Soil characteristics, moisture amount, precipitation pattern, crop rotation, temperature, altitude, fertility, weed control technology and other factors interact to determine weed flora and intensity. Generally, weeds causing significant losses in lentils are categorized as annual monocots, annual dicots, perennial monocots, perennial dicots and parasitic. *Avena, Lonium, Phalaris, Poa, Setaria,* monocots and annual grass (*Poaceae*) are commonly reported in lentils. Perennial weeds belonging to *Convolvulaceae, Asteraceae, Poaceae* and other families are also problematic in lentil crop. *Orabanche* and *Cuscuta* spp. have been reported to be parasitic weeds of lentil. Generally, weeds emerging before or at the time of crop emergence have a greater competitive advantage than those emerging later. Slow emergence, short plant height and late canopy cover of cool season legumes in general and lentils specifically, allow weeds to compete effectively. A study by Moes and Domitruck (1995) showed average emergence of lentils, chickpeas, dry peas and wheat of 21, 23, 18 and 17 days after planting, respectively, in a no-tillage system. Moreover, the same study showed average canopy closure of 62, 69, 56 and 53 days after planting for the same respective species. Slower crop emergence and canopy closure provides opportunity for weeds to germinate and establish with little competition from the crop.

Singh *et al.*, (1996) indicated that weeds could be allowed to grow in lentil from 34 or 41 days after emergence with crop yield losses not greater than 10%. This research was conducted at four non-irrigated locations in Jordan and concluded that crop yield losses were not greater than 10% when weeds were controlled from emergence up to 85 or 99 days after emergence. Mohamed *et al.*, 1997 observed that critical weed-free period between 2 and 4 weeks after seedling in Sudan under irrigation.

Seeding depth, rate and row spacing influence lentil establishment, competitiveness and yield. Seeding at 3-5 cm depth increases plant emergence, height, plant dry weight and grain yield compared to seedling at 8-10 cm. Greater seeding rates also reduce weed populations due to greater crop competitions. Narrow row spacing theoretically improves crop competitions against weeds as the lentil crop reaches full canopy closure earlier than with wider spacing. However Chaudhary and Singh (1987) found no effect of row spacing on final weed populations. Although the crop is likely to be less competitive with weeds with
wider row spacing, wider spacing can allow more efficient weed removal by tillage or hand weeding.

In some areas of the Indian subcontinent, lentil may be grown in rotation with millet, sorghum, maize, cotton, guar, sesame or rice. In other areas, lentil may be grown in rotation with wheat, barley or forage crops. Lentil is not grown to provide a weed control benefit. Moreover, lentil could become a liability with regards to weed control because of the increased weed – seed production due to poor competition (Ali et al., 1993; Yenish, 2007).

The seeds of *Lathyrus aphaca*, *Vicia sativa* and *V. Hirsuta* are such in shape and size that their separation from lentil is difficult. These weeds hence pose a serious problem in seed production and processing. *Saccharam spontaneum* and *Asphodelus tenuifolius* are also posing serious threats in lentil cultivation in light and dry soils in Bundelkhand region, South Haryana, Northern and Central M.P. *Cichorium intybus*, *Medicago denticulate* and *Convolvolus arvensis* are also the emerging problem weeds in winter legumes. In lentil parts of Madhya Pradesh, Tamil Naidu and Chattisgarh also weeds are a huge problem. *Orobanche* spp is most severe in Lentil in Europe and Asia. The 30% of the cropped area in Egypt is infested with *Orobanche* of which 50% is considered very serious. *O. ramosa* is a serious weed of beans and peas in Egypt, of chickpea and lentil in the near and middle east and of several legumes in Czechoslovakia, Italy, Egypt, Australia and Hungary. The planting of beans and peas has been abandoned in some areas of Malta, Morocco and Sicily due to severe infestation of crops with *O. ramosa*. The growth of parasitic plant biomass below ground is so vigorous at times that it may weigh several times more than crop to which it attached. Delayed sowing of lentil and chickpea is also reported to reduce the infestation of *Orobanche*– a root parasite (Linke and Saxena, 1989).

There are five recognized weed control techniques. These include preventive, cultural, mechanical, chemical and biological. Mixing two or more of these weed management principles is the basis for integrated weed management. Each of the five principal techniques is of equal value in managing weeds in lentil with the exception of biological control. Few biological methods of weed control have proven effective in annual cropping systems and individual weed species which are problematic in legumes are largely a function of cropping systems or rotation rather than the individual crop of lentil (Anderson, 1983).

Cultural practices are generally applied within, between, and throughout the crop rotation. Unfortunately, lentil is usually the weakest competitor in the rotations in which they
are grown. Lentil provides little to no opportunity for cultural weed control with the rotation. Tepe et al., (2005) reported minor differences in competitiveness between cultivars, but indicating that none of the cultivars were really effective as a ‘stand – alone’ component for weed control in lentils. McDonald et al., (2007) also showed that differences in early vigour between genotypes were insufficient to affect the competitive ability of lentil.

Mechanical practices range from tractor-powered tillage to weed removal by hand hoeing or pulling. Pulling weeds by hand or removal by human-powered equipment such as a wheel hoe is common in less industrialized countries (Knott and Halila, 1986; Bhan and Kukula, 1987 labour costs are becoming prohibitive for hand removal of weeds. However, mechanical control of weeds in lentils after crop emergence is largely limited to hand weeding only. Up to five mechanical weed removals have been necessary to ensure weed-free conditions in lentils (Bhan and Kukula, 1987; Solh and Pala, 1990).

Chemical weed control is synonymous with using herbicides to control weeds. Herbicides that are effective for controlling the weed spectrum in one particular lentil production system in one particular geographic area may have limited activity against weeds in another production system due to poor efficacy or soil persistence. Thus, discussing specific herbicides is somewhat pointless as recommendations for one country may be ineffective or illegal in another country or even different regions of the same nations. Readers need to be aware to follow all local laws and regulations, seeking out specific recommendations from local agronomists, extension personnel or other qualified individuals or entities.

Non-selective herbicides may be used alone or as an aid to tillage in controlling weeds prior to planting or emergence of grain legumes (McKay et al., 2002). Often residual herbicides are applied prior to planting lentil (Bhan and Kukula, 1987). These residual herbicides will provide control against weeds that emerge over the following few days to several weeks following herbicide application.

Ideally, residual herbicides will provide effective weed control from time of application until the lentil crop progresses beyond the critical weed-free period or the full bloom stage as noted earlier. Herbicides that have provided effective broadleaf-weed control with no or acceptable crop injury include several dinitroanalines (trifluralin, pendemethalin and others), triazines (metribuzin), acetanalides (metolachlor) (Bhan and Kukula, 1987; Solh and Pala, 1990) and imidazolinones (imazethapyr) (Lyon and Wilson, 2005). Often, it is
necessary to combine or tank-mix one or more herbicides in order to broaden the spectrum of weeds controlled (Bruff and Shaw, 1992; Hydrick and Shaw, 1994; Zhang et al., 1995).

Post emergence herbicides available for lentils are very limited relative to the number of products available for more widely grown legume crops such as soybean (Zollinger, 2006).

Chemical weed control is employed mostly in large scale intensive agricultural systems where labour costs are high and a majority of the farm operation is mechanized. It is most effective when used as a part of an integrated weed management package including cultural methods described above and crop rotations, particularly as the repeated use of any one effective herbicide may result in development of resistant weed types. For example, Maurice and Billet (1991) observed that green foxtail (*Setaria viridis*) became resistant to trifluralin and ethalfluralin in southern Manitoba in Canada following their repeated use in lentil-wheat-flax-canaflour cropping system. Similarly in Australia there is widespread resistance of annual ryegrass (*Lolium rigidum*) to chemicals such as haloxyfop, trifluralin and clethdim (Day et al., 2006).

Most herbicides, particularly residual, can cause significant crop damage (Saxena and Wassimi, 1980; Yasin et al., 1995; Nitschke, 2003) and it is important that recommendations found on labels are followed to minimize risks. For example, metribuzin applied at recommended rates resulted in no crop damage, and yield loss occurred (Nitschke, 2003).

Most herbicides at their recommended rate and time of application are not known to adversely affect the soil microflora. If at all there is some effect, it is considered to be transient and reversible. Praharaj and Dhingra (1995) observed that application of pendimethalin 0.50 kg/ha neither had any adverse effect on the nodulation and nitrogenise activity nor it influenced the efficiency of rhizobial inoculants in terms of biological nitrogen fixation (BNF) in soyabean. *Rhizobium* inoculation irrespective of the method of weed control (chemical or manual) enhanced the BNF and fixed an additional (66.1-74.7 kg N/ha) over uninoculated control.

Weed control is one of the major limitations to growing lentil worldwide. Many cultural, physical and chemical practices have been employed and often the total elimination of weeds during the entire period of crop growth is not economical or required. The control of weeds during critical phases of crop weed competition for the particular production region will be sufficient with weeds emerging thereafter not significantly affecting yield and quality.
Generally best results are achieved when a range of management practices are followed and weeds are adequately controlled throughout the whole farming system, rather than just focusing on control in the lentil crop. In rainy season, because of the continuous rains many a times, early weed removal may not be possible and the use of pre-emergence herbicides for removing early weeds may form a package of weed control practices. Integration of lower rates of pre-emergence herbicides with one hand weeding or hoeing at 30-40DAS provides excellent control of weeds in most situations.

Weed management in food legume crops is a challenging task due to emergence of weeds in flushes, unpredictable of rains, non-workable soil conditions and non-availability of timely labour, non-availability of broad spectrum herbicides etc. Considering the diversity of weed problem, no single method of weed control, whether manual, mechanical or chemical would be sufficient to provide season-long weed control under all situations. Integrated weed management system as a part of integrated crop management system would be an effective, economical and eco-friendly approach for weed management in food legumes. Combination of pre-emergence herbicides with manual or mechanical weeding would be required for effective weed management.

Overall, the selection of appropriate cropping systems combined with optimum cultivar, sowing depth and time, plant density and nutritional, disease and insect management will assist in the suppression of weeds and complement other methods of weed control.

Parasitic weeds viz. *Cuscata* and *Orobanche* are becoming serious threats to food legume cultivation in many parts of the world and their control is unsatisfactory. However, these parasitic weeds not observed in the lentil crop fields sampled so far in this region.

Considering the problems of weeds in crop fields and the need for weed research in India, a coordinated weed control scheme on wheat, rice and sugarcane was initiated by ICAR in 1952 in 11 states of the country to monitor the weed flora and also to find out the relative feasibility of economic weed control. In 1978, the All India Coordinated Weed Research Project on Weed control was started by the ICAR in collaboration with the United States Department of Agriculture (USDA) at six locations. At present, it is operating at 22 locations covering different agro-ecological zones all over the country. This project has brought out the need for carrying out more in depth studies.
Consequently, the National Research Centre for Weed Science was established in April 1989 which was further upgraded to Directorate of Weed Science Research (DWSR) in January 2009. A number of Crop Research Institutes of ICAR, and state Agricultural Universities (SAAU’s) are also involved in Weed control research.

The impact of weeds on the Indian economy estimated about two decades ago ranged from Rs. 20 to 28 billion (Sachan, 1989; Sahoo and Saraswat, 1988). A recent study undertaken at DWSR suggests that proper weed management technologies, if adapted, can result in an additional income of Rs. 1,05,036 crores per annum (NRCWS, 2007). Besides, huge amount of money is spent on controlling the weeds. At a conservative estimate, an amount of Rs. 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 infestation, weed species and management practices (Yaduraju et al., 2006).

Even in wheat imported recently during 2006-07, seeds of invasive weed species Cenchrus tribuloides, Solanum carolinense, Viola arvensis, Cynoglossum officianale and Ambrosia trifida have spread in our country. Some of the alien invasive weeds Lantana camara, Parthenium hysterophorus, Chromolaena odorata, Mikania micrantha, Mimosa spp. have already become great problem to the country. Chromolaena odorata, earlier restricted to NE region and Western Ghats is now fast spreading to other areas. Similarly, Mikania micrantha, which is popularly called mile-a-minute weed on account of its rapid growth is a big nuisance in forestry and plantation crops in NE and South India (Yaduraju et al., 2003).

Pendimethalin is an extensively used dinitroaniline herbicide. The half-life of pendimethalin in soil can be long, and accumulation of this herbicide in the environment is probable. An investigation was done to see the influence of different concentration of pendimethalin (0.033, 0.066, 0.099, 0.132 and 0.264 g/L) on cell division during short-term treatment (24 and 48 hours) using Allium test. The observation showed that inhibition of root elongation after 48 hours of incubation with pendimethalin. This effect was caused by the inhibition of mitoses varying from 1/3 to 1/2 in the case of 0.033, 0.066 and 0.099 g/L of pendimethalin, and almost complete restriction of mitoses under higher concentrations. Pendimethalin caused mitotic disturbances (c-metaphases, anaphasal and telophasal chromosome bridges, multipolar anaphases) and interphase abnormalities (micronuclei, multinuclear cells). This effect was irreversible during 48-hour post incubation in water.
Mitotic disturbances were caused by abnormalities in the organization of the tubulin cytoskeleton. The results showed that even small amounts of pendimethalin can be a danger for dividing cells and embryos (Tylicki, 2010).

Traditionally, lentil is grown for subsistence or local consumption on marginal lands on stored soil moisture with no inorganic nutrient input. Under these conditions lentil yields are relatively low, for example average yields in India are 0.7 t/ha (FAOSTAT, 2006). Lentil is grown on a wide range of soils ranging from light loamy sand to heavy clay soils in northern parts, and in moderately deep, light black soils in Madhya Pradesh and Maharashtra. Its range of cultivation extends to an altitude of 3,500 m in north-west hills. The optimum temperature for its growth and development ranges from 15-25ºC. It is generally grown as a rain-fed crop during rabi after rice, maize and pearl millet. The magnitude of nutrient removal from the soil by a lentil crop is dependent on nutrient availability, crop growth and development, and ultimately yield.

The recommended dose of fertilizers is 20kg N, 40kg P₂O₅ and 20 kg K₂O and 20 kg S/ha. In soils, low in zinc (Zn), 20 kg ZnSO₄ is recommended under rain-fed and late sown conditions; foliar spray of 2% urea improves yield. Light irrigation 40-45 days after sowing and at pod formation is beneficial. The average yield is 0.8 to 1.0 tonnes/ha under rain-fed and 1.2-1.5 tones/ha under irrigated conditions. Under good management, it may yield up to 2.0 tonnes/ha. However, in several countries, in particular Canada and USA, over the past 25 years, lentil production has increased greatly in high fertility soils with adequate soil moisture. Under these conditions, yields of 3 t/ha can be achieved (Andrews et al., 2001; FAOSTAT, 2006).

Lentil cultivation in the Indo-Gangetic Plains (IGP) is integrated into the Rice-Wheat Cropping Systems (RWCS). Diagnostics surveys (Yadav et al., 2000) have indicated that farmers are using very high doses of N (130-195 Kg N ha⁻¹) for non basmati rice in Punjab, Haryana and Western Uttar Pradesh. Application of 25-32 kg P₂O₅ ha⁻¹ is common in these areas, but K fertilization is limited. The need to apply micronutrients fertilizers to soils of IGP was first felt with the appearance of zinc (Zn) deficiency in rice and wheat (Nayyar et al., 2003). Recommended fertilizers are rarely used by the Rice Wheat Cropping System farmers in IGP. The RWCS in the IGP often experiences low N-use efficiency due to inefficient management of fertilizers N (Alam et al., 2006).
The survey data revealed that the farmers used higher than the recommended dose of nitrogen in wheat and rice crops. Use of N fertilizers at a higher dose as well as wrong time makes rice plants to succumb to lodging, and produces a paradise for insect pest and diseases (Islam et al., 2007). Farmers tend to use more nitrogenous fertilizer than needed mainly because of the subsidized price and its immediate visible impact on plant growth and leaf colour.

Lentil grows well on slightly acidic (5.5-5.6 pH) to moderately alkaline (7.5-9.0 pH) soils. However, it shows best production performance at neutral pH. Lentil performance is severely hampered in soil with acidic (< 5.0) and high (>9.0) pH. Soil pH influences nutrient availability, making some nutrients deficient while others highly available to the point to the point of becoming toxic for growing plants.

Soil acidity leads to deficiency of P, K, Ca, Mo and B; it can also lead to toxic acidity of Al, Fe and Mn. Molybdenum deficiency leads to hampered nodulation and symbiotic N\textsubscript{2} fixation of legumes. Owing to the above effects, lentil productivity was reduced by 71% in acidic soils as compared to normal soil (Diwedi, 1966). To alleviate the adverse effects of acidity, liming of soil is advocated to bring the soil pH around 6.0. Application of 6t lime/ha resulted in increased lentil seed yield from 325 to 1125 kg/ha due to decrease in exchangeable Al, Fe and Mn (as a result of their precipitation as carbonates, oxides and hydroxides respectively) coupled with an increase in pH, exchangeable Ca and Mg (Diwedi, 1966).

Lentil is one of the most salinity sensitive crop when it is grown on residual moisture in the post-rainy season (after rice or fallowing in the rainy season in South Asia) it is prone to salinity stress and salts accumulate in the soil solution and are then precipitated towards the soil surface as the soil dries out. Lentil yield and its biological N contribution get reduced by 9-100% (Hoorn et al., 2001; Katerji et al., 2003) at an electrical conductivity (EC\textsubscript{e}) of 3.1. At over 0.8 EC\textsubscript{e} in saline soils, deficiency of K and Ca (Finck, 1977) coupled with toxicity of Na sulphates and chlorides results in reduced nodulation of legumes (Bhardwaj, 1975). This results in poor yield performance. Salinity-induced nodulation inhibition in lentil was ascribed to inhibition of root hair root hair expansion leading to root curling (Sprent and Zahran, 1988).
Combining P application with *Rhizobium* and PSB inoculation, and better management practices can increase the response of Lentil to applied Phosphorus. Soil moisture also has profound effect on the efficiency of biofertilizers. Inoculation of seeds with both *Rhizobium* and Phosphate Solubilizing Bacteria (PSB) resulted in better Water Use Efficiency (WUE) and seed yield over recommended dose of synthetic fertilizers alone (Masood Ali *et al.*, 2008).