllanthus niruri, Echinochloa crus-galli, Echinochloa colonum.*
- **Pea :** *Chenopodium album, Cheonpodium murale, Asphodelus tenuifolius, Fumaria parviflora, Anagallis arvensis, Cyperus rotundus.*
- **Chickpea :** *Asphodelus tenuifolius, Argemone mexicana, Carthamus oxycantha, Melilotus spp.*
- **Linseed :** *Cheonpodium album, Convolvulus arvensis, Asphodelus tenuifolius, Carthamus oxycantha, Cyperus rotundus.*
- **Jute :** *Corchorus acutangulas, C.rotundus, Cyperus iria, Euphordia hirita, Eclipta alba.*
- **Potato :** *Chenopodium album, Anagallis arvensis.*
- **Groundnut :** *Phyllanthus niruri, Amaranthus virdis, Dactyloctenium aegyptium, Eleusine indica.*

ACCORDING TO ONTOGENY (LIFE CYCLE) OF WEEDS

Weeds differ in their life cycle. Some weeds complete their life cycle in one season or year, some in two seasons or years and some more than two seasons or years. Thus, on the basis of life cycle they are grouped in three categories:

1) Annual Weeds

Those weeds which complete their life cycle, within a season, and are propagated mainly through seeds. According to their prevalence they are classified in two categories:

i) Summer/Monsoon season (Kharif) annuals:

Those weeds which complete their life cycle in warm season (June to October), e.g. *Echinochloa spp, Trianthema monogyna, Ammania baccifera, Cyperus difformis, Fimbristylis miliacea, Celosia argentea* etc.

ii) Winter (Rabi) annuals :

Those weeds which are prevalent in winter season and complete their life cycle during cool-dry season (October-November to February-March), e.g. *Phalaris minor, Chenopodium album, Anagallis arvensis, Poa annua, Asphodelus tenuifolius, Vicia sativa* etc.

2. Biennial weeds:

Biennial weeds complete their cycle in two seasons. They complete their vegetative phase in the first season and reproductive phase, flowering and seeds setting in second season. Weeds like *Daucus carota, Launia nudicaulis, Circium vulgare, Plantago* spp, etc. are common weeds of this category.

3. **Perennial Weeds:**

These weeds complete their life cycle more than two seasons or years, and may survive indefinitely. Perennial weeds propagate by seeds or vegetatively usually they are propagating by rhizome, stolons, bulbs, tubers, stems roots, suckers etc.They are of three types :

i) **Simple perennials**: They propagate solely by seeds, e.g. *Ipomea carnea* and *Lantana camara* etc.

ii) **Bulbous perennials**: They propagate by under ground parts like bulbs, bulbils,
e.g. *Allium vineale*.

iii) **Creeping perennials**: They reproduce by creeping stems that grow along the soil surface, e.g. *Cynodon dactylon, Paspalum distichum*, beneath the soil surface, e.g. *Convolvulous arvensis, Sorghum halepense* and by roots, e.g. *Ambrosia trifida Sonchus arvensis*. On the basis of depth of under ground roots and rhizomes perennial weeds are classisfied as shallow rooted creeping perennials e.g. *Cynodon dactylon, Agropyron repens*, and deep rooted creeping perennials, e.g. *Cyperus rotundus, Sorghum halepense, Imperata cylindrica*.

ACCORDING TO HABITAT

On the basis of habitat weeds are classified broadly in two groups :

A. Terrestrial weeds: These weeds are found in upland soil conditions other than water logged condition. These are further grouped in three categories depending upon their habit and association with soil, climate and with other plants which influence the habit and characteristics of weeds.

i) **Weeds of cultivated crops:** These weeds grow mainly in cultivated crops like *Chenopodium album, Echinochloa spp, Phalaris minor* etc.

ii) **Orchard weeds**: The microclomate of orchards being different than the cultivated crop field due to shade, humidity and excessive soil moisture and some of the weed species like *Cannabis sativa, Euphorbia geniculata, Ageragtum conyzoides, Oxalis corniculata* etc. find this type of habitat congenial for their growth and become troublesome.

iii) **Weeds of Lawns and Parks**: A large number of annual and perennial weeds are found in lawns and parks and deprive the natural beauty. Some common examples are *Imperata cylindrica, Eleusine indica, Desmodium triforum, Setaria intermedia, Medicago denticulata, Poa annua* etc.

B. **Aquatic weeds habitat** : Aquatic weeds habitat in water. They are of different types, and depending upon their location in water body they are classified as :

i) **Floating:** (a) Free floating, e.g. *Eichornia crassipes, Pistia stratiotes*

(b) Rooted floating, e.g. *Trapa bispinosa, Ludwigia adscendens*

ii) **Submerged**, e.g. *Hydrilla verticillata*

iii) **Emerged**, e.g. *Typha elephantina, Sagittaria sagittifolia*

iv) **Amphibious**, e.g. *Ranunculus aquatilis, Scirpus supinus*

ACCORDING TO NATURE OF STEM

I. **Erect:** Stem of such weeds stands upright and does not require any support, e.g. Chenopodium album, Panicum repens, Melilotus spp. etc.

II. **Prostrate :** Those weeds instead of being erect have short internodes that bear a crown of leaves borne directly on a root, e.g.Eleusine indica, Digitaria sangunalis, Portulaca oleracea, etc.

III. **Twining:** Those weeds, stem will round the support e.g. Cuscuta spp. Ipomoea quamoclit etc..

IV. **Trailing:** Such weeds stems spread on ground, e.g. Convolvulus arvensis, Ipomea pandurata, Citrallus vulgaris etc.

V. **Runner:** Such weeds stem grow horizontally along the ground. Usually there is development of roots at the nodes of stem, e.g. *Cynodon dactylon Ipomoea bilobba, Launia asplenifolia* etc.

ACCORDING TO STRENGTH OF STEM

Depending upon the strength and characteristics of stem weeds differ and their control measures also differ.

i) **Herbaceous weeds:** They are usually annuals and have soft, succulent and green stems, e.g. *Chenopodium album, Amaranthus virdis, **Echinochloa colon***

ii) **Bush weeds**: They are usually perennials and have very hard stem, e.g. *Lantana camara, Acacia arabica, Zizyphus rotundifolia*. Control measures of these weeds are different than herbaceous weeds.

ACCORDING TO MORPHOLOGY.

Weeds classified on the basis of morphology as their leaves and stems differ from one and another. This classification helps in prescribing herbicides for their control, particularly if they are growing in cropped field.

I. **Monocot** or narrow leaved needs such as *Echinchloa* spp, *Phalaris minor*, *Cynodon dactylon* etc.

II. **Dicot** or broad leaved weeds such as *Chenopodium album, Vicia hirsuta, Amaranthus* spp, *Trianthema monogyna* etc.

III. **Sedges;** such as *Cyperus* spp, *Fimbristylis miliaceae*

IV. **Filamentous,** such as *Chara Zeylanica, Nitella hyalina.*

ACCORDING TO ORIGIN

On the basis of origin weeds are classified into two groups:

- **Alien Weeds**: When a weed is allowed to move from the place of its origin to a new area, and it establishes itself there, it becomes introduced weed in its new environment. Such weeds are known as alien weeds or anthrophytes. e.g. *Eichornia crassipes* (water hyacinth), *Parthenium hysterophorus* (Congress grass or Carrot grass), *Argemone mexicana* (Mexican Poppy), *Lantana camara* (Lantana). All these weeds are very troublesome and difficult to be controlled. A list of important alien weeds are given in **Table 5**.
- **Native Weeds**: These weeds occur within geographical limit of their origin.

ACCORDING TO THE SITE OF PREDOMINANCE

i) **Obligate Weeds:** Those species of weeds which grow primarily in the cultivated land and never in the wild form, e.g.,*Chenopodium album, Anagallis arvensis.*

ii) **Facultative weeds:** Those weed species that grow primarily in uncultivated land, e.g. *Argemone mexicana, Euphorbia hirta, Opuntia* spp. The facultatine weeds are also called “apophytes”

ACCORDING TO SOIL REACTIONS

Depending upon the dominance of weeds in different pH soils weeds are classified in three categories

i) **Acidic soils:** These weeds are also called acidophile weeds, e.g. *Rumex acetosella, Pteridium aquilinum.*

ii) **Saline Soils** : These weeds are also called basophile weeds, e.g. *Cressa erecta, Sporobolus diander*.

iii) **Neutral Soils:** These weeds are also called neutrophiles. All weeds other than acidic and saline soils come in this category.

Table 5: The Origin of Important Weeds (After De bach, 1964)

Weed species	**Probable origin**
Alternanthera spp	South America
Convolvulus arvensis	Eurasia
Cirsium arvense	Europe, North Africa & Eastern Asia
Cyperus rotundus	Eurasia
Centaurea repens	New East
Eupatorium odoratum	West Indies and Tropical America
Euphorbia hirta	Europe
Eichhornia crassipes	Tropical America, Brazil
Hologeton glomeratus	Western Asia
Lantana camara	Central America/Tropical America
Opuntia spp.	Western Hemisphere/South America
Orobanche spp.	Europe
Pluchea sp.	South-western U.S.A.
Senecio jacobaea	Europe
Sorghum halepense	Southern Europe and Asia
Tribulus terrestris	Southern Europe/Africa/Medeterrian region
Ulex eluropaeus	Europe

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