Review of

Weed Competition in Soybeans and Corn

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The effects of weed competition on crop yields demonstrate the importance of weed control practices. This review of weed competition focuses on crops that are economically important to Missouri.

Weeds adversely affect crop production by competing for water, light, nutrients, and space (2, 22, 26, 27, 33). Certain weeds interfere with the growth of crop plants by releasing chemical inhibitors, a process referred to as allelopathy (2, 7, 12, 13, 23, 36).

Weed species vary in their abilities to compete with other plants. However, certain density levels of weeds can be tolerated in a given crop, considering weed variability, the crop involved, and the economic aspects of weed management. The tolerable density, i.e., the number of plants per unit area of a weed species, beyond which weed management practices are deemed advisable, can be referred to as the economic threshold. Beyond a threshold the economic gain from a particular weed management practice will exceed the loss that might occur if no management practice is applied (6, 29).

The effect of weed competition is usually less obvious than crop damage caused by insects and diseases. For this reason, coupled with many environmental, ecological and economic variables involved, the development and practical use of economic thresholds for most weed species has been slow.

Research shows the effect of weed densities on yields and also demonstrates the importance of early season weed control. Economic thresholds may be inferred for particular species when percent yield reductions are given for a specified number of weeds per unit area.

Weed Competition in Soybeans[1]

Grasses and Sedges

Annual grasses that compete with soybeans include giant foxtail (*Setaria faberi*)[2], green foxtail (*Setaria viridis*), yellow foxtail (*Setaria glauca*), and fall panicum (*Panicum dichotomiflorum*). Removal of these grasses, even if present at densities as high as 15-20 plants per square foot, within 3-5 weeks following germination of the soybeans (*Glycine max*) will eliminate any significant reduction in yield resulting from competition. Grasses germinating after this stage of crop development make poor growth as a result of the greater competitive capability of the crop. Even at the higher density figure stated above, studies indicate a crop reduction of less than 15 percent (1, 28).

Full season competition from annual grasses, however, may significantly reduce soybean yield. Of the foxtails discussed here giant foxtail has the greatest impact. At densities ranging from approximately 7 to 66 plants per square foot giant foxtail reduced yields from 27-59 percent (15, 16, 27). Green and yellow foxtails, in general, appear to be somewhat less competitive than giant with indicated yield reductions about 15-29 percent lower than for giant foxtail at similar densities (27).

[1]Population densities in weed competition literature are presented in both English and metric measurement as the number of plants per unit area or number of plants per unit of row. Weed densities may be limited to a narrow band or distributed throughout the row. In the interest of uniformity and for the purpose of making comparisions, all weed densities per unit area have been converted to number of plants per square foot. Row foot densities are not converted unless the weeds were confined to a specified width.

[2]Nomenclature follows that of Steyermark, 1963 (30).

Fall panicum, when allowed to compete full season at a density of about 14 plants per square foot of row, was found to decrease the yield by 40 percent (1).

Johnsongrass (*Sorghum halapense),* a perennial that reproduces by rhizomes as well as by seeds, is a very serious problem in the South. A density of about one stem per square foot, a level of infestation common in soybean fields in the southeastern states, was found to reduce the yield of soybeans from 23-42 percent (17).

Yellow nutsedge (*Cyperus esculentus)* is not a grass though it resembles one. This perennial plant reproduces by means of small, nutlike tubers as well as by seed. Studies in Illinois have shown that 10-20 plants per square foot in a soybean field on July 1 will reduce yield. Lower densities probably cause little yield reduction. Because of the plant's ability to produce tubers, early season control does not preclude the possibility of future problems. Late sprouting tubers, however, probably cannot compete with the canopy produced by growing soybeans (31). Thompson (33) proposed a threshold of 18-30 plants per square foot.

Ivyleaf Morningglory

Broadleaved Weeds

Annual weed species do not significantly reduce yields unless they are allowed to remain with the crops longer than 5-6 weeks. Beyond 5-6 weeks significant yield reductions occur (9, 10, 11, 21). The degree of yield reduction in part, depends upon the density of the weed population, the weed species, and its competitive capabilities.

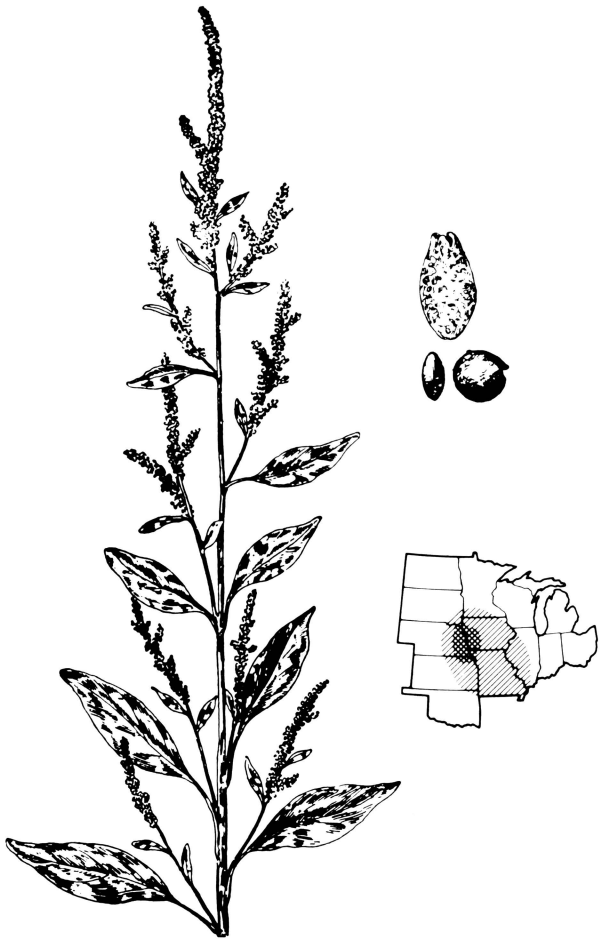
Velvetleaf (*Abutilon theophrasti)* densities ranging from one to as high as 19 plants per square foot did not cause a significant yield reduction in soybeans when kept in check for 3-5 weeks following emergence of early planted soybeans (11, 20). If the weed remains for a longer time, however, the competitive effects of the weed population significantly reduce the crop yield (27). At lower densities yield reductions are decreased. Velvetleaf plants that appear after 3-5 weeks of crop growth do not appear to reduce yield significantly because of the increased competitiveness of the soybeans (20). About one plant per 10 feet of row was suggested as a threshold (33).

In fields planted in late June, soybeans appear to be competitive with velvetleaf plants throughout the season. At densities of one plant per 6.7 square feet to one plant per 3.3 square feet, the yield reduction as a result of velvetleaf competition in late planted fields was found to be about one-half that in early planted fields (20).

Annual morningglory (*Ipomoea purpurea)* and ivy-leaf morningglory (*Ipomoea hederacea)* vary somewhat in growth habit, but have similar competitive effects on soybeans (35). Of the two species, ivy-leaf is the most common in Missouri soybean and corn fields (personal observation, 30).

Several studies indicate that the removal of morningglories every two weeks or their removal at 6-8 weeks after planting will permit maximum crop yield (21, 35). Allowing the vines to remain with the crop longer than 6-8 weeks results in varying yield reductions depending upon morningglory population densities. If the vines are removed before 6-8 weeks and new plants are permitted to become established and grow with the crop, significant yield reductions can occur if densities are high (35). Beyond eight weeks the competitive effects of morningglories are more pronounced as the soybeans are in the reproductive stage (21).

In competition studies, morningglory densities ranging from 0.5 to 12 plants per foot of row permitted to grow with the soybean full season affected yield reductions from 12 percent at the lowest to 40-60 percent at the higher densities (21, 35). Thus, yield reductions occurred even at the lowest densities studied. A suggested threshold is about one plant per 5 feet of row (33).



Water Hemp

Studies of cocklebur (*Xanthium pensylvanicum*) competition in soybeans, are numerous, especially in the southern and southeastern states. Cocklebur has been referred to as "the most troublesome weed in Arkansas and Mississippi" (6) and its reputation can be extended to include the southeastern United States. Indications are that it is becoming more of a problem in central states, notably Illinois (8).

Two investigators developed a method of estimating potential soybean losses and determining the threshold of cockleburs in soybeans. The threshold is based on cocklebur density, number of weeks after soybean emergence, expected reduction in yield losses, and several economic factors (6).

Densities of cocklebur greater than one plant per 9 feet of row have been found to produce a significant yield reduction in soybeans (3, 5, 8, 14, 17). As the weed density increases beyond this level competition becomes more severe. At cocklebur densities of about three plants per foot of row yield reductions as high as 80 percent have been recorded (5). Between 0.1 and three cockleburs per foot, yields decreased with increased cocklebur density. A suggested threshold of approximately one plant per 15 feet of row is probably a realistic figure (33).

If the crop can be maintained free of weeds for at least 4-6 weeks following emergence, the yield-reducing effects of even high cocklebur densities can be avoided or at least greatly minimized (5, 6, 14). If cockleburs are permitted to compete longer than 6-8 weeks, yield reductions increase sharply with each succeeding week (5, 6, 8). At about 12 weeks the maximum yield reduction has already been affected by the competing cockleburs (6). Plants that emerged after the first 4-6 weeks following crop emergence did not appear to be competitive with the soybeans and did not reduce yields significantly (5, 8).

Three annual broadleaved plants that are closely related and similar in appearance and growth habit are redroot, or rough pigweed (*Amaranthus retroflexus*), smooth pigweed (*Amaranthus hybridus*) and water hemp (*Amaranthus tamariscinus*). The first two are frequently referred to as careless weed. They occur more commonly in upland cultivated fields, but are also found in bottomland fields. Water hemp occurs primarily in bottomland fields, but is found also in upland cultivated fields (personal observation, 30). Although the following material is based on studies of pigweed competition, the remarks can probably be applied to water hemp because of similarities in biology and growth habit.

Pigweed was allowed to compete full season at densities ranging from one plant per 8 feet of row to greater than 12 plants per foot of row (4, 18, 19). At the latter density the weed was confined to a 4- to 6-inch band over the row. At the above density and a "natural density" which exceeded four plants per foot of row the yield of soybeans was reduced 55 percent (a three-year average) (18), 68 percent (a two-year average) (19), and 80 percent (4). Yield reductions of lighter pigweed densities were lower, but even at a density of one plant per 8 feet of row, a 30 percent reduction in yield was recorded (4). It appears that densities of less than one pigweed per 8 feet of row for a full season would have to be realized if a significant yield reduction is to be avoided.

As with most previously discussed weeds, if the crop can be kept free of pigweeds for 6-8 weeks after planting, yield reduction can be kept at a relatively low level. Pigweed, at the density of 12 plants per foot of row in the row, was allowed to compete with soybeans for a varying number of weeks up to full season. Yields were reduced by 30 percent when weeds competed beyond seven to ten weeks. Removal of pigweeds after 10-12 weeks still resulted in a yield reduction in excess of 50 percent as a consequence of the competition (19).

A naturally occurring population of common

Black Nightshade

ragweed (*Ambrosia artemisiifolia*) of about 16 plants per square foot did not significantly reduce soybean yields under normal moisture conditions if the period of interference was limited to six weeks or less following crop emergence (10). When common ragweed was allowed to compete with soybeans up to eight weeks yields were significantly less. Further study indicated the loss threshold for common ragweed growing in the soybean row averaged one ragweed per 8.2 feet of row. Densities greater than this resulted in increasingly greater yield reductions when competition was permitted for the full season.

Soybeans kept free of Pennsylvania smartweed (*Polygonum pensylvanicum*) for four weeks or more after crop emergence did not show significant yield reduction even if the smartweed density was as high as 7.2 plants per foot of row (9). Likewise, if smartweed competition was limited to six weeks or less following crop emergence, no significant reduction in crop yield occurred. If, however, smartweed was permitted to compete for more than six weeks the reduction in crop yield increased significantly. It was determined that a population density of Pennsylvania smartweed slightly over one plant per 6.6 feet of row was required to cause a significant reduction in soybean yield.

Black nightshade (*Solanum americanum*) has received much attention recently, especially as a weed in soybeans. This plant is an annual that can produce an abundance of relatively small, glossy berries that change in color from green to dark purple as they ripen. The sticky juice from the berries combined with weed and crop chaff, soil, weed seeds and beans forms a sticky mass that clings to machinery during harvesting operations. One nightshade plant per 10 feet of row is apparently sufficient to temporarily stop soybean harvest. Based on this aspect of interference, the threshold for this species would be less than one plant per 10 feet of row and is another means by which weeds affect crop growing activities.

The only perennial considered here is dogbane, or Indian Hemp (*Apocynum cannabinum*). This plant reproduces by seed and relatively deep, long, horizontal rhizomes. Because of the latter characteristic, management of this weed is more difficult than that of the annuals previously discussed. Yield reductions of 28-32 percent have been recorded in non-irrigated soybeans as a result of competition with dogbane at densities of one plant per 2 square feet. Irrigated soybeans with a dogbane density of about one plant per 0.7 square foot showed a yield reduction of 41 percent (25).

Weed Competition in Corn

Grasses and Sedges

As in soybeans, generally, if annual grasses can be controlled for 3-5 weeks after corn (*Zea mays*) germination no significant yield reductions will result.

Of the three foxtails considered in the section on soybeans, giant is also the most important competitor in corn and has received the most attention. As a result of full season competition giant foxtail at a density of about 22 plants per foot of row confined to a 4-inch band in the crop row reduced corn yield about 13 percent. Reduction in corn yield produced by the grass when controlled for 3-5 weeks after crop germination and then permitted to grow was not at a significant level (16). Other research with giant foxtail at a density of about 60 plants per foot of row yielded about the same results (15).

Yield reductions in corn with heavy to very heavy densities of green and yellow foxtail for the full season appear to be somewhat less than that caused by giant foxtail. However, yield reductions approximating 36 percent can occur as a result of green and yellow foxtail full season competition with corn where soil nitrogen is insufficient. Studies indicate that corn can compete well because it

responds much better to nitrogen application than either foxtail. Moderate levels of foxtail infestation in adequately fertilized corn will not significantly reduce the crop yield, especially if the weeds are controlled for the first 3-5 weeks following crop emergence (15, 16).

Fall panicum, another of the annual grasses commonly occurring as a weed in corn, has been found to significantly reduce corn yields at densities of 15 or more plants per square foot of row (24, 34).

Yellow nutsedge competition with corn resulted in corn yield reductions of 15-20 percent with weed densities of 10-20 plants per square foot (31). Each additional nine shoots per square foot can be expected to reduce the yield by about 8 percent (32). Lesser densities probably do not reduce corn yield significantly. Control of the weed for 3-5 weeks after crop germination should effectively reduce the effects of competition. The closing corn canopy will effectively shade most new plants; yellow nutsedge and most other crop-associated weeds are highly intolerant of shade (31).

Broadleaved Weeds

Annual weeds considered here are redroot or rough pigweed, smooth pigweed, and water hemp. As stated in the discussion of these species in the soybean section these three species are very similar in appearance especially during the early vegetative stages, and in growth habit.

Illinois researchers found that smooth pigweed grown in a 4- to 6-inch band in the row of corn (no actual density given) for the full season reduced yields by about 40 percent. Yield reductions of about 6-37 percent were reported for pigweeds growing in the row at spacings ranging from 1-40 inches. A sharp increase in yield reduction was noted when weed spacing was less than 10 inches. The greatest yield reductions resulted when the weeds were allowed to compete for 10 weeks or longer (18, 19).

Dogbane or Indian Hemp has received the most attention among perennial broadleaved weeds in corn. Studies indicate that season-long competition of dogbane at densities of one plant per 1.7-2.0 square feet adversely affected corn production and reduced yields by 8 and 10 percent, respectively (25).

References

1. Ambrose, L. G. and H. D. Coble. 1975. Fall panicum competition in soybeans. Proc. So. Weed Sci. Soc. 28:36.
2. Anderson, W. P. 1977. Weed Science: Principles. West Publish. Co., New York. 598 pp.
3. Anderson, J. M. and C. G. McWhorter. 1976. The economics of common cocklebur control in soybean production. Weed Sci. 24(4):397-400.
4. Asberry, J. and C. Harvey. 1969. The effect of pigweeds on the yield of soybeans. Proc. South. Weed Sci. Soc. 22:96.
5. Barrentine, W. L. 1974. Common cocklebur competition in soybeans. Weed Sci. 22(6):600-603.
6. Barrentine, W. L. and L. R. Oliver. 1977. Competition, threshold levels, and control of cocklebur in soybeans. Coop. Public. Miss. Agric. and Forestry Exp. Sta., Miss. St., Ark. Agric. Exp. Sta., Univ. Of Ark. Tech. Bull. 83, 27 pp.
7. Bell, D. T. and D. E. Koeppe. 1972. Noncompetitive effects of giant foxtail on the growth of corn. Agron. Jour. 64(3):321-325.
8. Bloomberg, J. R. 1977. Weed competition: cocklebur. In: Twenty-Ninth Illinois Custom Spray Operators Training School, Summaries of Presentations, Univ. of Ill., Urbana-Champaign, pp. 171-173.
9. Coble, H. D. and R. L. Ritter. 1978. Pennsylvania smartweed (*Polygonum pensylvanicum*) interference in soybeans (*Glycine max*). Weed Sci. 26(6):556-559.
10. Coble, H. D., F. M. Williams, and R. L. Ritter. 1981. Common ragweed (*Ambrosia artemisiifolia*) interference in soybeans (*Glycine max*). Weed Sci. 29(3):339-342.
11. Eaton, B. J., O. G. Russ and K. C. Feltner. 1976. Competition of velvetleaf, prickly sida, and venice mallow in soybeans. Weed Sci. 24(2):224-228.
12. Einhellig, F. A. and J. A. Rasmussen. 1973. Allelopathic effects of *Rumex crispus* on *Amaranthus retroflexus*, grain sorghum, and field corn. Amer. Midl. Nat. 90(1):79-86.
13. Gabor, W. E. and C. Veatch. 1981. Isolation of a phytotoxin from quackgrass (*Agropyron repens*) rhizomes. Weed Sci. 29(2):155-159.
14. Hardin, G. B. 1979. Cockleburs cut soybean yields. Agricultural Research 27(7):7.
15. Knake, E. L. and F. W. Slife. 1965. Giant foxtail seeded at various times in corn and soybeans. Weeds 13(4):331-334.
16. Knake, E. L. and F. W. Slife. 1969. Effect of time of foxtail removal from corn and soybeans. Weed Sci. 17(3):281-283.
17. McWhorter, C. G. and E. E. Hartwig. 1972. Competition of Johnson grass and cocklebur with six soybean varieties. Weed Sci. 20(1):56-59.
18. Moolani, M. K., E. L. Knake and F. W. Slife. 1964. Competition of smooth pigweed with corn and soybeans. Weeds 12(2):126-128.
19. Moolani, M. K. and F. W. Slife. 1960. The competitive effects of various intensities of pigweed on the development of corn and soybeans. Proc. North Cent. Weed Control Conf. 17:26-27.
20. Oliver, L. R. 1979. Influence of soybean planting date on velvetleaf competition. Weed Sci. 24(2):183-188.
21. Oliver, L. R., R. E. Franz, and R. E. Talbert. 1976. Field competition between tall morningglory and soybean. I. Growth analysis. Weed Sci. 24(5):482-488.
22. Oosting, H. J. 1956. The Study of Plant Communities: An Introduction to Plant Ecology, 2nd ed., W. H. Freeman and Co., San Francisco, 440 pp.
23. Rasmussen, J. A. and F. A. Einhellig. 1975. Noncompetitive effects of common milkweed, *Asclepias syriaca* L., weeds on germination and growth of grain sorghum. Am. Midl. Nat. 94(2):478-483.
24. Ritter, R. L. and W. M. Lewis. 1977. Fall panicum interference in corn. Proc. South. Weed Sci. Soc. 30:56.
25. Schultz, M. E. and O. C. Burnside. 1979. Distribution, competition, and phenology of hemp dogbane (*Apocynum cannabinum*) in Nebraska. Weed Sci. 27(5):565-570.

26. Smith, R. L. 1974. Ecology and Field Biology, 2nd ed., Harper and Row Publish., Inc., New York. 850 pp.
27. Staniforth, D. W. 1965. Competitive effects of three foxtail species on soybeans. Weeds 13(3):191-193.
28. Staniforth, D. W. and C. R. Weber. 1956. Effects of annual weeds on the growth and yield of soybeans. Agron. Jour. 48(10):467-471.
29. Stern, V. M. 1973. Economic thresholds. In: Annual Review of Entomology, 18:259-280.
30. Steyermark, J. A. 1963. Flora of Missouri. 3rd ptg. 1972. Iowa St. Univ. Press, Ames. 1728 pp.
31. Stoller, E. W. 1977. Weed competition: yellow nutsedge. In: Twenty-Ninth Illinois Custom Spray Operators Training School, Summaries of Presentations, Univ. of Ill., Urbana-Champaign, p. 170.
32. Stoller, E. W., L. M. Wax and F. W. Slife. 1977. Competition and control of yellow nutsedge in corn. Proc. North Cent. Weed Control Conf. 32:83.
33. Thompson, L., Jr. 1979. Weed Management in Soybeans. No. Carolina State Univ. (Mimeo)
34. Vengris, J. 1975. Weedy grass competition in corn. Proc. Northeast Weed Cont. Conf. 29:141.
35. Wilson, H. P. and R. H. Cole. 1966. Morningglory competition in soybeans. Weeds 14(1):49-51.
36. Wilson, R. G., Jr. 1981. Effect of Canada thistle (*Cirsium arvense*) residue on growth of some crops. Weed Sci. 29(2):159-164.

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