CHAPTER-I
INTRODUCTION

Cotton (*Gossypium* sp.) belongs to the family Malvaceae. It is an important commercial fibre crop grown under diverse agro-climatic conditions around the world. It provides fibre, an important raw material for textile industry. Every part of the cotton plant is useful to Indian farmers in one way or the other. The cotton seeds provide protein (20%), oil (20%), starch (3.5%) and their cake is used as cattle feed. Fibres grow from the seed coat to form a boll of cotton lint. The boll is a protective fruit and when the plant is grown commercially, it is stripped from the seed by ginning and the lint is then processed into cotton fibre. The seeds are about 15% of the value of the crop and are pressed to make oil and used as animal feed. The seed oil extracted from the kernels, after being refined serves as a good edible and nutritious source. It can be used as a cooking oil, salad dressings. It is also highly beneficial for the production of shortening and margarine. The fine quality oil extracted from cottonseeds during the extraction process is also used in cosmetic products moisturized. Therefore, the oil is used in moisturizing lotions and bath soaps. Cotton grown for the extraction of cottonseed oil is one of major crops grown around the world for the production of oil, after soy, corn and canola used for medical purposes also. The cottonseed meal after being dried up can be used as a dry organic fertilizer. The stalks are used as fuel and the leaves falling on the ground increase the content of organic matter in the soil.

Cotton is known as “white gold” and premier commercial crop in India, which occupies only five per cent of the arable land and supports sixty million people having direct bearing on the country’s economy. India is a unique among the cotton growing countries of the world in which four species of lint bearing *Gossypium* *viz.*, *G. hirsutum*, *G. barbadense*, *G. herbaceum* and *G. arborium* are growing commercially under diversified ecosystem. Maharashtra, Gujarat, Punjab, Madhya Pradesh, Andhra Pradesh, Haryana, Rajasthan and Tamil Nadu are the major cotton growing States.

In India, it is cultivated in area of about 126.55 lakh hectares with production of 400.0 lakh bale and productivity of 537 kg ha\(^{-1}\), (Anon. 2014\(^a\)). Whereas in Gujarat, it is cultivated in area of about 30.06 lakh hectares with production of 125.0 lakh bale and productivity of 707 kg ha\(^{-1}\), (Anon. 2014\(^b\)).

Modern weed science combines basic and applied science in the study of weeds, typically defined as plants that are objectionable or interfere with the activities or welfare of
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humans. Although weeds have been associated with human activity since the beginning of crop cultivation, the history of weed science parallels the history of modern day agriculture and is less than 100 year old. From an early emphasis on chemical weed control, the field of weed science now integrates preventive mechanical, chemical and biological measures in the management of weeds. Weeds cause tremendous economic costs to agriculture and natural resources in terms of crop loss, loss of land utility, health-related problem and the costs of control.

A recent study undertaken by National Research Centre for Weed Science, Jabalpur suggest that nearly one-third of oilseeds, half of the food grains and equal amount of pulses produced currently are lost due to weeds and proper weed management technologies if adopted can result in an additional production 103 million tons of food grains, 15 million tons of pulses, 10 million tons of oilseeds and 52 million tons of commercial crops per annum, which in few cases are even equivalent to the existing annual production. This amounts to an additional income of ₹. 1,05,036 crores per annum (NRCWS, 2007). At a conservative estimate, an amount of ₹. 100 billion is spent on weed management annually in India in arable agriculture alone. The potential yield losses due to weeds can be as high as about 65 percent depending on the crop, degree of weed intensity, weed species and management practices (Yaduraju et al. 2006)

There are some production problems in cotton cultivation. Weed infestation timing also affects cotton yield. Early weed infestation in cotton crop is one of the major constraints limiting the establishment of crop and thereafter its production. Competition in the early stages of plant growth is of more concern than weed infestation later in the year. Some weeds, such as broadleaf weeds, germinate and grow quickly. These weeds can establish root systems quickly and use much of the water and nutrients resulting in cotton plants not being able to develop (Chandler, 1983). Cotton losses due to the presence of weeds may occur in several ways, although damage caused is not always as obvious as losses caused by other pests. These losses occur at various stages in the cotton production cycle. Weeds (a) reduce seed cotton yields; (b) reduce the quality of the cotton fiber; (c) increase production costs (costs of hand weeding, mechanical tillage, fertilizer and herbicides); (d) impede efficient irrigation and water management; (e) reduce market value of the land; (f) serve as hosts and habitats for insects, disease-causing organisms, nematodes and rodents; and (g) can cause allergenic reactions in humans. Under the present situation of non-availability of labour for timely weeding and high costs involved therein, it has become very difficult to maintain
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cotton crop free from mixed flora of weeds particularly in the initial stage of growth. Hence, herbicidal control of the weeds could assume greater significance. Day by day weed control through herbicide is increasing and popularizing among farmers. A number of herbicides are recommended for field crops in the intensive cropping system may lead to residue accumulation in soil. This causes considerable health hazards and environmental pollution. Therefore, persistence studies are essential to determine the duration of herbicidal efficacy and effect on follow up crop.

Some herbicides bind strongly (adsorb) to soils and therefore, are not easily removed. Clay minerals and organic matter favour strong adsorption. Use soil analysis information on soil texture and organic matter content when selecting pre-emergence herbicides and application rates. Herbicides that are highly soluble in water have increased leaching potential. However, leaching of an herbicide can be minimized by proper herbicide application rate, timing and method of application. Choose the right herbicide and rate for prevailing situation. Herbicide degradation by natural processes is highly dependent on both the herbicide class (chemistry) and environmental factors. Sunlight, temperature, soil pH, microbial activity and other soil characteristics affect the breakdown of herbicides. Some herbicides break down slowly and therefore have greater potential for leaching. On the other hand, short-lived herbicides may be degraded before any leaching occurs. Choosing a short-lived herbicide when practical can minimize leaching potential. Microbial degradation occurs when fungi, bacteria and other soil microorganisms use herbicides as a food (energy) source. High organic matter along with other properties such as optimum moisture, aeration, temperature and soil pH can enhance microbial degradation. In addition, chemical degradation of herbicides can occur by reaction with water, oxygen and other chemicals. In general, herbicides that are highly water-soluble, relatively persistent and not readily adsorbed by soil have the greatest potential for leaching.

What is a residual herbicide and herbicide persistence?

Herbicide breakdown requires sufficient time under adequate moisture and soil temperature to support the growth of microbes that degrade herbicide molecules. Some herbicides are broken down quickly or are bound tightly to soil, preventing them from causing problems for crops that are planted the following season. Other herbicides take longer time to decay, and as a result, persist into seasons following the year they were
applied. These residues can injure sensitive crops that are seeded in following seasons. Herbicides that have restricted recropping options are considered residual herbicides.

The residual problem due to the application of herbicides poses a threat towards widespread use of herbicides and limits the choice of herbicides to be chosen in a crop rotation. An ideal persistence of a herbicide in soil on crop land is the all that brings about selective control of weeds for sufficiently long period to give competitive advantage to the crop but, at the same time, allows the herbicides to dissipate from the soil before the close of the crop season so that rotation crop could be plant safely (Gupta, 2000).

The length of time a herbicide remains active in soil is called "persistence," "residual life" (Figure). For some herbicides, there may be a fine line between controlling weeds for the entire growing season and then planting a sensitive rotation crop. Certain rotational crops (e.g. potatoes) are extremely sensitive to herbicide carry over, particularly the residues of persistent herbicides. Accurate quantification of herbicide residues are essential as it may also do harm to humans and animals through both water and food. Currently, detection of herbicide residues mainly relies on methods such as gas chromatography, high performance liquid chromatography and gas chromatography mass spectrometry in advanced countries. Although these techniques are reliable, they are relatively expensive and time consuming because of multistep sample cleanup. Furthermore, the results of chemical analysis do not tell what the effects will be on the next crop. (Pahwa and Bajaj, 1997).

Bioassay is a major tool for quantitative and qualitative determination of herbicide residue. In this method, the property of a chemical is measured in terms of some biological responses. Sensitive plant species called as indicator or test species are used for conducting bioassay. The major advantages of this techniques is that the procedure followed is generally more economically and easy to perform, costly equipment are not required. The indicator plant is grown in a field and pot and is compared with that of similar plant grown in untreated soil. Bioassay methods allow for a rapid assessment of “biologically active” materials throughout a soil core. However, the herbicide could be chemically present, but
because of soil binding, might not be biologically active; or, a biologically assessment might be that result of two or more chemicals interacting.

**Practical utility of the research problem:**

The judicious use of herbicides in crop land generally results in increase crop yield, improve crop quality and reduce production costs. Therefore, herbicides used alone or in combination with other weed management techniques reduce weed crop competition and the risk of weeds growing unchecked in period of adverse weather or soil condition and residue accumulation in soil due to the application of herbicides poses a threat towards widespread use of herbicides and limits the choice of herbicides to be chosen in a crop rotation. Certain rotational crops are extremely sensitive to herbicide carry over, particularly the residues of persistent herbicides. Accurate quantification of herbicide residues is essential as it may also do harm to humans and animals through both water and food. Taking note of the facts highlighted above, a field experiment entitled “Efficacy of various herbicides in Bt cotton (*Gossypium hirsutum* L.) and determination of their persistence through bioassay technique” is proposed to undertaken at Instructional Farm Junagadh Agricultural University, Junagadh, during *Kharif* season of 2013-14 & 2014-15 with following objectives.

**Objectives:**

I. To study the effect of different treatments on growth, yield attributes, yield and quality parameters of cotton.

II. To evaluate the efficacy of different herbicides for control of weeds in cotton

III. To study the persistence of herbicides through bioassay technique

IV. To determine residual phytoxicity of different herbicides on succeeding summer crops.