IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 2, Issue 3 (Jan. - Feb. 2013), PP 11-14
www.iosrjournals.org

Weed Biology and Ecology: - A Key to Successful Weed Management and Control

Talaka, A and Rajab, Y.S
Department of Agricultural Technology, Federal Polytechnic, P.M.B. 05, Bali, Taraba State, Nigeria.

Abstract: *Weed biology is related to the study of weeds in relation to their geographical distribution, habitat, growth, population dynamics and communities. On the other hand, ecology is the interrelationship between organisms and their environment. Weed ecology is thus concerned with growth characteristics and adaptations that enable weeds to survive changes in the environment. The environment includes climatic, edaphic and biotic factors and it determines the distribution, prevalence, competing ability, behavior and survival of the weeds. Development of an appropriate and effective weed management program is dependent on the sound knowledge of weed biology and ecology i.e. a thorough knowledge regarding propagation, dispersal, behavior, survival and persistence behavior of weeds. Man plays an important role in changing the environment by altering the crop husbandry practices and by managing weed-free mono crop or multi crop cultures. Mono crop culturesutilize moisture, nutrients and light available for plant growth in a way different from multi crop cultures and this influences the ecological requirements for weed growth, behavior, competition and survival. The various aspects related to weed biology and ecology are discuss in this paper and the importance of weed biology in weed control have been reviewed in the paper. The discussion on weed biology may sometime overlap weed ecology.*
Key Words: *Weed, biology, ecology, management and control.*

I. Weed Classification

Weeds are classified into three broad groups based on lifespan: annuals, biennials and perennials. In each group there are both broad leaf weeds and grasses (Rao, 2000).

Annuals complete their life cycle in a year or less. They propagate by seeds. Normally, they are considered easy to control, but they are very persistent because of abundance of seeds which continue to germinate and emerged seedlings that grow fast until conditions become unfavorable.

Biennials have a lifespan of two years. The first year's growth may be purely vegetative and this is known as rosette stage. The tap root is often fleshy and serves as a food-storage organ. During the second year, a flower stalk arises from the crown; this is known as bolting stage. After producing seed, the plant dies.

Perennials live for more than two years and some of them almost indefinitely. They propagate by seeds and underground storage organs like rhizomes, stolon, bulbs, tuber, etc. some of them strike roots when the nodes come into contact with the soil. Perennials, with their remarkable capacity for both vegetative reproduction and prolific seed production, are very aggressive and competitive weeds.

Thus, this classification of weeds is based only on their life span for one year, two years or more. This behavior is not always constant, however, as the duration of weeds is sometimes determined by climatic factors. Many weeds that are annuals or biennials in severe climates may act as biennials or perennials respectively in milder climates (Jensen, 1971).

II. Weed Propagation

Annuals And Biennials: - Annual and biennial weeds depend on seed production as the sole means of propagation and survival while perennial weeds are less dependent on this mechanism. Production of abundant and small seeds is a common adaptation that ensures a high probability of dispersal and re infestation. A single plant of an annual weed can produce enough seeds in one season to cover an entire area of one acre with this weed species next year. For example, one plant of *Sisymbrium altissinum* (tumble mustard) produces over a half million (511,208) seeds which are enough, if evenly scattered, to sow at least 11 seeds ft^2 in an acre of land (Rao, 2000).

Some weed species have the ability to produce seeds between intervals of normal disturbance associated with a crop situation. *Avena fatua* (wild oats) germinate at the same time the wheat crop is sown and shatter their mature seeds before crop harvest. Many weeds can produce a large number of vital seeds even after having been cut off soon after flowering. A few weed species produce seeds through apomixis i.e. without fertilization. Weeds such as ferns reproduce by spores rather than seeds (Rao, 2000).

Perennials: - Vegetative propagation is a common trait of perennial weeds. Vegetative propagation includes rhizomes, stolon, tubers, bulbs, corms, roots and stems. Some perennial weeds propagate in one or more ways. Aside from their remarkable capacity for vegetative, most perennial weeds are also prolific seed producers.

Their ability to produce both vegetative propagules and seeds make them very competitive and aggressive in cropping systems (Walia, 2003). Even if the aerial parts of perennial weeds die, the vegetative propagules continue to live and send up new growth, leading to flowering of shoots and production of a seed crop year after year.

Weed Seed Bank: - The seed bank in the soil is the primary source of new infestations of weeds each year. The species composition and density of weed seed in soil vary greatly and are closely linked to the cropping history of the land. The size of seed bank in agricultural land ranges from near zero to as much as 1 million seed m^2 (Fenner, 1985). Seed banks are generally composed of numerous species belonging to three groups. The first includes a few dominant species accounting for 70-90% of the total seed bank (Wilson, 1988). These species represent most of the weed problems in a cropping system. A second group of species, comprising 10-20% of the seed bank, generally includes those adapted to the geographic area but not to current production practices. The final group accounts for a small percentage of the total seed and includes recalcitrant seed from previous seed banks of the previous crop(Wilson *et al.*,1985*).* This group undergoes constant changes due to seed dispersal by humans, animals, wind and water.

Most of the seeds entering the seed bank come from annual weeds. A characteristic of many weed species is the potential for prolific seed production. Weeds present in agricultural fields usually produce less seed due to competition from the crop, damage from herbicides and other factors (Walia, 2003).

Biodiversity Of Weeds: - In spite of using manual and mechanical methods for thousands of years and adopting modern herbicide technology extensively for over 50 years, weeds have not disappeared from agricultural fields. As man controls certain weed species, new weed species always take their place. Even if control of a particular species is achieved, it is not always complete; certain plants of the same species are left behind, so they can take control of the whole field in the following year(s).

In a situation where in total weed-free crop production is possible for several years, a year of negligence or complacency in using an effective weed control system could lead to the field once again being choked with weeds (Rao, 2000). One of the most important reasons weeds are so successful, despite numerous and sustained efforts to eliminate them, is their biodiversity (Dekker, 1997). Biodiversity is an inevitable consequence of the struggle an individual weed species undergoes in the presence of neighbors and occupying a physical space in an agro system (Dekker, 1997).

Biodiversity in weedy populations results from taxonomic diversity, as well as diversity in those traits that affect the survival, mortality and reproduction of individual weeds (Harper, 1977).

Persistence Of Weeds: - Persistence is a measure of the adaptive potential of a weed that enables it to grow in any environment. In an agricultural situation, the cropping system with its associated habitat management practices determines the persistence of weed species and thus the particular crop-weed association (Rao, 2000). A persistence weed species will not necessarily pose a hazard if suitable control measures are applied. Persistence of a weed is largely influenced by climatic, edaphic (soil) and biotic factors which affect its occurrence, abundance, range and distribution.

The occurrence of weeds in this universe is much earlier than field crops. In spite of our best weed management practices, these weed plants are frequently seen to associate with the field crops because of the phenomenon of persistence behavior of weed plants (Rao, 2000).

Weeds possess the following mechanisms by which these persist for a very long period. Higher seed production rate, asexual propagation, rapid dispersal, crop-weed association and continuous use of single herbicide result in weed resistant.

Survival Mechanism Of Weeds: -The seed is the primary means of survival mechanism of annual weeds. The vegetative plant propagules such as buds, rhizomes, tubers, bulbs and stolon offer an additional survival mechanism for perennial weeds. The major adaptations for survival of weeds include prolific seed production, survival of vegetative propagules under adverse conditions, seed dissemination and dormancy, and ability of weeds and propagules to resist any detrimental effects of the environment. Of these, dormancy is probably the single most important characteristic of weeds that enable them to survive when crops cannot (Walia, 2003).

III. Dormancy Of Weed Seeds

Dormancy is a type of resting stage for the seeds. Seeds which lie in the soil, alive but got germinating are said to be dormant. Seeds of most weed species possess this ability. Indeed, plants which lack it can only become weeds if they are repeatedly reintroduced, or can survive by their perennial habit and vegetative spread (Walia, 2003). Dormancy, which enables the species to survive husbandry control methods, is thus a major factor in the success of many weeds and of paramount importance to annuals. Seeds of weed species of *Boragina-*

ceae, Convolvulaceae, Cucurbitaceae, Leguminoseae and Gramineae families have a long dormancy period often running into several years (Jayakumar and Jagannathan, 2003).

Three types of dormancy are recognized: innate, induced and enforced-

1. ***Innate dormancy:-*** some seeds are dormant when they leave the parent plant. This primary dormancy is a property of the seed, and is genetically controlled e.g. *Avena fatua* and *Avena indoviciana.* The type of dormancy is characterized by***: (i)***rudimentary embryos (ii) physiologically immatured embryos resulting from inactive enzyme systems (iii) mechanically resistant seed coats which prevent embryo from expansion (iv) impermeable seed coats preventing entry of water or gases and (v) excessive presence of inhibitors.
2. ***Induced dormancy:*** - seeds which ordinarily would germinate immediately if planted under favorable conditions may be thrown into dormancy by an unfavorable environment so that they will not germinate even when conditions become favorable.
3. ***Enforced dormancy:*** - seeds may be prevented from germination by various environmental factors such as lack of moisture, oxygen or low temperature. When the external limitation is removed, as in seeds brought to the surface by ploughing, the germination occurs (Walia, 2003).

IV. Weed Competition

Weed competition with crops is a part of weed ecology. The word competition comes from the Latin word *competere*, which means to ask or sue for the same things another does. Competition in ecology involves two or more organisms seeking for a particular factor, thing or material when they are in short or limited supply.

Weed competition is complicated because various factors affect the extent to which it occurs. It affects the growth of crop plants. The total effect of the competition as reflected in crop growth and yield results from competition for nutrients, moisture and sunlight (Chiska, 1977). As a general rule, for every unit of weed growth there will be one less unit of crop growth. The plants that germinate first and grow fast tend to exclude others. The first plants that occupy an area have an advantage over the late comers. If weeds emerge after the crop is well established, they may not pose as serious a problem as those that emerge before the crop plants emerge and establish. Competition between plants is maximum when available resources for crop growth become limiting. Competition between crops and weeds is most severe when the competing plants have similar vegetative habits and demands upon resources (Rao, 2000).

Many weeds are prolific producers of seeds which remain viable or dormant in the soil depending on the adaptive mechanism used. When the soil is disturbed by tillage, weed seed germination takes place and the weeds emerge before or along with the emergence of crop plants. A vigorous crop can enjoy a temporary competitive advantage over weeds, but this advantage is lost in the absence of timely and proper control measures. Thus, dominance of a habitat by crop or weeds is dependent on the rapidity of germination, seedling establishment and subsequent growth. Differences in photosynthetic area, root development, root growth etc,determine the competitiveness of plants (Isikawa and Fujii, 1961).The degree of weed competition is determined by the weed species infesting the area, density of infestation and duration of infestation.

V. Characteristics Of Efficient Weed Competition

The growth and yield of a plant are directly related to its efficiency to assimilate carbon by photosynthesis, which is dependent on many physiological and environmental factors. Black *et al.,*(1969) classified plants as efficient and non-efficient on the basis of the following factors:

(1) Response to light intensity (2) response to temperature (3) response to oxygen
(4) Presence or absence of photorespiration (5) pathway of photosynthetic carbon dioxide assimilation and (6) photosynthetic compensation point level.

Black *et al.*, (1969) hypothesized that efficient plants are used in agriculture because of their high production and competitiveness. Efficient plant fixes carbon even at higher light intensity levels and temperatures, while non-efficient ones cannot do so. In efficient plants, photosynthesis is not inhibited by oxygen. At normal oxygen concentration (21%), photosynthesis is inhibited in non-efficient plants.

VI. Importance Of Weed Biology In Weed Control

The effective use of control measures, whether cultural or chemical, requires an appreciation of the biological characteristics of weed concerned. Correct identification of the species present is the first step, before appropriate control methods could be selected.

The time of year at which germination occurs is important in relation to control by cultivation and crop competition. Where the germination period is restricted, it may be possible to take advantage of this in planning the crop sequence so that competition during the early stages of crop growth is avoided. For example, in rice nursery, time of germination of *Echinochloa crusgalli* is the same. If nursery could be kept free of weeds either by applying herbicides or by physical methods, weed competition in transplanted crop could be avoided.

Periodicity of germination of weeds must be taken into consideration in deciding when to apply herbicides. It is useless to apply a relatively non-persistent pre-emergence treatmentor a contact herbicide before the species to be controlled has begun to germinate, and too early application during the germination period is followed by the emergence of sufficient undamaged seedlings to constitute a weed problem. Depth of germination is an important consideration when planning cultivations aimed at depleting the weed seed content of the soil by stimulating germination and destroying the resulting seedlings.

With weeds that reproduce vegetatively, the type of vegetative system, its depth in the soil and its response to disturbance and fragmentation are of great importance in control, and must be taken into account. The period of active growth and state of the underground food reserves may determine the best time for defoliation and for the application of translocated herbicides. For example longevity of yellow sedge (*Cyperus rotundus)* tubers depends upon the tuber depth in the soil. As the depth increases the longevity time for tubers increases. Temperature influences the longevity of tubers. Temperature extremes can kill both yellow and purple nut sedge tubers (Bhowmik, 1993). Repeated cultivations during hot months of May-June drastically reduced the tuber population of *Cyperus rotundus* in soils. Gill *et al*.,(1983) reported that larger proportions of tubers from upper surface of 12cm are destroyed due to hot weather cultivations but tubers in deeper zone remain unaffected. Researches also indicated that the nut sedges lack a competitive edge with the crops which form a dense canopy (Keeley *et al;* 1983), and both the purple and yellow nut sedges were very sensitive to shading (Keeley and Thullen, 1978; Patterson, 1982). It is also noted that shading decreases the partitioning of plant biomass into tubers and rhizomes resulting in increased partitioning into leaves. Hence some crop management practices which influences growth of nut sedge like date of planting, row spacing, crop cultivars, competitive crop species, crop rotation and method of planting could be exploited in weed management (Bhowmik, 1993).

VII. Conclusion

It is important to realize that any control measure is an attempt to shift the balance of an ecological community in the desired direction. So far as possible, therefore, factors that can be controlled, such as times of cultivation and sowing, should be adjusted so that they operate in favor of the crop rather than weeds. Such factors as choice of appropriate crop variety, spacing and maintenance of healthy growth can help to reduce the weed problem.

Usually several weed species are present in any of situation, and measures which control some but leave others unharmed may merely alter the relative abundance of the species without decreasing the total harmful effect of the weed vegetation. In addition, the nature of the weed problem in future years may be markedly influenced.

An efficient means of reproduction is a primary characteristic of weeds, therefore, an appreciation of the ways in which weeds can be spread is necessary in order to prevent their introduction into new areas.

References

[1] Bhowmik, P.C. (1993). Weed biology: its importance in integrated weed management systems. *Proceedings of the international symposium on integrated weed management for sustainable agriculture.* Vol. 1: pp. 57-66. Department of Agronomy, CCS, HAU, Hissar, Haryana, India.
[2] Black, C.L, Chen, T.M. and Brown, R.H. (1969). *Biochemical basis for plant competition.* Weed Sci. 17: 338-344.
[3] Chiska, H. (1977). Weed damage to crops: yield loss due to weed competition (eds).Integrated control of weeds. Uni. Press of Tokyo, Tokyo, pp: 1-16.
[4] Dekker, J. (1997).*Weed diversity and weed management.* Weed Sci. 45: 357-363.
[5] Fenner, M. (1985). *Seed ecology* (chapter 4). Chapman hall, New York, NY, pp. 87-104.
[6] Gill, H.S, Bhatia, R.K, Sandhu, K.S. and Mehra, S.P. (1983).*Ecological studies on Cyperus rotundus L.* Tropical ecology. 24: 292-298.
[7] Harper, J.L. (1977). *Population Biology of Plants.* Academic press, San Diago, C.A, pp. 892.
[8] Isikawa, S. and Fujii, T. (1961). Photo control and temperature dependence of germination of *Rumex* seeds. *Plant and cell physiology*. 2: 51-62.
[9] Jayakumar, R. and Jagannthan, R. (2003). *Weed science principles.* Kalyani publishers, New Delhi, India. Pp 15-24.
[10] Jensen, L.L. (1971). Morphology and photoperiodic responses of yellow sedge. Weed Sci. 19: 210-219.
[11] Keeley, P.E. and Thullen, R.J. (1978). Light requirements of yellow nut sedge (*Cyperus escullentus)* and light interception by crops. Weed Sci. 26: 10-16.
[12] Keeley, P.E, Thullen, R.J, Miller, J.H. and Carter, C.H. (1983). Comparison of six cropping systems for yellow nut sedge (*Cyperus esculentus)* control. Weed Sci. 31: 63-67.
[13] Patterson, D.T. (1982). Shading response of purple and yellow nut sedges (*Cyperus ro-tundus* and *C. esculentus).* Weed Sci. 30: 25-30.
[14] Rao, V.S. (2000). *Principles of Weed Science.* 2nd edition. Oxford & IBH Publ. Com; New Delhi. Pp 7-35.
[15] Walia, U.S. (2003). *Weed Management.* Kalyani pub. New Delhi, India. Pp 20-37.
[16] Wilson, R.G. (1988). Biology of weeds in the soil. In MA. Atien and M. Liebman, (Eds.). Weed Management in Agro-ecosystems: Ecological Approaches. CRC Press, Boca Raton, F.L; pp 25-39
[17] Wilson, R.G., Kerr, E.D. and Nelson, L.A. (1985). Potential for using weed seed content in the soil to predict future weed problems. Weed Sci. 33: 171-175.