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Weed Problems and Site-Specific Herbicide Application in Wheat Cultivation

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Abstract **–** Wheat, one of the most ancient plant species in human history, is one of the first plant examples cultivated with the beginning of agriculture. Even today, it is one of the most cultivated plants in the world and has great importance in human nutrition. In parallel with this wide cultivation area, there are agricultural problems that need to be solved. The first and perhaps most important of these is the weed problem. Many annual and perennial, broad and narrow-leaved weed species compete with annual wheat plants and cause significant yield losses. In large areas and densely planted wheat, the most preferred control method is chemical control, as it has a quick effect, is relatively easy to apply, and alternative methods are not very suitable. Intensive and continuous use of herbicides causes many health and environmental problems in the long term. At this point, it is extremely important to determine methods that will reduce the amount of herbicide used. One of these methods is site-specific herbicide applications.

Keywords – Wheat, Weed, Herbicide, Site-Specific, Precision Agriculture

I. INTRODUCTION

A long period of time has passed since the first day that human communities began to live settled lives. During this time, which has continued throughout the ages, human communities have grown various plants both for food and for their non-nutritional needs. One of the most important nutritional sources of human beings is grains, which meet approximately half of the protein and carbohydrate needs. The plants that are most consumed in the world and have the highest cultivation area in terms of production amounts are also grains. Among grains, wheat constitutes 40% of consumption [1]. Today, wheat is one of the most important food sources consumed by people living all over the world, from the European continent to the Asian continent, from the American continent to the African continent. Wheat meets the basic food needs of a significant part of the world's population and provides a significant portion of 20% of the 3000 calories we need in our daily lives from wheat [2].

In addition to the products, we consume daily such as flour, bulgur, pasta and starch obtained from wheat production; The stems of the wheat plant can be used in the paper-cardboard industry and animal nutrition, in addition to human food. The decrease in the production of the wheat plant, which has an important place in human life directly and indirectly, affects everyone by causing the prices of many products we consume in our daily lives to increase. It is strategically important for countries whose consumption habits are based on grain and wheat products to constantly monitor wheat production areas and production amounts and to keep production amounts at a level that meets the nutritional needs [3]. Considering Turkey's climate zone and soil structure, wheat ranks first in agricultural production in terms of

both cultivation area and production amount and meets the main nutritional needs of people [4]

68.3% of the 26 million 606 thousand hectares of agriculturally produced area, and garden crops are grown in 13% [5]. When table 1 is examined, according to 2021 FAO (Food and Agricultural Organization) data, world wheat production is approximately 771 million tons. The country with the largest share in this production is the People's Republic of China (17.64%). China is followed by India (14.14%), Russia (11.29%), United States (6.53%), Canada (4.62%), France (3.96%), Pakistan (3.32%), Ukraine (3.27%), Germany (2.91%) and Turkey (2.69%). Our country ranks 10th in world wheat production with an annual production of approximately 20 million tons [6].

Table 1. Wheat production values in the World [6]

	2019	**2020**	**2021**
Area (ha)	21.569.3643	21.789.8510	22.075.9739
Yield (kg/ha)	3542.4	3473.9	3491.9
Production Amount (tons)	764.063.333	756.949.628	770.877.072

Table 2. Wheat production values of Turkey [6]

	2019	**2020**	**2021**
Area (ha)	6.831.854	6.914.632	6.623.061
Yield (kg/ha)	2781.1	2964.7	2664.9
Production Amount (tons)	19.000.000	20.500.000	17.650.000

II. WEED PROBLEM AND SITE-SPECIFIC HERBICIDE APPLICATION

Wheat is produced in every region of Turkey, and it ranks first among field products in terms of cultivation area and production amount. A total of 61.7 million tons of grains and other plant products have been produced in Turkey as of 2021 [7]. Weeds are one of the most important problems of plant production in Turkey. Since wheat is not a hoe plant, there is no valid method that the producer can use other than chemical control. For this reason, yield losses due to weeds in wheat are increasing [8]. It has been stated that the yield loss in wheat due to weeds in Turkey is 24% [9]. In addition to the negative impact of weeds on yield, the damage they cause to quality is not insignificant. As a result of the mixing of weed seeds with the plant material produced, the quality of the flour produced and the bread produced from it decreases, and some weed seeds may cause poisoning in humans and animals [10]−[15].

One of the important methods used for weed control in wheat growing areas is cultural measures. Crop rotation, seedbed preparation, adjustment of sowing time, sowing frequency and selection of competitive varieties have effects on reducing weed populations before production in wheat fields. After wheat planting, mechanical control methods cannot be applied to prevent the wheat plant from lodging. Therefore, in addition to cultural practices, chemical control should be used before the stemming period to prevent loss of productivity due to weeds [16].

The use of pesticides against harmful agents using chemical control methods is increasing every year in the world and in Turkey. Farmers are turning to chemical methods because they provide more practical and faster results against diseases, insects and weeds [17]. According to Turkish Statistical Institute (TUIK) [7] data, the most important groups used in chemical control in our country are 38% fungicides, 24% herbicides and 23% insecticides. Chemical control is the most commonly used control method for weed control in agricultural production areas, as it is easy to apply chemical control, has a rapid effect in a short time, and minimizes the labor force. However, chemical methods cause residue problems in the living and non-living environment and negatively affect human and environmental health [18]. The effects of chemical control methods on non-harmful organisms and the damage they cause to the soil, groundwater and the entire environment should not be ignored. Due to the unconscious use of chemical pesticides and their easy access, they endanger human and animal health and cause acute poisonings, chronic cases and deaths [19].

Pesticides are harmful to humans as well as to the entire living and non-living environment. They cause poisoning and death in animals, just like in humans. Pesticides cause residues in major food items consumed, such as livestock fat, milk, meat and eggs. Unconsciously used pesticides mix with underground and surface waters and harm fish and aquatic ecosystems. As a result of these effects, aquatic creatures may die in masses or be displaced

[20]-[21]. It is known that some soil herbicides negatively affect the development and activity of beneficial mycorrhizal fungi that live symbiotically with plant roots in the soil by 81.8% to 100% [22]. Many more examples of the side effects of pesticides used can be given. Many countries in the world are working to reduce the use of chemicals such as precision agriculture practices or good agricultural practices. The aim is to reduce the negative effects on the environment and human health by using less chemicals. One of these good agricultural practices is site-specific herbicide applications.

Weeds do not emerge homogeneously in agricultural lands. In the same garden or field, weeds are dense in some places and sparse in others, and in some places, there is no weed emergence or it is at an insignificant level. However, in conventional herbicide applications, the entire area (coverage) is sprayed, regardless of the presence and density of the weed in the land. Herbicide applications made by taking into account the weed types and densities found in agricultural lands are called "*site-specific herbicide applications*" and thus the amount of herbicide used is reduced. Today, in site-specific herbicide applications, both weed detection and spraying can be easily carried out with unmanned aerial vehicles. For this purpose, the area to be sprayed is visualized, especially with drones carrying multispectral cameras, and weed maps are created using appropriate software. With the application maps created, with the help of the global positioning (GPS) system, pesticide is applied to areas where weeds are present, while pesticides are saved by not applying pesticide to areas where it is not present or below the economic threshold. Today, many European countries are taking the necessary measures to reduce pesticide use and directing producers to alternative methods. While weeds are controlled by site-specific spraying, the soil and the environment are less polluted with the decrease in herbicide use [23].

In order to carry out site-specific pesticide application, each part of the land must first be examined thoroughly. For this, certain decision algorithms must be used to determine the most appropriate herbicide rate for each part of the field. Threshold models of the entire field should be extracted and weed density in only a part of a field should not be taken into account to make decisions. Site-specific information on yield and soil conditions makes it possible to establish site-specific economic thresholds based on the competitiveness of weeds and cultivars and yield expectations [24]. Some of the commercial hardware and software developed for precision agriculture applications include weed mapping tools in agricultural areas and control software that determines population densities and ensures appropriate chemical spraying. However, the number of farmers applying site-specific weed management is very low [25].

In order to contribute to the development of strategies for weed management in wheat cultivation areas, there is a need to conduct research on both reducing chemical use and examining the effects in terms of yield and quality by applying site-specific herbicides according to the density of weeds.

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