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Chapter 4

Weed Management in the Soybean Crop

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1. Introduction

Inadequate weed control is one of the main factors related to decrease in soybean production. Weeds compete with crops by resources (water, light and nutrients). This competition is important mainly in the initial stages of crop development, due to possible losses in production that can be up to 80% or even, in extreme cases, hinders harvest operations [1].

Weeds have traits which confer them great aggressiveness even in adverse environments. High number of seeds, seed dormancy, discontinuous germination, effective dispersal mechanisms and population heterogeneity, are very important for weed establishment during crop development. During this phase, weeds may rapidly capture resources and occupy space; this is often linked to their competitive ability, because rapid growth requires the prompt and efficient conversion of resources into biomass. Thus, the yield is reduced and production costs increase, resulting in a decrease in farmer's income.

Besides reducing crop yield, weeds can cause other problems, like reduce grain quality, cause loss and difficulty during harvesting and serve as hosts of pests and diseases. The role of weeds as alternate hosts for soybean crop pests and diseases and their interference with cultivation operations resulting into higher costs of production must not be over looked. Weeds can also release toxins highly harmful to crop development. However, despite weeds show many negative aspects, they can also show advantages, like: providing food for the wildlife; potential source of germoplasm; recycling nutrients and preventing soil erosion.

Competition is defined as the condition that exists when requirements of one or more organisms living in a community cannot be obtained from available resources. Because competition involves many direct and indirect factors, it is often, preferable to consider it as interference of a plant community on another one, rather than competition. Interference is a natural phenomenon in a plant community where limited resources exist, and tends to be more harmful to competitors as more equal are the environmental demands and vegetative habit between them.

In agricultural ecosystems, weeds show competitive advantages over crop plants, because the aim of crop breeding is to increase the economic productivity, and this is almost always accompanied by a decrease in the competitive potential. Another important aspect in weed interference is the capacity of weeds in reducing or preventing cultivated plants to get access to resources. Thus, when those are limited, weeds almost always stand out, due to its higher efficiency in either capturing or using them. It is up to farmers and agronomists to use weed control methods and cultural practices in order to increase the chances of the crop overcoming weeds in the competition for resources.

Reduction in weed competition is perfectly achievable with the wide spectrum of tools and herbicides existing in the market, but weed management strategies are not related solely to the use of herbicides [2]. Weed control consists in suppressing the development and/or decreasing the number of weeds per area, until an acceptable levels for the coexistence between the species involved is reached, with minimum damages to both. In soybean crop, weed control can be achieved by using one or more control methods that are: preventive, mechanical, chemical, biological and cultural. Farmers can also use the integrated weed management (IWM), in which two or more of these methods are adopted.

The IWM approaches incorporate multiple tactics of prevention, avoidance, monitoring and suppression of weeds, undergirded by the knowledge of the agroecosystem biology [3]. The development of IWM was motivated by a desire to provide farmers with systematic approaches to reduce reliance upon herbicides [4] and, consequently, retard the selection of herbicide-resistant biotypes. The use of integrated control facilitates weed control during all crop cycle. The cultural practices, like soil tillage, fertilization, cultivar choice, sowing time, number of plants per area and crop rotation should be done in order to benefit crop development, and in some cases can reduce or eliminate the need of using other control methods.

The aim of this chapter is to summarize basic information about weed interference and weed management in the soybean crop, subsidizing technicians in the adoption of suitable positions regarding problems with weed control.

2. Competition between weeds and soybean by abiotic and biotic factors

Plants genetically improved by human action, aiming increases in productivity, lost part of their aggressive nature and therefore the ability to survive and compete against adversities imposed by the environment. Thus, most of the weeds show higher extraction capacity and

utilization of environmental resources compared to cultivated species. The competition for limited resources or not, directly or indirectly, can be described as: *spatial* competition, which is generated by the physical dominance of a given species over another, simultaneously; a second classification that could be addressed is *temporal* competition, that results from competition over the time in which the crop is under development [5].

The various aspects of competition occurring between weeds and crops may also be named *ecological*, being classified as to their nature in biotic or abiotic [5]. The former are those from the live action elements of the ecosystem, such as predation, parasitism, commensalism, morphophysiological factors among others. The latter is a result of the action of non-living environmental factors, such as climatic and soil factors.

2.1. Competition between soybean and weeds for biotic factors

The biotic factors that determine the increased competitiveness of certain species over others are: plant size and architecture, growth rate, extension of root system, dry mass production, increased susceptibility to environmental elements (such as frost and dry spells), greater leaf area index and greater capacity for production and release of chemicals with allelopathic properties [6].

Morphophysiological traits of plants influence the competitive relationship between crop and weeds. Plant height and development cycle, for example, are features that have been positively associated with competitive ability in soybean; cultivars with higher cycle length and height reduce seeds production and size of weed species due to the increase in competitiveness of the crop [7].

Moreover, yield losses due to competition tend to be higher the more similar are the individuals, i.e. their morphophysiological traits, reaching maximum stress within the same species, because in this case neighboring plants compete for the same resources and occupy the same ecological niche [5].

2.1.1. Plant traits indicators of higher competitive ability

The competitive ability of crops can be expressed according to the crop ability to compete with weeds, reducing the production of seeds and dry mass accummulation by weeds, which is called *suppressive ability*. There is also the crop ability to *tolerate competition* with weeds, when under competition the crop is capable of maintaining yields almost unchanged [8, 9]. For Jordan [10], the suppressive ability should be preferred because it reduces seeds production by weeds and its benefits remain for subsequent growing seasons, while tolerance to weeds limits its benefits only to the current growing season. It is worth noting that in case crops do not have the ability to suppress weeds, the probability of yield reduction is increased, regardless of crop tolerance to competition.

Olofsdotter [11] remarks that several traits which confer competitive ability are genetically changeable, and can be manipulated by plant breeding, as they are elucidated by research. According to the author, it is necessary to identify one or more traits as well as their genetic

variability in the crop. After demonstrating its variability, studies are needed to indicate the mechanisms involved and the environmental effect on the expression of these traits. Finally, it is necessary to involve geneticists and breeders in the identification of genes coding for the desired trait, as well as to evaluate the usefulness of indicators in the selection, i.e. if the character can be selected.

Differences in competitive ability between soybean cultivars with weeds have been reported by Bussan et al. [12]; Jannink et al. [9]; Lamego et al. [13]; Bianchi et al. [14] and Fleck et al. [15]. Suitable conditions for crop planting, such as moist soil, proper and uniform planting depth, close contact between seed and soil, as well as certified quality seeds, are essential to ensure competitive advantage to the crop by promoting the rapid emergence and establishment of uniform populations. In a study with soybeans, higher size of seeds resulted in seedlings with higher hypocotyl expansion rates, which may constitute a favorable feature in adverse conditions of emergence as in the case of soil crusting following heavy rainfalls [16].

2.1.2. Exploring competitive traits

The use of cultural methods for weed management can minimize weeds interference on soybean. Among the most efficient management practices for the suppression of weeds, the population density of the crop can be highlighted, as well as equal plants arrangement, development cycle and root growth of the crop.

2.1.3. Population density

In areas of agricultural production, the density of cultivated plants is kept constant along the field while weeds density varies with the degree of infestation, which is determined by the soil seed bank richness [17, 5]. According to these authors a variation occurs in the crop/weeds density ratio, making important to understand in competition studies not only the influence of density in the competition process – additive studies, but also the influence of the variation in the species proportion in the population - substitutive studies [5].

The duration of the period planting-emergence is also affected by seeding rate, temperature and soil moisture, planting depth and seed traits [18]. The duration of this period changes seedling height and subsequently, the intra-specific competitive ability. According to this author, the effects on the duration of this period are more evident under high plant densities.

2.1.4. Emergence speed

The use of high vigor seeds, which provide immediate plant emergence after planting, is important for the cultural management of weeds. In the dispute for limited environmental resources, the advantage is granted for plants that exhibit early establishment. A growing plant must quickly seize space and other resources, and its competitive success depends on the anticipated use of them. Plants stop growing when its area is restricted by competitors, so that the last individuals appear to grow very little due to shading. Thus, a fast emergence is often more important than the spatial arrangement of individuals in determining the competitiveness of the population [19].

7. Final comments

The challenge of agriculture sustainability requires solving the trade-off between producing satisfying levels of agricultural products, both in terms of quantity and quality, and reducing the environmental impacts and preserving non renewable resources. Weed management is a key issue, because herbicides are the most sprayed pesticides around the world and they are some of the mostly found contaminating substances in the surface and below-ground waters. Therefore, it is necessary to adopt correct strategies for weed management, but for that it is necessary to know the ability of weed species, present in a given area, in relation to the crop, to compete for water, light and nutrients, factors responsible for decreasing crop yield. Simple measures like choosing the correct cultivar, adopting correct tillage practices, using cover crops and crop rotation are responsible for decreasing the use of herbicides and, consequently, contribute for environmental sustainability.

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