Chapter 10: Cultural Control

Charlie Cahoon

Summary

Cultural weed control consists of crop rotation, variety selection, soil fertility, planting date, seeding rate, row spacing, leaf architecture, and disease and insect management (in other words, good agronomic practices). These methods are used to produce a healthy crop that can efficiently compete with weeds. Achieving rapid crop canopy closure and maintaining a dense crop canopy is the cornerstone of integrated weed management.

Introduction

Crops and weeds continually compete for valuable resources, including light, nutrients, water, and space. Cultural weed control encompasses any tactic that creates a competitive advantage for a crop. A competitive and healthy crop better suppresses weed growth. Ultimately, this comes down to a "survival of the fittest" contest between crops and weeds.

Many cultural tactics for weed management have been employed since the beginning of cultivated agriculture, but their contributions to weed control are often overlooked. Examples of these tactics are selecting varieties adapted to the area; manipulating seeding rates, row spacing, and planting dates; maintaining soil fertility; scouting for and controlling insects and diseases; and rotating crops. To boost crop yield, quality, and economic return, farmers frequently employ all of these tactics. Many of these tactics establish a crop canopy quickly and maximize the amount of sunlight captured by the crop. The amount of light available to weeds then decreases. The following sections will discuss specific cultural weed management tactics more in depth.

Crop Rotation for Weed Management

Crop rotation often increases crop yield by improving soil fertility and suppressing insects and disease. Strategic crop rotation also increases the crop's ability to suppress weed growth.

Planting crops with varying growth habits, growing seasons, and characteristics disrupts weed life cycles. Each crop has different optimum planting dates and weed management schedules. Farmers can uses these varying schedules to manipulate their cropping systems and prevent the dominance of a weed species. For example, Italian ryegrass is a troublesome winter annual weed that infests winter small grain. To avoid Italian ryegrass, farmers can plant summer annual crops and work to control Italian ryegrass before the summer cash crop is planted and before it produces seeds. After ensuring Italian ryegrass does not reproduce for a few seasons, the farmer can return to growing winter small grain. Then Italian ryegrass will be less of a problem.

Using a more competitive crop to suppress certain weeds prior to planting a less competitive crop also can be helpful. A more competitive crop will rapidly establish its canopy or maintain its canopy longer, while a less competitive crop is slow to develop a canopy or may have a short-lived canopy. For example, in a Maryland study, researchers observed that corn planted after hay had fewer smooth pigweed and common lambsquarters than corn planted after soybean (Teasdale et al. 2004b). Smooth pigweed and common lambsquarters, which are more competitive with soybean than a densely planted hay crop, produced more seed in soybean than hay. In addition, the hay crop was periodically mowed, which reduced seed production of smooth pigweed and common lambsquarters. This resulted in a greater weed problem in corn planted after soybean compared to corn planted after hay. The opposite was true for grass species, grasses are difficult to control in hay. Annual grasses were denser in corn planted after hay than in corn planted after soybean.

Crop rotation also is important when planning herbicide programs. Herbicide use varies by crop, and rotating crops means farmers can alternate herbicide sites of action (see Chapter 7: *Chemical Control*), which is essential in avoiding herbicide resistance. Additionally, the ease of controlling a certain weed in a rotational crop often depends on what herbicides are available for use in that crop. For example, in the Mid-Atlantic region, common lambsquarters was found to be more easily controlled in a corn-soybean and corn-tomato-soybean rotation than in a continuous soybean system (Manley et al. 2001) (Figure 10.1). In this study, each crop received a different combination of herbicides. Soybean plots received a mixture of fomesafen (Reflex®) and fluazifop plus fenoxaprop (Fusion®); corn plots received a mixture of atrazine and butylate (Sutan +); and tomato plots received a mixture of metribuzin and trifluralin (Treflan®). Because the mixture of fomesafen and fluazifop plus fenoxaprop did not effectively control common lambsquarters, the weed could reproduce in years when soybean were grown.

In contrast, herbicides used for corn and tomato plots controlled common lambsquarters well, so common lambsquarters density decreased when these crops were incorporated into the rotation. Although Figure 10.1 indicates that common lambsquarters control was best in the continuous corn (C-C-C-C) treatment, diverse crop rotations are necessary to decrease herbicide resistance development.

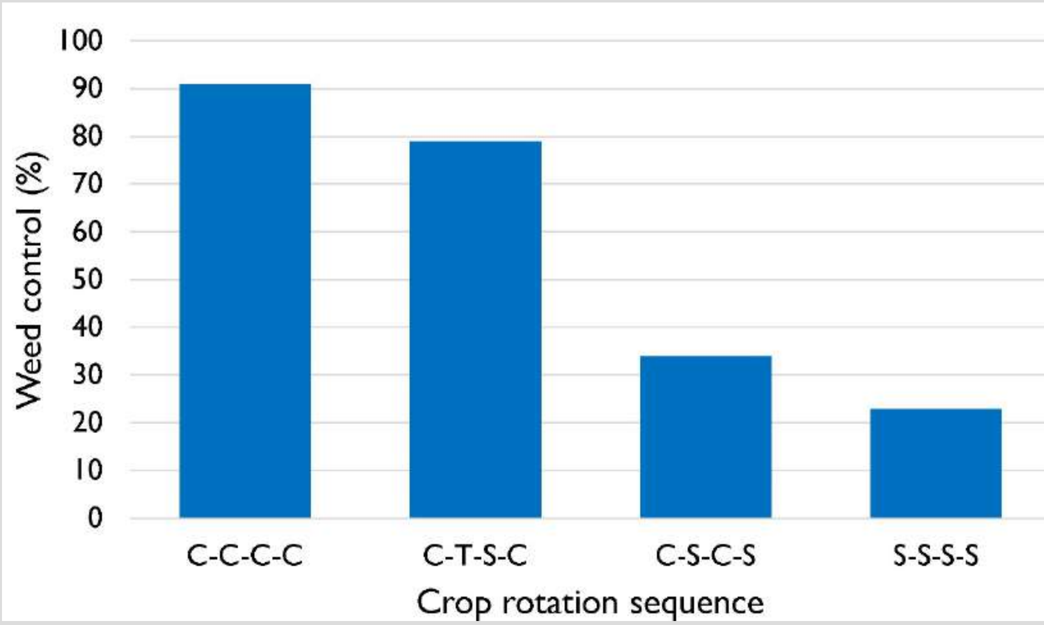

Figure 10.1. Common lambsquarters control during the last year of a four-year cropping system as affected by crop and herbicide rotation. C = Corn; S = Soybean; T = Tomato (Adapted from Manley et al. 2001).

Crop Variety Selection

Selecting vigorous crop varieties limits competition from weeds and reduces weed seed production. Farmers should plant crop cultivars most adapted to local planting date and growing conditions. Varieties that quickly form a dense canopy are often more competitive than slower growing cultivars. In addition, full-season varieties may be more competitive compared to earlier-maturing varieties because their canopy stays fuller longer, shading out weeds. In one study, North Carolina researchers reported seeing more late-season weeds in an early-maturity soybean cultivar than in a full-season variety after a postemergence spray (Yelverton and Coble 1991). A crop's early leaf shed allows more light to penetrate the canopy, allowing weed development late in the season. Canopies of later-maturing varieties impeded light for a longer duration than early-maturing varieties. Likewise, another North Carolina study reported three winter wheat varieties differed in their abilities to suppress Italian ryegrass (Worthington et al. 2013). In this study, tall cultivars were more competitive than short cultivars with Italian ryegrass by decreasing light penetration through the canopy compared to shorter cultivars. Farmers also should consider disease and insect tolerance in variety selection, since varieties affected by disease or insects are not as effective in developing a dense canopy.

Soil Fertility

Farmers often apply soil amendments, such as fertilizers and lime, to achieve higher crop yields. However, these amendments also jumpstart crop growth, establishing a competitive advantage over weeds. For example, wheat is more responsive to nitrogen than the weed Persian darnel (Blackshaw and Brandt 2008). Persian darnel growth is favored when the soil is low in nitrogen. Therefore, wheat can better compete with Persian darnel with sufficient nitrogen. A similar phenomenon is seen with phosphorus: wheat is more competitive with downy brome, henbit, and wild oats under low phosphorus conditions because wheat is less responsive to phosphorus than the weeds (Blackshaw and Brandt 2004). Soybean are capable of creating their own nitrogen with nitrogen-fixing bacteria. Limiting external nitrogen while producing soybean prevents weeds from obtaining of an essential nutrient without penalty to the crop.

Soil pH also can favor one species over another. Most plants grow best at slightly acidic to near neutral soil pH. However, some plants require more acidic or alkaline conditions. Buchanan et al. (1975) reported large crabgrass could tolerate soil pH as low as 4.8, whereas redroot pigweed was less vigorous at pH 5.3 or below. This means that under acidic conditions, when most plants suffer, some weeds gain the upper hand.

Maintaining a competitive crop means paying close attention to soil fertility and supplying soil amendments, such as nitrogen, phosphorus, potassium, other nutrients, or lime, in a timely manner. Consider the 4 Rs of nutrient stewardship: right source, right rate, right time, and right place when fertilizing crops to ensure the crop is healthy and can compete with weeds to the best of its ability (Figure 10.2) (TFI 2017). Right source means choosing a fertilizer that best matches your crop's nutrient needs. The right rate is achieved by matching fertilizer rates with crop nutrient demand. Fertilizer applications should focus on feeding the crop. Supplying only what the crop needs limits surplus nutrients that otherwise would be used to improve weed growth. Coordinating fertilizer applications when the crop needs nutrients corresponds to the right time. And right place means placing nutrients where the crop can best utilize them. A nutrient's close proximity to a crop allows roots to readily access nutrients that weeds may not access. Following the 4Rs prevents the waste of money spent on excess fertilizer.

Figure 10.2. 4R's: Right source matches fertilizer type to crop needs; Right rate matches amount of fertilizer to crop needs; Right time makes nutrients available when crops need them; and Right place keeps nutrients where crops can use them (TFI 2017).

Planting Date

Planting date can be strategically planned to give crops or cover crops a competitive edge. If planned strategically, planting date can give crops a competitive edge. Farmers should choose planting dates that encourage a crop's rapid emergence (warm seedbed, warm air temperatures, and adequate soil moisture), early-season growth, and formation of a dense canopy. The goal is to rapidly form a dense crop canopy that efficiently gathers sunlight and shades out weeds.

Planting crops when conditions are not favorable for weed germination and development is also important. A Maryland experiment studied the effect of a planting delay in corn on plant weight of several weed species (Teasdale and Mirsky 2015). In this study, common ragweed, giant foxtail, and corn weight changed little over planting dates ranging from May 7 to June 30. However, smooth pigweed weight increased 10.5 grams from the earliest to latest planting date. This means that early planted corn was more competitive with smooth pigweed than the later planted crop.

Knowing when weeds emerge can be useful in determining planting dates that give crops a competitive advantage over weeds. While the start of the weed seed germination period varies each year, the emergence sequence of weed species is fairly consistent (see Chapter 3: *Weed Emergence, Seedbank Dynamics, and Weed Communities*, see Figure 3.2*)*. For example, common ragweed is one of the first summer annual broadleaf weeds to emerge during the spring. Pigweed species normally germinate later than common ragweed. When planting corn, early-emerging weed species, such as common ragweed or common lambsquarters pose more of a threat than late-emerging weeds like pigweed species. Early-emerging weeds may germinate before or shortly after corn emerges, giving them the opportunity to use light, moisture, nutrients, and space that would otherwise be available to the corn. However, late-emerging species may not germinate until after a dense corn leaf canopy has been established.

Germination of early-emerging weeds would be near completion when soybean are planted. These weeds can be removed by mechanical or chemical methods prior to planting soybean with less chance of more weeds emerging after planting. Late-emerging weeds will be a bigger issue in soybean planting than in corn. With this knowledge, farmers can adjust planting dates such that crop and weed emergence do not occur simultaneously (Myers et al. 2004).

Planting date also plays an important role in cover crop biomass accumulation and subsequent weed control by the cover crop. Nord et al. (2012) reported cereal rye sown in September accumulated more biomass and suppressed weeds better than cereal rye sown in October. Likewise, hairy vetch (Teasdale et al. 2004a) and mixtures of rye and hairy vetch (Mirsky et al. 2011) biomass declines as planting is delayed and subsequent weed control is reduced. Because cover crops planted early in the fall accumulate more biomass, they may better suppress weeds the following spring (see Chapter 12: *Cover Crops for Weed Suppression*)

Seeding Rate, Row Spacing, and Leaf Architecture

Achieving rapid crop canopy closure is critical to establishing a competitive advantage over weeds and is key to cultural weed management. Crop canopy closure interrupts a weed's ability to intercept light, suppressing weed growth and development (Yelverton and Coble 1991). Seeding rate and row spacing adjustments are cost effective ways to enhance canopy closure. Crops planted at high seeding rates can reach canopy closure sooner than crops planted at low seeding rates. Many studies from the Mid-Atlantic region have demonstrated that increased seeding rates and narrow row spacing provide weed control benefits. In an organic soybean production system, redroot pigweed density decreased from approximately 32,000 plants per acre to 12,000 plants per acre as soybean seeding rate increased from 75,000 seeds per acre to 225,000 seeds per acre (Place et al. 2009). In general, soybean seeding rates less than 80,000 seeds per acre experienced higher weed density or less weed control (Bell et al. 2015; Jha et al. 2017). Similarly, increasing spring wheat seeding rate by 50% (1.6 to 2.4 million seeds per acre) reduced mustard density by 36%, biomass by 37%, and seed production by 42% (Kolb et al. 2012). In North Carolina, increasing sorghum seeding rate from 80,000 seeds to 120,000 seeds per acre, improved weed control (Besançon, et al. 2017). The effectiveness of increasing seeding rates is generally reduced when preemergence herbicides are used.

Using narrow row spacing has a similar effect on weed density. Narrow rows allow for quicker canopy establishment. North Carolina researchers studied the effects of row spacing on late-season weed resurgence in soybean (Yelverton and Coble 1991). Compared to soybean grown in 36-inch rows, late-season weed resurgence was reduced 43 to 86% by growing soybean in 18-inch rows. Growing soybean in 9-inch rows reduced weed resurgence even more (Figure 10.2). In a Maryland study, researchers reported the canopy of corn grown in 15-inch rows closed one week earlier and was more competitive with weeds than corn grown in 30-inch rows (Teasdale 1995). But in general, narrow row soybean are more likely to impact weed competition than narrow row corn (Bradley 2006).

Leaf architecture of a crop also affects the ability of a crop canopy to intercept sunlight. Horizontally-oriented leaves capture more light than vertically-oriented leaves, reducing weed density, weed biomass, and weed seed production (Sankula et al. 2004). Farmers should use these strategies to produce a crop that efficiently captures sunlight, while at the same time limiting light available to weeds.

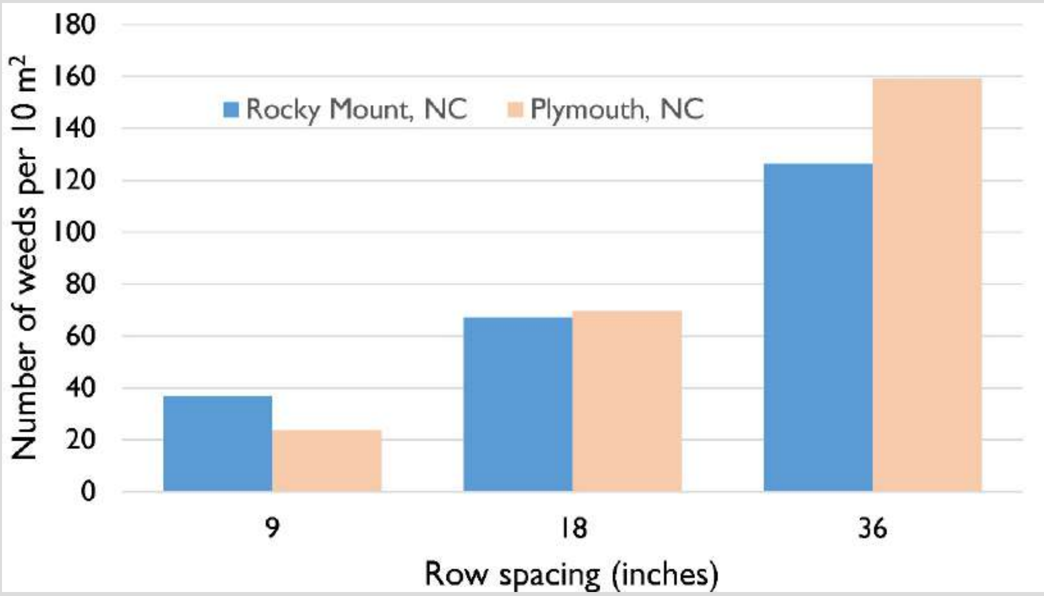

Figure 10.2. Effects of soybean row spacing on late-season weed emergence at Rocky Mount and Plymouth, NC. Adapted from Yelverton and Coble (1991).

Disease and Insect Control

Although diseases, insects, and weeds are often separated into different pest categories, controlling one can influence another. Many diseases and insects can defoliate crops. Premature crop defoliation increases light available to weeds. For example, many insects feed on soybean leaves. Holes created in leaves or leaf drop caused by intense feeding allow more sunlight to penetrate the soybean canopy, which is then available to suppress weed growth. Because of this, farmers may need to control weeds for a longer period of time in a crop defoliated by insect pests than in a non-defoliated crop. For example, Nebraska researchers reported that a soybean crop defoliated by 60% required weed control for an additional 14 days (Gustafson et al. 2006).

Farmers will see similar trends when encountering diseases that cause defoliation. Severe infections of bacterial blight, downy mildew, and soybean rust are some of the diseases that can defoliate soybean (Faske et al. 2014).

From an Integrated Weed Management standpoint, farmers should routinely scout for disease and insects and control these pests when necessary (see Chapter 4: *Weed Scouting and Mapping*). It is important to remember that a healthy crop, free of disease and insects, maintains its competitive advantage over weeds.

Key Points

- Any tactic that improves the ability of a crop to compete with weeds is considered a cultural method of weed control.
- Some weeds are easier to control in certain crops; making crop rotation a good strategy for reducing weed populations.
- A healthy crop competes better with weeds.
  - Be sure the fertility demands of your crop are met,
  - Ensure your crop is free of disease and insects.
- Rapid germination and early-season growth is key to choosing varieties that can better compete with weeds.
- Plant crops and cover crops when conditions favor crop development and less favorable for weed growth.
- Time of weed emergence varies by species; choose a planting date that gives your crop an advantage.
- Quickly forming a dense crop canopy is critical to disrupting weed germination and growth. This can be achieved by the following:
  - Selecting vigorous varieties adapted to local conditions;
  - Increasing seeding rates;
  - Planting the crop on narrow row spacing;
  - Choosing varieties or a crop with leaf orientation that limits light penetration.

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