Crop-Weed Competition

Mirza Hasanuzzaman, PhD
Associate Professor
Department of Agronomy
Sher-e-Bangla Agricultural University

Concept

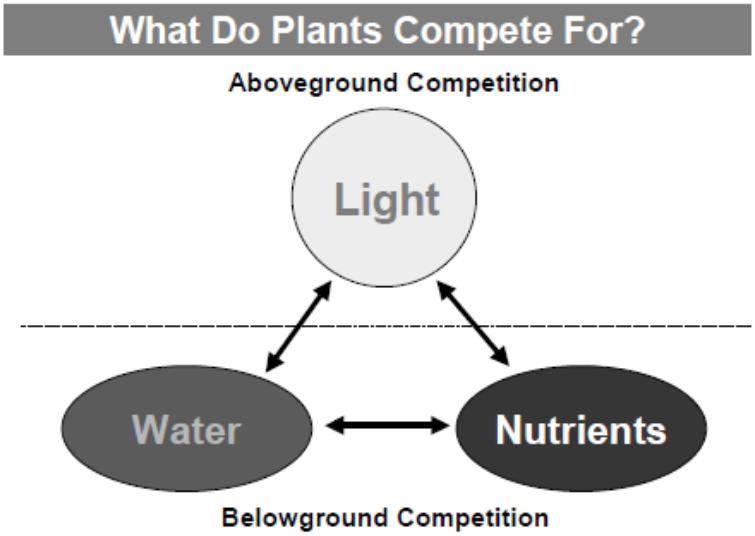
Competition is nothing but the struggle for existence and superiority. Competition exerts a powerful force in the plant community, irrespective of the mechanism, tending towards limitation or extinction of the weaker competitors. Competition is maximum when available resources for crop growth become limited.

Competition is a negative interaction where individuals make simultaneous demands that exceed limited resources and, while both suffer, one individual suffers less.

So, crop weed competition indicates competition between crop and weed in a natural ecosystem in response to resources struggle for their existence and superiority.

Crop weed competition occurs in two broad aspects:

1. Direct competition- for nutrient, moisture, light and space
2. Indirect competition- through exudation and / or production of allelopathic chemicals.



By and large, weeds appears much more adapted to agroecosystem than our present day crop plants.

Components of the overall competitive effect

In an infested field it is possible to identify different components of the overall competitive effect:

- Intraspecific competition between plants of the cultivated species;
- Interspecific competition between plants of the cultivated species and weed species;
- Interspecific competition between plants of the different weed species;
- Intraspecific competition between plants of the same weed species.

Competition between weeds and crops is expressed by altered growth and development of both species. Interspecific competition occurs when two or more species coexist in time and space and simultaneously demand a limited resource. Intraspecific competition occurs when two or more plants of the same species coexist in time and space and simultaneously demand a limited resource.

Competition for nutrients

Plants compete mostly for nitrogen, phosphorus and potassium (but there are many others). Phosphorus is usually the most limited nutrient in aquatic ecosystems. Nitrogen is usually the most limited nutrient in terrestrial habitats. Potassium is often overlooked but some terrestrial weeds can grow well in K-rich soils. Approximately competition for nutrients constitutes an important aspect of weed crop competition. Weeds usually absorb mineral nutrients faster than many of our crop plants and accumulate them in their tissue in relatively large amounts.

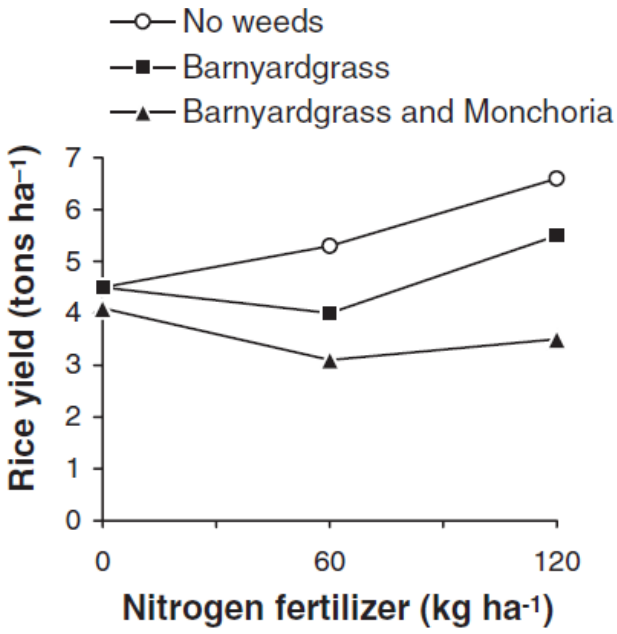


Fig. Effect of nitrogen addition and two weeds (barnyardgrass and the annual broadleaf Monchorias) on rice yield (redrawn from data from Moody, 1981 in Zimdahl, 1999)

Table: Kilograms of Nutrients Required to Produce Equal Amounts of Dry Matter

Plant	Nitrogen	Phosphorus
Wheat	5.5	1.2
Lambrushquarter	7.6	1.6
Pig weed	5.1	1.4

- Species of *Amaranthus*, for example, often accumulate over 3% N in their dry matter.
- *Chenopodium* and *Portulaca spp*. are likewise potassium lovers with over 1.3% K_2O in their dry matter.
- Nutrient removal by weeds during the first 30 days of maize growth was 59 kg N, 10 kg P and 59 kg K per hectare, which was 7-10 times more than the nutrient removal by the crop
- Weed posses not only a capacity for heavy nutrient absorption and accumulation but also gather tremendous quantities of dry matter.

Competition for moisture

Competition for water occurs below ground between roots. The ability to absorb water is related to rooting volume. However, not only are the dimensions (breadth and depth) of rooting zones important: so is the degree of water extraction.

In general, for producing equal amounts of dry matter, weeds transpire more water than do most of our crop plants. In weedy fields, the soil moisture may be exhausted by the time the crop reaches the fruiting stage, which is often the peak. The consumptive use of water of a common weed

Chenopodium album as 550 mm against 479 mm for wheat crop itself. It is because weed can remove moisture from deeper depth of soil than crops.

Table: Water Required to Produce One Pound of Dry Matter (Dillman, 1931; Shantz et al., 1927)

Plant	Litres of water
Wheat	227
Lambrushquarter	300
Corn	159
Pigweed	132-139

Competition for light

Although it varies in duration, intensity, and quality, light regulates many aspects of plant growth and development. Neighboring plants may reduce light supply by direct interception: shading. Leaves are the site of light competition. Whenever a leaf is shaded by another, there is competition for light.
Light competition is most severe when there is high fertility and adequate moisture because plants grow vigorously and have larger foliar areas. Plants with large leaf area indices (LAI) have a competitive advantage with plants with smaller leaf areas.

Both light quality and quantity are important aspects of competition. Since the presence of dense leaf canopies reduces the quantity and quality of light available to weeds, competition for light is greatest when plant density is highest. Plant height defines an effective component of the competitive struggle for light. It becomes most important element of weed crop competition when moisture and nutrients are plentiful, and weeds have an edge over crop plants in respect of height. Light competition may commence very early in the crop season if a dense weed growth smoother the crop seedlings. Once a plant is shaded by another plant, increased light intensity cannot benefit it.

Critical period of weed growth

Critical period of weed growth can be defined as that shortest time span in the ontogeny of crop growth when weeding with result in highest economic returns. The crop yield level obtained by weeding during this short span should provide crop yield sufficiently close to that obtained by the full crop season freedom from weeds. A fundamental principle of plant ecology is that early occupants on a soil tend to exclude the later ones.

- On the basis of the plant ecology, crops required a weed free respite during the first one-forth to one-third of its growing period.
- Sharma *et al.* (1977) found that in direct seeded rice, the critical weed competition period occurred 10-20 days after crop emergence. For the transplanted rice the critical periods of weed crop competition were identified. These were (i) 4-6 weeks after transplanting and (ii) during the 12th weeks of crop growth.
- In maize for example, during the first 2-3 weeks of emergence, weeds often completed 15-18% of their total growth, while maize put up only 2-3% of growth. Such observations have provided a basis in favour of early season weeding to harvest acceptable yields.
- Singh *et al.* (1980) found that 4 to 16 weeks period after planting sugarcane critical for competition weeds.
- In potato, weeding was found most essential between 2 and 4 weeks after planting. Delayed weeding caused considerable shrinkage in tuber yields (Gupta *et al*., 1979).

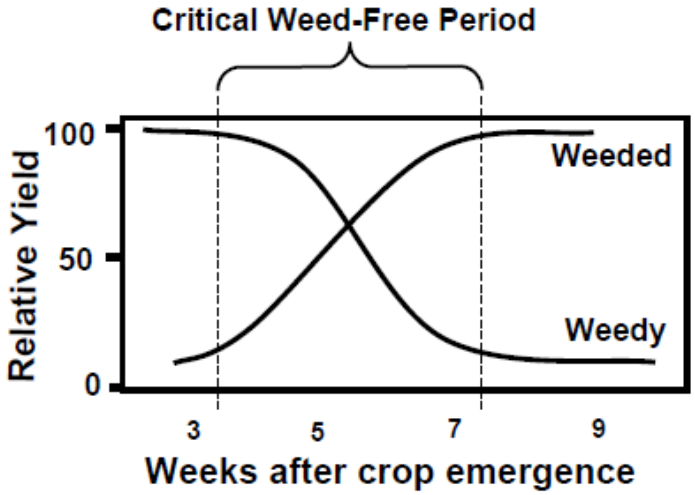


Table: Crops with an Apparent Critical Period for Weed Competition (Zimdahl, 2004)

Crop	Weed-free weeks required	Weeks of competition tolerated
Maize	3-5	3-6
Rice	4-6	4-9
Soybean	2-4 after planting	4-8 after planting
Potato	4-6	4-9

Factors affected weed crop competition

Competition depends on four interrelated factors-

A. Timing of weed emergence: The first plant that effectively obtains water, nutrients and sunlight from a site and becomes established at that site has distinct competitive advantages over plants that develop later. The effect of a weed competition is greatest when the crop is young, since this is the stage which plant growth is inhibited most by inadequate light, water and nutrients. Crop yields are much more reduced by early season weed competition than by later season competition.

B. Growth form: Growth form is manifested in two major parts i.e.,

- **Growth habit:** Extent of root development, height, leaf area, amount of branching
- **Growth rate:** Those which can develop canopy very rapidly over another, has definite advantage of shading over the second plant communities.

C) Weed Density: The numerical superiority that weeds exhibit greatly reduces the availability of water, nutrients and light to crop plants and accounts for much of what we consider to be weed competition. Increase in crop population density distributes available resources among the crop community, but increase in weed population diverts available resources from the crop communities. For example: 1 kg increase in weed dry matter = 1 kg loss in crop dry matter. Weed density is generally higher in distributed or agricultural soil than in undistributed soils.

D) Duration of weed growth: The duration of weed growth is equally important with all other factors. If weeds are allowed to grow for an extended period crop yield may be drastically reduced. Weeds that are not controlled within 2-3 weeks of emergence usually affect crop yield. This is particularly important for upland rainfed crops i.e. aus rice, jute etc. In most crops weed infestation during the first 3-8 weeks is very critical which is termed as “Critical period” of weed infestation. Crop fields must be kept weed free during this period.

E) Characteristics of Weed species: Weeds differ in their ability to compete with crops at similar density levels. This is primarily because of differences in their growth habits and to some extent in the allelopathic effect they may exert on the germination and growth of neighbouring crop plants. Zimadahl and Fertig (1967) found *Brassica spp*. (Wild mustard) reduced the sugarbeet yield much more than *Setaria glauca* (Yelow foxtail). In dry areas perennial weeds like *Cirsium arvense*

(Canada thistle) and *Convolvulus arvensis* (Bindweed) have been found more competitive than the annual weed species because of their deep roots and early, heavy shoots growth.

F) Characteristics of crop species: Crops and their varieties differ in their competing ability with weeds. Several researchers are available to differentiate crop species and varieties in this respect. Among winter grasses, for example, the decreasing order of weed competing ability is as barley, rye, wheat and oat. High tolerance of barley to competition from weeds is assigned to its ability to develop more extensive roots during its initial three weeks growth period than the other grains.

- ***Boro* Rice:** Do not appreciably suffer from weed competition due to standing water throughout the growth period, particularly during the critical periods of weed infestation, i.e., seedling establishment, panicle initiation, flowering stages etc.
- ***Aman* Rice:** Do not usually suffer at earlier stages until warming of soil temperature in later growth stages, which causes weeds to germinate or being rapid growth.
- ***Aus* Rice:** Most sensitive to weed infestation. Suffers weed competition from very beginning. Cost of production is high due to intensive weed management. Entire crop failure is possible if weed control is not done timely and properly.
- **Onion:** Slow growing, never forms a canopy, poor competitor to late germinating weeds. Critical period of crop-weed competition was found to be 20-60 DAT. Early infestation of weeds in onion is one of the major constraints limiting the establishment of the crop and thereafter its production.
- **Field Pea:** The critical period for crop-weed competition was observed to be between 30-60 days after sowing when the crop should be kept free from weeds to prevent the potential yield loss and to economize weeding in fieldpea. (Prakash and Srivastava, 2007).

List of characteristics associated with competitive plants

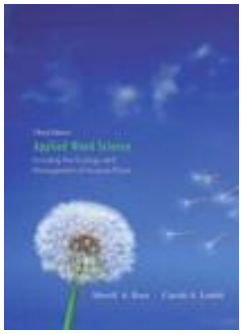
Shoot characteristics

- Rapid expansion of tall, foliar canopy
- Horizontal leaves under overcast conditions and obliquely slanted leaves (plagiotropic) under sunny conditions
- Large leaves
- A C_4 photosynthetic pathway and low leaf transmissivity of light
- Leaves forming a mosaic leaf arrangement for best light interception
- A climbing habit
- A high allocation of dry matter to build a tall stem
- Rapid extension in response to shading

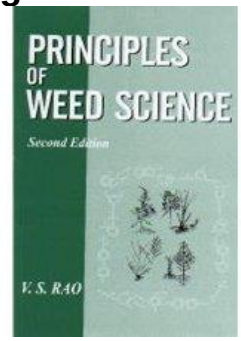
Root characteristics

- Early and fast root penetration of a large soil area
- High root density/soil volume
- High root–shoot ratio
- High root length per root weight
- High proportion of actively growing roots
- Long and abundant root hairs
- High uptake potential for nutrients and water

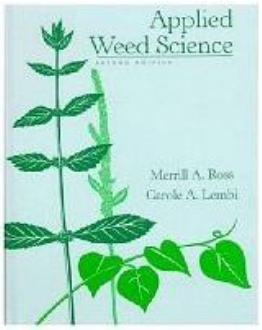
Suggested Books:



Applied Weed Science: Including the Ecology and Management of Invasive Plants,
By Merrill A. Ross and Carol A. Lembi



Principles of Weed Science
By V. S. P. Rao)



Applied Weed Science
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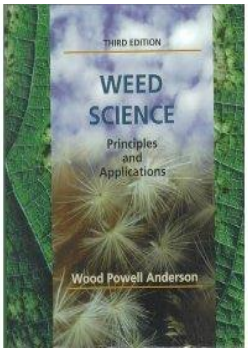
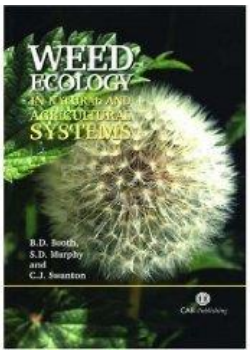


Weed Science: Principles and Applications
By W. Powell Anderson

Weed Science: Principles and Practices
By Monaco, Thomas J. Weller, Steve C. and Ashton, Floyd M.



Weed Ecology in Natural and Agricultural Systems
By B. D. Scoth, S.D. Marphy and C.J. Swamton

