POSSIBILITIES OF WEED CONTROL IN SPRING CEREALS USING SMALL HERBICIDE DOSES IN POLAND CONDITIONS

MOŻLIWOŚCI ODCHWASZCZANIA ZBÓŻ JARYCH Z ZASTOSOWANIEM MAŁYCH DAWEK HERBICYDÓW W POLSCE

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ABSTRACT

Optimized application of the preparations aims at the utilization of the current state of knowledge, extension services and technical potential of sprayers in order to apply herbicides in the amounts required to achieve a specific objective, at the same time not exceeding the recommended dose of the preparation. The choice of a herbicide for a given level of weed infestation and development phases of weeds is a key element in weed control strategy. Weed control in spring cereals in Poland is based on the use of foliar applications. In studies on spring cereals the application of herbicides in the split dose system, using preparations designed for early weed growth stages, made it possible to obtain high effectiveness of weed control.

Key words: spring cereals, herbicide, reduced dose

STRESZCZENIE

Optymalizacja stosowania preparatów ma na celu wykorzystanie stanu aktualnej wiedzy, doradztwa oraz technicznych możliwości opryskiwaczy, w celu aplikacji środków ochrony roślin w ilości niezbędnej do uzyskania określonego celu, nie przekraczając zalecanej dawki preparatu. Dobór herbicydu do występującego zachwaszczenia oraz faz rozwoju chwastów jest kluczowym elementem w strategii odchwaszczania. W Polsce zwalczanie chwastów w zbożach jarych oparte jest na stosowaniu nalistnych zabiegów. W badaniach w zbożach jarych aplikacja herbicydów w systemie dawek dzielonych, stosując preparaty na wczesne fazy wzrostu chwastów, umożliwia uzyskanie wysokiej efektywność odchwaszczania uprawy zbóż jarych.

Słowa kluczowe: zboża jare, herbicydy, redukcja dawki

DETAILED ABSTRACT (IN POLISH)

W Polsce produkcja roślinna jest dużym działem rolnictwa, w którym w różnych systemach gospodarowania rolniczego dużo uwagi poświęca się występowaniu chwastów, stanowiących jedno z największych zagrożeń uzyskania odpowiedniej ilości i jakości plonu. W krajach europejskich, również w Polsce, poszukuje się nowych rozwiązań w celu ograniczenia szkodliwych aspektów oddziaływania rolnictwa na środowisko. Zmniejszenie ilości substancji aktywnej aplikowanej na powierzchni 1 ha nie należy traktować jako działania zmierzające do zmniejszenia intensywności produkcji, czy też obniżenia ilości i jakości plonu. Optymalizacja stosowania preparatów ma na celu wykorzystanie stanu aktualnej wiedzy, doradztwa oraz technicznych możliwości opryskiwaczy, w celu aplikacji środków ochrony roślin w ilości niezbędnej do uzyskania określonego celu, nie przekraczając zalecanej dawki preparatu. Prowadzone doświadczenia mają na celu opracowanie metod aplikacji minimalnej skutecznej dawki herbicydu w warunkach konkretnego pola, w ściśle określonych warunkach glebowo-klimatycznych. Obecnie jednym z ograniczeń optymalizacji stosowania herbicydów poprzez redukcję dawek są ograniczenia prawne. Według Ustawy o Ochronie Roślin (Ustawa z dnia 18 grudnia 2003 r. o ochronie roślin) zabrania się podawania informacji niezgodnych z etykietą-instrukcją stosowania, tym samym nakazuje się stosowanie dawek zapisanych w etykietach. Dawka herbicydu zawarta w etykiecie-instrukcji stosowania to ilość preparatu konieczna do osiągnięcia wymaganego stopnia efektywności zwalczania gatunków chwastów, (wymienionych w etykiecie-instrukcji stosowania) z uwzględnieniem szerokiego zakresu warunków klimatycznych, agrotechnicznych, edaficznych obszaru całego kraju. Dobór herbicydu do występującego zachwaszczenia oraz faz rozwoju chwastów jest kluczowym elementem w strategii odchwaszczania. Zboża jare są uprawiane na powierzchni niespełna 2 milionów ha stanowiąc około 17% w strukturze zasiewów. Zwalczanie chwastów w zbożach jarych oparte jest na stosowaniu nalistnych zabiegów. W badaniach w zbożach jarych aplikacja herbicydów w systemie dawek dzielonych, stosując preparaty na wczesne fazy wzrostu chwastów, pozwoliła uzyskać wysoką efektywność odchwaszczania zbóż jarych. W tych uprawach stosując eksperymentalnie mieszaniny herbicydów w ilości 10-20% zalecanej dawki skutecznie zmniejszyło zachwaszczenie w stopniu porównywalnym z obiektem standardowym, w którym stosowano zalecana dawkę herbicydu w jednym zabiegu.

INTRODUCTION

Plant production is a large sector within agriculture, in which in different farming systems a significant problem is the incidence of weeds, determine a major threat to the adequate level and quality of yields. An increasing supply of agricultural products imposes on farmers the necessity to be increasingly competitive, e.g. by reducing production costs while maintaining high levels and quality of yields. There is an increasing focus in many countries on the possible adverse effect of pesticides on human health and environment and in some European countries pesticide action plans have been implemented seeking to reduce the effects on non-target species, pollution of surface and ground water and pesticide residues in food [15]. In European countries, including Poland, novel solutions are searched for in order to limit the adverse aspects of environmental impact of agriculture. One of such systems, potentially offering the biggest chance of development in widely understood practice are crop production technologies in sustainable agriculture, which in contrast to intensive farming connected with high investment outlays, takes into consideration ecological aspects, profitability and social expectations. An important element of sustainable agriculture is the technology of integrated plant production and related integrated plant protection, in which weed control of crops is an indispensable element. Herbicides are an important element of this system.

Economic profitability is a crucial objective in plant production. However, apart from the production and economic objectives, more and more commonly ecological goals are also realized, understood as the protection of the natural environment against different types of pollution and hazards resulting from intensive farming activity. Insight into the problem of losses caused by weed infestation of fields is required into the understanding of the complexity of competition, which in turn facilitates the search for effective methods to prevent these losses or at least to reduce them.

WEED COMPETITIVENESS

The composition of segetal weed communities developed of crops exhibit certain characteristic features, indicating conditions under which they were generated. The species composition of weeds, as well as the occurrence of species more or less competitive towards the crops, are on the one hand connected with the resources of weed diaspores in the soil and on the other hand with the opportunities offered by the crop itself [9]. The harmful effect of weeds is going to increase as a consequence of adverse changes in plant biodiversity in agrobiocenoses

under the influence of anthropogenic factors, connected with the direct human activity as well as environmental factors [11]. This disadvantageous phenomenon may be prevented only by searching for new methods to control weed infestation of farmland.

WEED CONTROL OF SPRING CEREALS

Spring cereals are grown on almost 2 million ha, accounting for approx. 17% of arable land in Poland [2]. In spite of the large cropping area there seems to be no interest in the implementation of new systems of chemical weed control of these crops. Weed control in case of spring cereals is based on foliar applications.

Studies in Poland and other countries are conducted to assess the possible reduction of doses of applied plant protection agents. These studies are focused on two aspects the development of techniques of performed measures and optimization of applied herbicides. Efficiency of plant protection measures is closely related with the use of an appropriate spraying equipment. Moreover, the properly prepared sprayer, being in good working order, is a guarantee that used agents will reach their destination and provide the desirable biological effect [17]. At present sprayers fully meeting the requirements concerning precise application of pesticides are available in Poland.

An example of a novel herbicide application technique is the use of a sprayer equipped in a system for site-specific weed control. The system includes on-line weed detection using digital image analysis, computer-based decision making and Global Positioning System-controlled patch spraying [7]. A common use of such a solution is the matter of the future, while at present its application is limited by available technological solutions.

There is another direction of studies, focusing on the optimization of herbicide application. The aim of the performed experiments was to develop application methods for the minimum effective dose of a herbicide under the conditions found in a specific field, under precisely defined soil and climate conditions.

A reduction of active substance doses applied per 1 ha may not be treated as an action aiming at a limitation of production intensity or the deterioration of the level and quality of yields. Optimized application of the preparations aims at the utilization of the current state of knowledge, extension services and technical potential of sprayers in order to apply herbicides in the amounts required to achieve a specific objective, at the same time not exceeding the recommended dose of the herbicide [14].

The researches in order to reduce the input of agrochemicals for weed control, it may be possible to combine reduced doses of herbicides and still maintain acceptable weed population levels were conduced in the Institute of Plant Protection. In studies on spring cereals the application of herbicides in the split dose system, using preparations designed for early weed growth stages, made it possible to obtain high effectiveness of weed control. In those plantations the experimental application of a mixture of herbicides at 10 - 20% recommend dose effectively reduced weeding in a degree comparable with the standard object, in which the recommended herbicide dose was applied during one application (Table 1).

The primary objective of regulation of weed infestation should not be to completely eliminate weeds. The term "regulation of weed infestation" is being used with increasing frequency, especially in integrated protection methods. Studies conducted so far indicate that the regulation of weed infestation is dependent on the group of crops. The crop with high density, such as those of cereals or winter rape, it is frequently sufficient to reduce weed infestation by approx. 90%. The other weeds are overgrown as a result of competition of the crop effectively covering the soil. In such a situation this small number of weeds is of no economic importance. An essential element in the regulation of weed infestation rate on arable land is an appropriate crop rotation system. An appropriate crop rotation prevents before occurrence of weeds escalate. In integrated farming programs it is recommended to apply the crop rotation [8]. The competitiveness of the crop is enhanced by such measures as the timing of agricultural practices, mechanical weed control and the use of seeds free from weed diaspores.

Traditional ploughing, commonly applied in Poland, is more and more frequently modified in different ways. Apart from physical and chemical properties of soil, field weed infestation is affected by introduced simplifications in soil cultivation, often applied on the same field. Analyses most frequently indicate an increase in weed infestation with perennial and annual monocotyledon species, which requires intensification of cultivation measures [6].

The primary commodity crops production program focuses on the method by used herbicides as a valuable tool reducing the negative effect of weeds. The adoption of production practices are based on reduce tillage and crop rotation are contribute to herbicide application as the only solution in weed control.

Biological differences in growth and development between crops and weeds to a considerable degree determine the adopted weed control method, using both agricultural and chemical measures. In the regulation of weed infestation, apart from an appropriate herbicide

Table 1. Efficacy of weed control in spring barley
Tabela 1. Skutecznośc zwalczania chwastów w jęczmieniu jarym

Treatmet *Obiekt*	Rate of herbicide	Time of application in BBCH*) scale of crop	Fresh mass of weeds *Świeża masa chwastów*
	Dawka herbicydu	*Termin zabiegu w fazie wzrostu rośliny uprawnej wg skali BBCH**	[g m^{-2}]
Untreated - *kontrola*	-	-	1364,0
Micro-A	100%	GS21 + GS29	0,0
Micro-A	50%	GS21 + GS29	6,2
standard	100%	GS21	59,8
standard	100%	GS29	33,4

*) BBCH scale of plant growth stage [1]
Weeds in field experiments - *Gatunki chwastów w doświadczeniu:*
Anagallis arvensis, Anchusa arvensis, Chenopodium album, Fallopia convolvulus, Galium aparine, Galinsoga parviflora, Polygonum lapathifolium, Veronica sp, Viola arvensis
Micro A 100%: tribenuron-methyl 1,5 g·ha^{-1} + florasulam 0,5 g·ha^{-1} + fluroxypyr 12,5 g·ha^{-1} + clopyralid 15 g·ha^{-1}
Standard 100%: tribenuron-methyl 11,25 g·ha^{-1}

choice, depending on the floristic composition of a given field, a significant role is played by the date of the procedure, adjusted to phenophases of crops and weeds [12].

An appropriate regulation of weed infestation is based on plantation monitoring, in order to perform the herbicide application according to the weed infestation thresholds established for the most harmful species in a given culture and region of the country. The determination of weed infestation thresholds is not simple since its level depends on many factors; however, it ensures an appropriate decision is made on the required application of measures [16].

PRACTIC OPTIMIZATION OF HERBICIDE APPLICATION

At present one of the limitations in the optimization of herbicide application by reducing their doses is connected with legal regulations. According to the Act on Plant Protection (the Act of 18 December 2003 on plant protection) it is prohibited to supply information inconsistent with the label – application instructions (Art. 67), thus it is demanded to use doses given in the labels. Moreover, another aspect we need to consider is the fact that only plant protection preparations authorized for sale may be used, according to the label – instructions for use and closely following the manufacturer's recommendations. The Act stipulates that application treatments with these preparations are performed first of all using biological, agricultural and selection methods or integrated plant protection. Thus in accordance with the letter of the law, the application of a lower dose than that specified on the label is inadmissible. The herbicide dose given in the label – instruction is the amount of the preparation necessary to reach the required degree of control efficiency for specific weed species (given in the label-application instruction), taking into consideration a wide range of climatic, agricultural and edaphic conditions found throughout the country.

Under conditions found in a specific field it is not always necessary to apply the full recommended herbicide dose. The efficiency of the weed control measure is affected by many factors. Sensitivity of weeds to herbicides is decreasing with progress in successive phenophases — young plants are most sensitive. When applying herbicides at early phenophases of weeds, to 2 leaf stage (BBCH 12) [1], we may obtain high efficiency using lower herbicide doses [3, 4, 5, 13]. Different weed species, at different phenophases, respond to the same herbicide doses in a different manner. Efficiency of a weed control treatment is dependent on the weed infestation structure of a plantation and sensitivity of individual species to the applied herbicide. At a wide spectrum of redundant vegetation species or at the occurrence of persistent weeds it is advisable to use a herbicide mixture [15]. The choice of a herbicide for a given level of weed infestation and development phases of weeds is a key element in weed control strategy. Increased plant density of a crop increases its competitiveness in relation to weeds, which makes it possible to apply lower herbicide doses [10]. However, excessive plant density leads to an increased risk of lodging and disease infestation.

CONCLUSIONS

Access to information and professional extension services make it possible to obtain high efficiency of weed control measures using lower herbicide doses, applied in the split-dose systems. In weed control in the split-dose system it is essential to monitor plantations in order to apply appropriately selected herbicides to weed infestation conditions.

The problem of weed infestation is a major element in strategies of plant production in different plant production systems. The qualitative and quantitative changes of agroecosystem flora are dynamic processes, thus it is necessary to take them into consideration when adapting measures aiming at the regulation of weed infestation. In order to effectively manage weed infestation we need to gain insight into the position of weeds in the biocenosis and their effect on a given crop. New strategies of weed control may become more effective than those used in the past thanks to the combination of the previous holistic approach with extensive knowledge in the field of weed and crop ecology. Crop protection programs need to be precisely adapted to the situation found in the field.

REFERENCES

[1] BBCH Monograph., Growth stages of mono- and dicotyledonous plants (2nd ed. Uwe Meier), Federal Biological Research Centre for Agriculture and Forestry, 2001.

[2] Statystical yearbook of agriculture and rural areas, Central Statistical Office, Warsaw, 2007.

[3] Dogan M.N., Hurle K., Influence of growth stage and environmental factors on the efficacy of reduced doses of tribenuron-methyl on Chenopodium album L. Pflkrankh. Pflschutz, Sonderh. (1998) XVI: 673-679.

[4] Domaradzki K., Efektywność regulacji zachwaszczenia zbóż w aspekcie ograniczenia dawek herbicydów oraz wybranych czynników agroekologicznych, Monografie i Rozprawy Naukowe, IUNG-PIB Puław (2006) 17: 54-64.

[5] Domaradzki K., Kieloch R., Rola H., Skuteczność herbicydów w zależności od dawki i fazy rozwojowej chwastów, Prog. Plant Prot. (2003) 43(1): 109–114.

[6] Frant M., Bujak K., Wpływ uproszczeń w uprawie roli i poziomów nawożenia mineralnego na zachwaszczenie pszenicy jarej. Acta Agrophysica (2006) 8(2): 327-336.

[7] Gerhards R., Oebel H., Practical experiences with a system for site-specific weed control in arable crops using real-time image analysis and GPS-controlled patch spraying, Weed Research (2006) 46: 185-193.

[8] Głowacka A., Wpływ monokultury, płodozmianu i uprawy współrzędnej na bioróżnorodność chwastów w pszenicy jarej. Acta Agrophysica (2006) 8(3): 569-577.

[9] Jędruszczak M., Bojarczyk M., Smolarz H. J., Dąbek – Gad M., Konkurencyjne zdolności pszenicy ozimej wobec chwastów w warunkach różnych sposobów odchwaszczania – behawior zbiorowiska chwastów, Annales UMCS, Sec. E (2004) 59(2): 903-912.

[10] Kapeluszny J., Zachwaszczenie łanu zbóż jarych w warunkach zróżnicowanej gęstości siewu i oszczędnego stosowania herbicydów, Prog. Plant Prot./ Post. Ochr. Roślin (2002) 42: 483–485.

[11] Krawczyk R., Kierunki zmian zachwaszczenia - Szanse i zagrożenia, Prog. Plant Protection/Post. Ochr. Roślin (2005) 45(1): 233-241

[12] Krawczyk R., Aspekty stosowania obniżonych dawek herbicydów w zbożach jarych, Prog. Plant Protection/Post. Ochr. Roślin (2006) 46(1): 223-231.

[13] Krawczyk R., Wpływ terminu stosowania zredukowanych dawek herbicydów w zbożach jarych na efektywność zwalczania chwastów, Prog. Plant Protection/Post. Ochr. Roślin (2007) 47(3): 151-158.

[14] Krawczyk R., Obniżona dawka herbicydu − uwarunkowania, badania i praktyka, Prog. Plant Protection/Post. Ochr. Roślin (2008) 48(2): 621-627 .

[15] Kudsk P., Optimising herbicide dose:a straightforward approach to reduce the risk of side effects of herbicides, Environmentalist (2007) 28: 49−55.

[16] Lipa J., Nowoczesna ochrona zbóż, Pam. Puł. (1999) 114: 242-259.

[17] Wachowiak M., Kierzek R., Uszkodzenia roślin uprawnych a technika wykonania zabiegów ochronnych, Prog. Plant Protection/Post. Ochr. Roślin (2003) 43, (1): 442-447.