CHAPTER - I

GENERAL INTRODUCTION
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Weeds are ‘plants out of space’ or to be more explicit ‘plants other than the crop sown’ (Brenchley, 1920). They are unwanted, non-useful, often prolific and persistent plant species, which interfere with agricultural operations, add to cost and reduce yield of crop (Robbins et al., 1953).

Weeds interfere with the utilization of land and water resources in crop fields as they adversely affect the crop productivity. In addition, the ruderal weeds growing in wastelands, road sides, and other disturbed habitats cause a serious threat to the local flora and a large number of native species are in the process of extinction. Weeds not only compete with other plants for resources but they also reduce the land value, choice of crop and human efficiency through physical discomfort caused by allergy and poisoning (Rao, 1983). Some of the weeds serve as alternate host to several crop insects, nematodes and pathogens. The effect of the weeds on crop plant increases by hosting these insects and pathogens.

Despite of all these losses, weeds are regarded as an essential component of the ecosystem by several ecologists. As Salisbury (1961) suggests “An aggressive weed in one environment may be delightful wild flower in another”. Thus the value of the weed is determined simply how the viewer perceives it (Radosевич and Holt, 1984). Tripathi (1977) has emphasised the beneficial role of weeds as soil binder, soil fertility improver, suitable agro niche creator and pest attack discourager. He further stressed the need of bringing the weed population under subjection but not the complete elimination. A thorough understanding of the ecology of weeds should be needed to achieve this goal.
It is necessary to have a knowledge of the organisms and the environment of any habitat for understanding the exchange and interdependencies involved between the environment and organisms. Thus the study of individual species and its populations are important in understanding the kinds and extent of plant responses at various stages of its life cycle to the variation in stresses of environmental components. Such type of study is known as autecology.

Studies on autecology is a pre-requisite for detailed understanding of the communities which develop as a result of organisation of individual species. A proper perspective of the community is not possible without autecological studies of dominant species (Tansley, 1949). Mishra (1957) also emphasised the significance of autecology in the correct assessment of ecological niches in any ecosystem. Greater emphasis has been given on the importance of autecological studies to the applied plant sciences especially forestry, range management, soil conservation and weed control (Sampson, 1917; Phillips, 1927; Olmsted, 1941; Duncan, 1952). Studies on autecology of weeds which can provide answer to eradicate or control their population is of paramount significance.

The autecological studies of plants were first carried out in Europe (Olson, 1921; Mukherji, 1936). Realizing their importance, Salisbury (1928) emphasised the publication of ‘Biological Flora of British Isle’. This was adopted by the British Ecological Society and since 1951, the ecological life histories of plants are appearing as a regular feature in ‘Journal of Ecology’. Some of the important contributions to this feature are Stevens (1957), Thurston (1959), Welblank (1963), Williams (1963), Pancho (1964), Schriber and Oliver (1971), Summerfield (1974), Holm et al., (1977).
In India, earlier contributions on the autecology of plants were made by Dastur and Saxton (1922), Tadulingam and Cheriyan (1924) and Mukherji (1936) in the form of autecological notes. Later on, because of the economic importance of certain tree species, their autecological studies were carried out. Some of the important contributions made are those of Smythies (1963), Prasad (1943), Kadambi (1949), Bhatia (1955), Jones et al., (1963), Kotwal (1973) and Verma (1976). The autecological studies of weeds, however, were initiated by Mishra and Rao (1948) followed by Bakshi (1952), Mall (1957), Kaul (1959), Ambasht (1963), Tripathi (1965), Pathak (1967), Lavana (1971), Sant and Lalman (1975), Gupta (1976), Kumar and Singh (1979), Nair (1981), Ambasht (1984). Ambasht and Lal (1978) have reviewed autecological findings on weeds.

Phytosociological analysis of a plant community is the first and foremost basis of the study of any piece of vegetation. The vegetation complex fluctuates from season to season and year to year. This fluctuation suggests a response by each species of population to the incoming heat, moisture and light as modified by vegetation itself (Heady, 1958).

Dry matter production is the key function in ecological life of a plant. Dry matter production by the plants always constitute the basis for further studies in production ecology (Leith, 1968). Studies of biomass allocation in plants have revealed several general features of resources partitioning (Hickman, 1975; Struick and Bray, 1976).

Besides the energy from sun for the production of biological material, plants require nutrients, out of which nitrogen is the most important one. Several workers have analysed nutrients in both plants and soil (Allison, 1965; Hirose, 1971; Harner and Harper, 1973; Kummerow et al., 1980).
These studies help to analyse the nutrient uptake and retention by plants and how much is being released into soil medium by decomposition.

Soil is the major source and vast reservoir of plant nutrients in an ecosystem. To support the efficient growth of the land plants, the soil should be adequately fertile and the fertility depends upon the combined effects of several physical, chemical and biological factors, which are closely interrelated with one another (Mulder et al., 1969). Hence, the study of soil system forms a vital part of the study of productivity and nutrient dynamics of terrestrial communities.

Distribution of any plant species at particular habitat is influenced by seed germination (Went, 1957). Seed germination is an important phase of the ecological life history of a plant. A good deal of work has been done by several workers on various aspects of seed germination (Newman, 1963; Shetty, 1967; Fenner, 1980, 1985; Williams, 1980). Some plants by virtue of their nature produce some chemical compounds which cause harmful or allelopathic effects on other plants. Allelopathic studies on several plants species have been observed by Rice (1968, 1974); Rajan (1973); Kohli and Batish (1994); Adkins and Sowerby (1996); Oudhia and Tripathi (1998) and others.

For the present study, *Parthenium hysterophorus* L. was selected for its ecological studies with a view of knowing the critical stages of its growth in different climatic conditions.

*Parthenium hysterophorus* L. is an exotic, noxious terrestrial weed which has covered vast area in India since 1956 and has been declared a national health hazard. It is commonly known as parthenium weed in Australia; bitter weed, carrot weed, broom-bush and congress weed in India;
white top, escobar amarga and feverfew in West Indies; false ragweed and ragweed parthenium in U.S.A. (Navie et al., 1996).

Parthenium weed probably originated in the area surrounding the Gulf of Mexico or in Central South America. In North America, South America and West Indies, it is widespread and has probably spread from its original range as a result of anthropogenic disturbances (Hammerton, 1981). From North America this weed has been introduced to South Africa, Madagascar, Kenya, Mozambique, Mauritius, Rodriquez, the Seychelles, Israel, India, Bangladesh, Nepal, China, Vietnam, Taiwan, Australia and many South Pacific Islands (Towers and Mitchell, 1983; Joel and Liston, 1986; Njoroge, 1989).


It is believed to have entered India through PL-480 wheat imports from America. It was first reported by Rao (1956) as a new record for the country, but Bunnet et al., (1978) traced its entry into India in 1810 and explained that the plant was surviving in obscurity for about one and a half century till Rao (1956) reported it. Later on, it has spread to several states (Maheshwari, 1966; Krishnamurthy et al., 1977; Rao, 1979). It was not reported from North India till 1979 (Sharma and Tiagi, 1979). In India, *Parthenium* has encroached on cultivated pastures and grasslands and
reduced the yield of grass forage to about 10% (Jaychandra, 1971). This is also a serious weed of crops and orchards throughout India as well as in many other countries around the world (Gupta and Sharma, 1977; Pandey and Dubey, 1991). Khosla and Sobti (1979) stated that the weed invades all sorts of crop in India, causing a subsequent loss of yield. In Gorakhpur, the weed is very common along the roadsides, railway tracks and irrigation canals and on vacant lands, abandoned cultivated fields, agricultural fields, play grounds etc.

*Parthenium hysterophorus* L. is included in family Asteraceae, tribe Heliantheae and sub-tribe Ambrosinae. It is an annual weed exists as a rosette in its early stage of growth. The stem of weed then elongates rapidly and starts branching. Mature plant is erect, much branched, up to 2 meter or more in height, stem hairy, octagonal and longitudinally grooved; leaves simple, alternate, pinnately or bipinnately dissected, 20-30 by 12-25 cms, becoming smaller towards the apex of the branches. Large lower leaves spread radially on the ground forming mats and not allowing any vegetation underneath. The stem and leaf surface is covered with glandular or non-glandular, multicellular white trichomes (Rodriges et al., 1976). These trichomes contain sesquiterpenes which cause skin allergy. This weed also produces a long taproot (upto 30cms deep) which enable it to obtain water from deep within the soil profile. In addition, this taproot stores energy resources for rapid regrowth, if the plant is slashed or grazed. The heterogamous capitula are terminal as well as axillary, corymb like, ending in scorpoid uniperosus cyme. Each capitulum is pentangular, creamy-white, having five fertile ray florets. About forty fertile disc florets are also present. The ray florets are pistillate, zygomorphic, epigynous 2.0-3.5 mm in length, urceolate, corolla lobes indistinct. Gynoecium bicarpellary, syncarpous.
unilocular, ovary inferior, placentation basal, style single, stigma bifid; bract abovate and transparent. The fertile disc florets are staminate, actinomorphic, epigynous; coralla five lobed; stamens five and syngenious; bract oblanceolate, boat shaped. The sterile disc florets are neutral. The dried ray florets having mature seeds are shed along with two sterile disc florets and subtending bract as a unit called achene complex. Seeds are small, flattened, triangular and dark brown. As many as 25,000 seeds are produced from an average sized plant.

One of the major derimental effects of Parthenium and a reason for its aggressiveness, is its allelopathic effect on the plants. In many studies, water soluble phenolics and sesquiterpene lactones, mainly parthenin, have been found in the roots, stem, leaves, infloresence, achenes and pollen of Parthenium (Kanchan and Jayachandra, 1979, 1980a; Jarvis et al., 1985; Patil and Hegde, 1988; Pandey et al., 1993). These chemicals have been observed to exhibit an inhibitory effect on both the germination and growth of a wide variety of plants including pasture grasses, cereals, vegetables, other weeds and even the tree species (Nath, 1981; Srivastava et al., 1985; Mersie and Singh, 1987, 1988; Swaminathan et al., 1990). Research has shown that the growth and nodulation of legumes is also inhibited by the weed (Kanchan and Jayachandra, 1981; Dayama, 1986). Kanchan and Jayachandra (1980 b) have reported that pollens of parthenium weed can have an adverse effect on the chlorophyll content of leaves into which it comes into contact, and can interfere with the pollination and fruit set of nearby species. Tower et al., (1977) reported that heavy deposition of parthenium weed pollen on the stigmatic surface caused a 40% reduction in the grain-filling of maize and claimed that as a result, the weed may still exhibit an inhibitory influence on crops even when growing at a considerable distance from cultivated fields.
Such detrimental toxic effects are not limited to plant, and it has been observed that a wide variety of organisms are influenced by the allelopathic substances produced by parthenium weed. Meghraj et al., (1987) found that when dried leaf powder of parthenium weed was placed in the soil, the native algal flora was inhibited, as was the growth of nitrogen-fixing bacteria in culture in experiments conducted by Kanchan & Jayachandra (1981). Luke (1976) noticed a general suppression in the growth of fungal species in the rhizosphere of parthenium weed and concluded that root exudates can influence the composition of the soil microflora near the weed's root.

Although parthenium weed is usually avoided by stock as it is toxic to animals but in situation where the weed forms almost pure stands, animals may consume significant quantities of it. Studies in India on the toxicity of the weed to cattle and buffaloes have shown that a significant amount (10-50%) of the weed in the diet can kill these animals within 30 days (Narasimhan et al., 1977a, b, 1980; More et al., 1982). In such cases the animal often develop dermatitis with pronounce skin lesions, became highly emaciated and eventually died due to the rapture of tissues and haemorrhages in their internal organs (Ahmed et al., 1988). Narsimhan et al., (1980) found that by the end of six weeks period all three bull calves that were fed a diet of 5% parthenium weed had died.

One of the most detrimental effects of parthenium weed is the human health hazard that it poses. Those who have continual close contact with the weed can develop allergic eczematous contact dermatitis. Parthenin is the causative agent of this reaction, and is one of the very reactive toxic class of compounds known as sesquiterpene lactones (Tower, 1981). The flower head of parthenium weed can contain upto 8% of their dry weight as
sesquiterpene lactones, with parthenin being the major component (Rodriguez et al., 1976). There has been an epidemic of hundreds of cases of pathenium weed dermatitis in India and several cases have been reported from the U.S.A. (Rao, et al., 1977; Tower, 1981). The contact allergy can be developed from repeated contact with the weed or its disseminated parts, and can be perpetuated in sensitized individuals by air-borne pieces of dried plant material, such as trichomes (Tower, 1981; Towers and Mitchell, 1983). Patients with severe dermatitis suffer fatigue and weight loss and about 12 deaths have occurred in such severely affected patients (Lonkar et al., 1974). Complete remission of the disease was observed when patients were transferred to an area not infested with parthenium weed.

The pollen of parthenium weed has also been observed to cause allergic rhinitis (hay fever) and allergic bronchitis (asthma) in humans (Lonkar et al., 1974; Parsons and Cuthbertson, 1992). Lewis et al., (1991) stated that parthenium weed was a major allergen despite producing significantly less ambient pollen than other allergenic species (e.g. Ambrosia sp.) and they suggested that this may be due to the higher allergenicity of parthenium weed pollen toxins or the longer season over which parthenium weed pollen is present in the air.

Despite several detrimental effects on plants, animals and human, the weed is reported to have some beneficial properties.

Parthenium weed may be a useful source of potash and oxalic acid (Mane et al., 1986; Parsons and Cuthbertson, 1992). The weed is also a good source of easily extractable, high quality protein that can be used in stockfeeds and resembles products made from conventional forage species (Gore and Joshi, 1972; Savangikar and Joshi, 1978).
The sesquiterpene lactones present in this weed deter insect feeding and exhibit oral toxicity to insects, hence the plant may have some potential as an insecticide source (Ahmed and Bhattacharya, 1991; Parsons and Cuthbertson, 1992). The allelopathic nature of the weed has also led to studies on the use of extracts from parthenium weed to inhibit the growth of other weed species (Mersie and Singh, 1987; Pandey et al., 1993). Khosla and Sobti (1979) noted that parthenin extracted from parthenium weed seems to have a greater inhibitory effect on monocots than on dicots and suggested that it could be used selectively to control monocot weeds.

The antifungal activity of parthenin may also lead to its utilization as a fungicide. Patil and Hegde (1988) noted that parthenin inhibited the growth of *Aspergillus* spp. and suggested that it could, therefore, be exploited in agriculture. Similarly, Ganeshan and Jayachandra (1993) observed that parthenin had the ability to inhibit the germination of several species of pathogenic fungi.

Parthenin also has many medicinal properties. Mew *et al.*, (1982) demonstrated that sub-lethal doses of parthenin exhibited antitumour activity in mice, and that the drug could either cure mice completely or increase their survival time after they had been injected with cancer cells. Other authors have found its antiamoebic activity to be comparable to standard drugs in fighting hepatic amoebiasis (Sharma and Bhutani, 1988). Uphof (1959) noted that a decoction of the boiled roots of parthenium weed is used by South American Indians to cure dysentery. Mexican chemists have reported that parthenin is also pharmacologically active against neuralgia and certain types of rheumatism (Dominguez and Sierra, 1990).

In the Caribbean and Central America parthenium weed is used as folk-remedy. It is applied externally on skin disorders and the bitter
decoction of the plant is often taken internally as a remedy for a wide variety of ailments (Dominguez and Sierra, 1970; Mortan, 1981). In Jamica the decoction is prized as a flea-repellent bath for dogs and other animals (Morton, 1981).

A knowledge regarding the autecological studies of *Parthenium hysterophorus* L. is very little, of course, some works have been done on the allelopathy. In the present investigation, conducted between August 1999 and August 2001, an attempt has been made:

1. To Study the distribution pattern of the weed under diverse ecological conditions.
2. To study the various phytosociological characters of the weed.
3. To study the growth behaviour and phenology.
4. To find out the productivity ability of the weed.
5. To study the nitrogen status.
6. To find out germination ability of the weed under various environmental conditions.
7. To study the allelopathic aspects.
8. To find out suitable control measures to check the rapid spread of the weed in various parts of Gorakhpur.