I- Introduction

Weeds are intimately related to the activities of mankind. Without man there would be no weeds. Jethro Tull was among the first to use the word 'Weed' with its present spelling and meaning. Weeds have been defined variously as 'an undesirable plant','a plant with negative value' or 'plants which compete with crop for the soil'. Abundant seed production, dormancy, competitive ability, vigorous vegetative reproduction which helps them to spread and ability to survive in unfavourable growing conditions are the characteristics of weeds. Crop plants may also be considered as weeds if they are growing where they are not wanted as for example, asparagus in grapevineyards and orchards, rye in a wheat field or corn in peanut field is considered as a weed.

Man is probably responsible for the evolution of weeds as for the evolution of crops. Weeds are usually adapted to disturbed habitats and agriculture is the main cause for the rapid disturbance. Most of the modern weeds did not exist before agriculture. They have been evolved alongwith the crops and are in many instances, the ancestors of the cultivated varieties.

Weeds primarily affect the crop growth by sharing the light, nutrients, water and space. More water and nutrients are required to raise a ton of weeds than to raise a ton of most crops. Rapidly spreading and deeply penetrating root system enables them to obtain water and nutrients. Competition for light and space results in the reduction in photosynthesis and ultimately leads to the crop losses. The weeds account for about 9% loss in the annual agricultural productivity (Gruzdyev 1983). Many weeds such as quack grass, false flax etc. exude inhibitors from their living or dead roots which reduce crop growth. Many times weeds impart an off-flavour to milk. Serious illness or even death may be caused in cattle, horses and sheep due to an excessive amounts of poisonous constituents. Spiny weeds injure soft tissues of the mouth of cattle. Unripe seeds or stems of seeds may be harvested alongwith the cereal or legume crops and such contaminated seed stocks help in the spreading of weeds. Many weeds serve as alternate hosts for insects and fungi.

Weeds of the waterways reduce the stream flow, cause silt deposition and provide protection to rodents which burrow in the banks. Fishing, swimming and recreation may be almost eliminated by weed infestations. Boat transport is severly limited by aquatic weeds.

Many poisonous weeds cause allergies caused by pollen or contact with the leaves to human being. Seeds or fruits of certain species of weeds have been proved poisonous when present in flour or bread (Muzik 1970).

Control of weeds is as old as the growth of food crops. For centuries man fought weeds with hands, sharp sticks, and hoes. Slowly and steadily he learned to use tools, horse power, tractor power and chemicals to control weeds. Before 10.000 B.C. weeds were removed by hand and later on sharp sticks were used to uproot the weeds. The metal hoe was discovered many centuries later. By 1000 BC man started using animals like horse or ox to drag the hoe which reduced greately the human labour. After 1937, when planting of crops in rows was proposed, horse hoeing was introduced. Afterwards in the beginning of 20th century horses were replaced by mechanical powers such as tractors.

Sea salt was probably the first chemical to kill the plant life. About 1900, purified chemicals were used for selective weed control. The science of weed control has advanced more since 1947, after the discovery of 2,4-D (Klingman et al. 1982). Important events in the history of chemical weed control are summarised in Table 1.

The use of herbicides increased as man started concentrating more and more on crop production. Herbicides contribute significantly in increasing yields of the major food and fibre crops. To date there are about 400 herbicides which have been registered or being registered and form the active ingredients of commercial products.

It is true that herbicides have benifited the man in terms of increased food supply, however, these benifits are followed by many drawbacks.

Table 1. History of Chemical Weed Control

1959-1887	Julius Sachs	Reported that "Chemical messengers" were related to the flowering behaviour of begonias and squash.
1890	Charles Darwin	Observed light stimulated growth regulation effects.
1908	Bolley	Reported successful weed control in wheat using common salt, iron sulphate copper sulphate, lead arsenite.
1919	--	Sodium chlorate was first used for perennial weed control.
1933	--	The chemical messenger or plant hormone was identified as indoleacetic acid.
1941	R. Pokerny	Reported chemical synthesis of 2,4-D.
1942	P.W.Zimmerman & A.E.Hitchock	First reported 2,4-D to be a growth substance.
1945	W.G.Templeman	Established the pre-emergence principles of soil treatment for selective weed control.
1951	--	Organization of Weed Science Society of America and publication of "Weeds".

1961	--	European Weed Research council was published.
1968	--	National Acadamy of Sciences published "Weed Control", Principles of Plant and Animal Pest Control' Vol.2pb No. 1597.
1970	--	FAO of the United Nations organized 'The International Conference of "Weed control".
1976	--	Formation of International "Weed Science Society."

(Muzik 1970; Klingman and Ashton 1982).

Davis (1965) observed that the effects of the herbicide are shortlived in the soil and do not cause any long term changes in soil fauna, 2,4,5-T was being used as a defoliant in the Vietnam war and a high number of malformed babies were reported being born.

Among the diseases caused by herbicides and the pesticides the most remarkable one is cancer. Organochlorine chemicals normally accumulate in adipose tissue (Kasai et al. 1972, Unger and Olsen 1980) and induce leukaemia.

Several pesticides such as 2,4-D, MCPA, DDT, Hexachloro cyclohexane, DNOC, parathion etc. have been reported to cause cancers of lung, stomach, skin, bladder, rectum, kideny, oesophagus, gall bladder, epiglottis etc. or lymphoma (IARC 1974-1980).

MCPA a post emergence herbicide is detected in food items at ·4 mg/kg. In rats it developes abnormal histological changes (Gurd et al. 1975). No data is available of effects of MCPA on humans.

Soft tissue sarcomas in human beings exposed to phenoxy acetic acid herbicides such as 2,4-D and 2,4,5-T have been reported (Erikkson et al. 1981; Coggon and Acheson 1982).

Sheail (1985) has discussed the effects of herbicides on wild life, Forestry, aquatic system etc.

MODE OF ACTION OF HERBICIDES

When herbicide comes in contact with a plant its action is influenced by the morphology and anatomy of the plant as well as various physiological and biochemical processess that occur within the plant. These processes include absorption of herbicide, its translocation within the plant, molecular fate of the herbicide in the plant and effect of the herbicide on the plant metabalism. The interaction of these factors with the herbicide determines its effects on the plant. When one plant species is more tolerant to the chemical than another plant species, then the chemical is said to be selective. Herbicidal action might be described in simple term as the physiological and biochemical interaction of herbicide with plant.

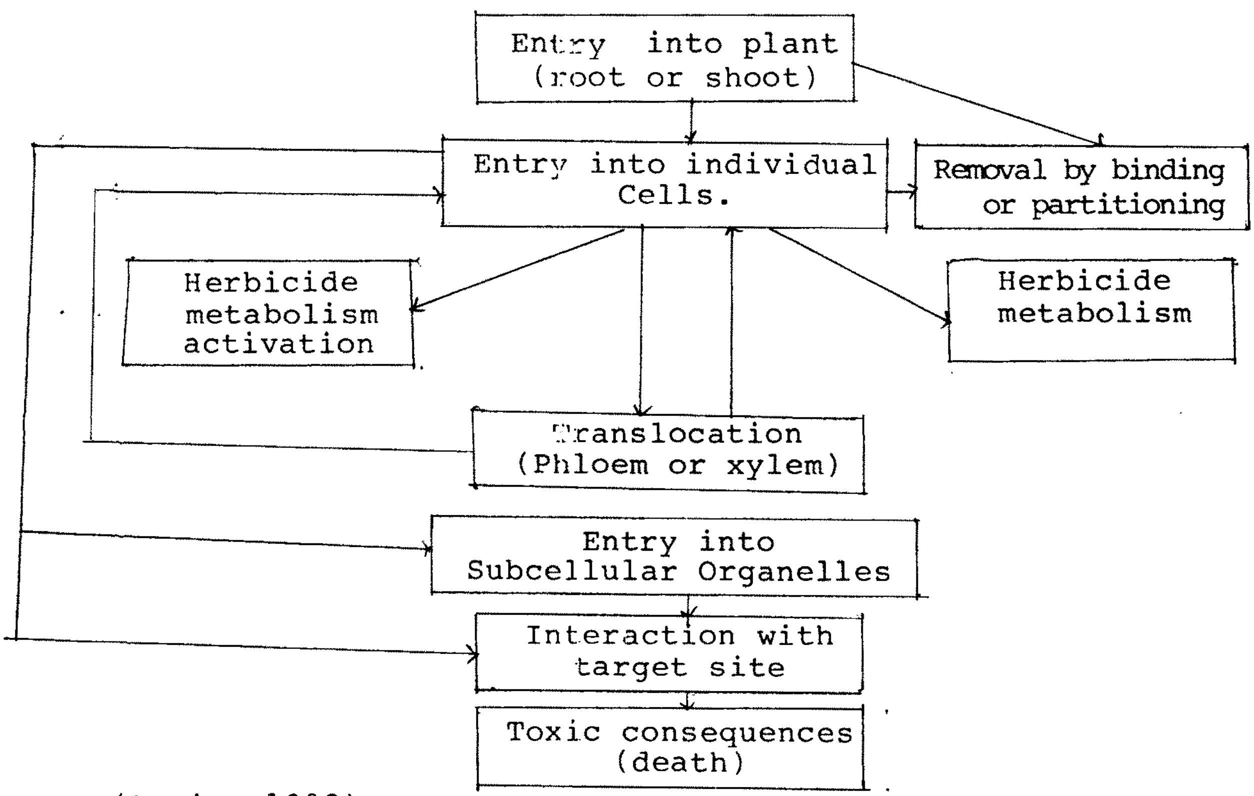
Entry of a herbicide in the plant depends upon its absorption by the plant surface and the chemical nature of the herbicide. Leaves and roots are the two most common ways for entering the herbicide in plants. Some herbicides are also absorbed effectively through the stems, coleoptiles, young shoots and seeds. After absorption herbicide is translocated within the plant through the symplastic system or the apoplastic system. Herbicide applied to the leaves or shoots usually follow the symplastic rout. They enter the phloem and move in the same manner in the plant as the photosynthates. Herbicides absorbed by the roots are translocated via apoplastic system and follow the same pathway as the water. They enter the xylem and move upword with the transpiration stream of the water and soil nutrients.

All types of herbicides including very toxic ones can be absorbed from the soil and quickly translocated to all parts of the plant. The xylem and cell wall are the principle components of apoplastic system and being non-living, the absorption of poisonous herbicides does not injure the xylem. Many herbicides are not restricited to either of these systems and involve both the symplastic and apoplastic translocation.

The molecular fate of a herbicide involves the changes in its chemical structure within the plant. These changes may increase or decrease the phytotoxicity of the chemical by activation or inactivation of a herbicide repectively. Molecular fate may also include degradation or conjugation with the normal plant constituents. A wide variety of chemical reactions such as oxidation, reduction, hydrolysis, decarboxylation, deamination, dehalogenation, dethiolation, dealkylation, hydroxylation etc. have been shown to be involved in higher plants which alter the molecular configuration of herbicides.

Plant metabolism includes numerous biochemical reactions occurring in the living plant cells. A herbicide may interfere with a single biochemical reaction or it may attack several reactions simultaneously. Photosynthesis, respiration, carbohydrate metabolism, lipid metabolism, protein metabolion, nucleic acid metabolism are the major biochemical reactions affected by herbicides. (Ashton and Crafts 1981).

Biochemical reactions are closely coupled and when one reaction is altered others are soon affected. Thus by disrupting any of these biochemical reactions, herbicids are able to upset entire metaboliom of the plant which ultimetely results in the death of the plant. The interaction of herbicide and the plant with the chain of events from the first contact of herbicide with the plant to its final effect are summarised in the following flow chart.



(Devine 1993).

Since the discovery of first synthetic organic herbicide in the 1940s, a great deal of work has been carried out to understand mechanism of the herbicidal action. There are about 100 herbicides that inhibit photosystem II electron transport, 37 that inhibit the branched chain amino acid synthesis, 32 that are active auxins, and 28 that interfere with microtubular synthesis or function. Several important sites of molecular action of herbicides including acetolactate synthase, acetyl COA carboxylase and protcporphyrinogen oxidase have been discovered recently. In some instances the study of mechanism of herbicidal action has contributed to our understanging of plant physiology and biochemistry.