Roczniki Akademii Rolniczej w Poznaniu – CCCLXX (2005)

ROMUALD GÓRSKI[1], ROMAN KIERZEK[2]

THE EFFECT OF AGENTS MODIFYING PROPERTIES OF SPRAY LIQUID ON THE ACTIVITY OF PROPOXYCARBAZONE SODIUM (ATTRIBUT 70 WG)

From [1]Department of Plant Protection Methods
The August Cieszkowski Agricultural University of Poznań
and [2]Institute of Plant Protection, Poznań

ABSTRACT. Adjuvants used in the experiments caused an increased action of herbicide preparation propoxycarbazone sodium (Attribut 70 WG). After their application in the cultivation of spring wheat the efficiency of the herbicide in controlling common oat, considered a monocotyledonous weed in the conducted experiment, was found to increase. Adjuvants Superzwilżacz and Olbras Super 90 EC had a considerable effect on the efficiency of the herbicide. Controlling common oat with the use of the propoxycarbazone sodium preparation with the addition of one of the above mentioned adjuvants resulted in a significant increase in the grain yield of spring wheat in comparison to the object protected with the use of the herbicide with no adjuvants added. At the same time a considerable decrease was observed in oat fresh weight and its grain number and weight.

Key words: adjuvants, propoxycarbazone sodium, Attribut 70 WG, spring wheat, monocotyledonous weeds

Introduction

The application of adjuvants, enhancing the action of chemicals, is becoming increasingly important in plant protection. Their main role is to improve the properties of the spray liquid used while spraying plants.

The quality of water used to prepare the spray liquid to a large extent determines the weed-killing ability of herbicides. Extensive knowledge of its properties makes it possible to enhance the efficiency of weed control. Water quality may be improved by the addition of appropriate adjuvants to the liquid. Adjuvants modify the physicochemical properties of the liquid, increase herbicide retention on the surface of controlled weeds and enhance the uptake and translocation of active substances of applied herbicides directly to the place of their action. It is of special importance in case of the post-emergence control of monocotyledonous weeds (**Matysiak** et **al.** 1995).

Rocz. AR Pozn. CCCLXX, Ogrodn. 39: 33-44

PL ISSN 0137-1738

Attribut 70 WG is a selective systemic herbicide, uptaken by both roots and leaves of weeds (**Feucht** et **al.** 1999, **Pontzen** 2002). The tested preparation Attribut 70 WG belongs to herbicides from the group of sulfonylaminocarbonyltriazolinones. It contains 70% propoxycarbazone-sodium. This herbicide belongs to the group of agents with low toxicity to humans. Their action consists in blocking the enzyme of acetolactate synthase (ALS) in plant cells, a result of which is the retardation or inhibition of growth and dwarfing of weeds. At the base of leaf blades decolourations appear leading to their withering. This preparation acts effectively also against weeds emerging several weeks after its application; however, full herbicidal action is maintained 4-6 weeks after treatment. Under unfavourable weather conditions a very important effect on propoxycarbazone-sodium activity can have adequate foliar coverage and distribution of active ingredient. It is possible through an increased retention of a.i. by adding adjuvants (**Amann** 2002, **Fandrich** et **al.** 2001).

The aim of the conducted investigations was to determine the effect of selected adjuvants, modifying the properties of the spray liquid, on the improvement in the efficiency of herbicide propoxycarbazone-sodium in controlling a monocotyledonous weed (common oat – *Avena sativa* L.) in the cultivation of spring wheat (*Triticum aestivum* ssp. *vulgare* Mac Key) cv. 'Helia'.

Material and methods

Field trials, investigating the effect of agents modifying the properties of spray liquid on the action of propoxycarbazone-sodium in the control of a monocotyledonous weed in the cultivation of spring wheat, were conducted in the years 2002 and 2003 at the Winna Góra Experimental Farm, the Institute of Plant Protection of Poznań. Observations were conducted at the plantation of spring wheat (*Triticum aestivum* ssp. *vulgare* Mac Key) cv. 'Helia'. In order to enhance weed competition the wheat seeding rate was reduced by approx. 25%, amounting to 150 kg/ha. Wheat was sown at the spacing of 24 cm. Common oat (*Avena sativa* L.) cv. 'Dragon', considered in this study to be a monocotyledonous weed, was sown between rows in the amount of 50 kg/ha. Common oat (as model weed) was used also in other publications (**Kafiz** and **Caussanel** 1989, **Kibite** and **Harker** 1995, **Xiao-Yong Luo** et **al.** 2001).

Experiments were conducted in six plots (combinations), in a random block design with four replications. Plants were grown on a gray brown soil with pH 6.0, containing 0.8% humus. The area of one plot was 16.5 m^2 (length of 11 m, width of 1.5 m). Agrotechnical measures and mineral fertilization were performed according to recommendations developed at the Institute of Plant Protection of Poznań. In the vegetation season a standard program of wheat protection against diseases and pests was applied (Recommendations of the Institute of Plant Protection for 2002/2003).

The following combinations of agents modifying the properties of spray liquid (adjuvants) were added to propoxycarbazone-sodium:

– Atpolan 80 EC (mineral oil – 80% paraffin oil),
– Break Thru S 240 (non-ionic organosilicon surfactant – trisiloxane 100%),
– Olbras Super 90 EC (multicomponent adjuvant – no data),
– Superzwilżacz (surfactant – no data).

At the same time the effectiveness of the herbicide with no added agents modifying the properties of spray liquid was also tested. In the control object weeding was not performed.

The recommended dose of propoxycarbazone-sodium in the amount of 42 g a.i. /ha was applied for the purpose of weed control. Surfactants such as Superzwilżacz and Break Thru S 240 were applied at the constant concentration of 0.1%, whereas agents Atpolan 80 EC and Olbras Super 90 EC were used at 1.5 l/ha and 1.0 l/ha, respectively. Tap water was used to prepare spray liquid.

Applications were performed using an experimental field sprayer AP 12/t with a frame structure, mounted on a tractor adapted to field applications. The sprayer was equipped with slit nozzles by Spraying System, type Turbo TeeJet TT 110-02 VP, working at constant operating pressure of 3 bar (0.3 MPa). Spray boom at 2.0 m width was equipped with four nozzles. During the applications a total of 250 l spray liquid was used per hectare. The travelling speed of the sprayer was 3.8 km/h. The distance between sprayers and sprayed weeds was 50 cm.

Sprayings were performed when spring wheat was at the 4-6 leaf phase and the controlled oats at the 3-5 leaf phase. The effectiveness of adjuvants and the herbicide in oat control was assessed on the basis of measurements of fresh weight of weeds collected from individual plots from the area of $1m^2$, using the square-frame method. In each replication four measurements were taken with the use of a 100 × 25 cm frame and they were compared with the control objects not treated with the herbicide. The gravimetric analysis of oat fresh weight was performed 6 weeks after the herbicide application.

From a randomly selected sample taken during harvest the amount of 50 g grain was collected and divided into fractions, i.e. spring wheat grains were separated from oat grains. The number of grains found in each fraction was calculated along with their total weight. Moreover, the grain yield of spring wheat was also determined.

The numerical data obtained in the experiment were analyzed statistically using Duncan's test at the level of significance $\alpha = 0.05$.

Results

Table 1 presents the analysis of fresh weight of common oat after the application of propoxycarbazone-sodium with and without the addition of adjuvants in the cultivation of spring wheat.

It results from the data in the table that the application of adjuvants affected the efficiency of propoxycarbazone-sodium. In all the combinations with the adjuvants added a decrease was found in the fresh weight of oats in comparison to the object protected with the herbicide with no adjuvants applied. However, this decrease was statistically significant only in 2001.

In growing season in 2002 a significant improvement of efficacy was achieved by applying propoxycarbazone-sodium with adjuvant Break Thru S 240. In 2002 among all the tested adjuvants the highest efficiency was found for Olbras Super 90 EC, after the application of which the decrease in oat fresh weight in comparison to the control was 73.39%. The lowest efficiency was observed for the combination of herbicide propoxycarbazone-sodium with adjuvant Break Thru S 240. In this combination a decrease of 64.00% in oat fresh weight was recorded in comparison to the control.

Table 1

Efficiency of propoxycarbazone-sodium (Attribut 70 WG) with and without the addition of adjuvants in the control of monocotyledonous weed in the cultivation of spring wheat – analysis of common oat fresh weight (two growing seasons 2002-2003)
Skuteczność działania propoksykarbazonu sodowego (Attribut 70 WG) bez i z dodatkiem adiuwantów w zwalczaniu chwastu jednoliściennego w uprawie pszenicy jarej – analiza świeżej masy owsa siewnego (dwa sezony wegetacyjne 2002-2003)

Combination Kombinacja	Doses of herbicide (g a.i.) and adjuvant (l) per ha or concentration (%) Dawka herbicydu (g s.a.) i adiuwanta (l) na hektar lub stężenie (%)	Oat fresh weight from 1 m^2 plot Świeża masa owsa z 1 m^2 poletka (g)	
		2002	2003
Propoxycarbazone-sodium + Olbras Super 90 EC	42 + 1.0	–	226.68 a
Propoxycarbazone-sodium + Atpolan 80 EC	42 + 1.5	–	239.93 a
Propoxycarbazone-sodium + Superzwilżacz	42 + 0.1%	–	266.60 a
Propoxycarbazone-sodium	42	181.50 b	315.97 a
Propoxycarbazone-sodium + Break Thru S 240	42 + 0.1%	44.30 a	318.62 a
Control Kontrola	–	425.00 c	885.00 b

Means denoted with identical letters do not differ significantly at the level of significance $\alpha = 0.05$ according to Duncan's test.

Średnie oznaczone tą samą literą nie różnią się istotnie na poziomie istotności $\alpha = 0{,}05$ wg testu Duncana.

The analysis of variance showed the significance of differences while comparing the testing results obtained for the combinations of propoxycarbazone-sodium with and without the addition of adjuvants in relation to the control, in which no herbicide was applied.

Table 2 presents the analysis of the common oat grain number and weight after the application in spring wheat of herbicide propoxycarbazone-sodium with and without the addition of adjuvants (data only from 2003).

The application of adjuvants enhancing the action of propoxycarbazone-sodium resulted in its improved efficiency. In objects where adjuvants were added to spray liquid a decrease was recorded in oat grain weight and in case of Olbras Super 90 EC and Superzwilżacz a decrease was also observed in the oat grain number in comparison to the combination protected with the use of the herbicide alone. However, this decrease was not statistically significant.

The highest efficiency of herbicidal action in terms of the reduction of oat grain yields was found for Olbras Super 90 EC. The oat grain number after the application of this adjuvant was reduced by 77.77% in comparison to the control, whereas in case of oat

Table 2

Efficiency of propoxycarbazone-sodium (Attribut 70 WG) with and without the addition of adjuvants in the control of monocotyledonous weed in the cultivation of spring wheat – analysis of common oat grain yield in a sample of harvested crop in 2003
Skuteczność działania propoksykarbazonu sodowego (Attribut 70 WG) bez i z dodatkiem adiuwantów w zwalczaniu chwastu jednoliściennego w uprawie pszenicy jarej – analiza ziaren owsa siewnego w próbie zebranego plonu w 2003 roku

Combination Kombinacja	Doses of herbicide (g a.i.) and adjuvant (l) per ha or concentration (%) Dawka herbicydu (g s.a.) i adiuwanta (l) na hektar lub stężenie (%)	Mean number of common oat grains in tested sample (no.) Średnia liczba ziaren owsa w badanej próbie (szt.)	Decrease in mean oat grain number in comparison to control Zmniejszenie średniej liczby ziaren owsa w stosunku do kontroli (%)	Mean oat grain weight in tested sample Średnia masa ziaren owsa w badanej próbie (g)	Decrease in mean oat grain weight in comparison to control Zmniejszenie średniej masy ziaren owsa w stosunku do kontroli (%)
Propoxycarbazone-sodium + Olbras Super 90 EC	42 + 1.0	129.00 a	77.77	3.80 a	81.20
Propoxycarbazone-sodium + Atpolan 80 EC	42 + 1.5	196.00 a	66.23	4.90 a	75.73
Propoxycarbazone-sodium + Superzwilżacz	42 + 0.1%	157.75 a	72.82	4.95 a	75.50
Propoxycarbazone-sodium + Break Thru S 240	42 + 0.1%	186.00 a	67.95	5.41 a	73.24
Propoxycarbazone-sodium	42	184.25 a	68.25	5.66 a	72.01
Control Kontrola	–	580.25 b	–	20.22 b	–

Means denoted with identical letters do not differ significantly at the level of significance $\alpha = 0.05$ according to Duncan's test.

Średnie oznaczone tą samą literą nie różnią się istotnie na poziomie istotności $\alpha = 0{,}05$ wg testu Duncana.

grain weight this decrease was 81.20%, respectively. The lowest efficiency in the limitation of the oat grain number in relation to the control, amounting to 66.23%, was recorded for adjuvant Atpolan 80 EC. The organosilicon adjuvant Break Thru S 240 reduced the oat grain weight the least of the tested agents, as at the application of this adjuvant a 73.24% decrease in the oat grain weight was found in comparison to the control.

The application of adjuvants enhancing the action of propoxycarbazone-sodium in the cultivation of spring wheat had a significant effect on the improvement of the efficiency of this herbicide in comparison to the control object, not subjected to any chemi-

cal procedures. After the application of adjuvants a statistically significant decrease was observed in the common oat grain number and weight.

The efficiency of common oat control using herbicide propoxycarbazone-sodium with adjuvants added was also manifested in the obtained spring wheat grain yields (Table 3). In 2002 yield ranged from 6.80 t/ha to 7.50 t/ha for propoxycarbazone-sodium treatments (alone and in tank mixture with Break Thru S 240) and were significantly higher as compared with untreated plots. In the second season of 2003 after the application of Superzwilżacz a statistically significant increase was observed in the yield of spring wheat grains, whereas in case of the other adjuvants this increase turned out to be statistically non-significant in comparison to the combination, in which the herbicide was applied with no addition of adjuvants. The highest increase in wheat grain yields was found after the application of a mixture of propoxycarbazone-sodium with

Table 3

Efficiency of propoxycarbazone-sodium (Attribut 70 WG) with and without the addition of adjuvants in the control of monocotyledonous weed in the cultivation of spring wheat – analysis of spring wheat yield structure (two seasons 2002-2003)
Skuteczność działania propoksykarbazonu sodowego (Attribut 70 WG) bez i z dodatkiem adiuwantów w zwalczaniu chwastu jednoliściennego w uprawie pszenicy jarej – analiza struktury plonu pszenicy jarej (dwa sezony 2002-2003)

No. Lp.	Combination Kombinacja	Doses of herbicide (g a.i.) and adjuvant (l) per ha or concentration (%) Dawka herbicydu (g s.a.) i adiuwanta (l) na hektar lub stężenie (%)	Grain yield from plot Plon ziarna z poletka (t/ha)		Efficiency of preparation (% increase in oat grain yield) Skuteczność preparatu (% przyrostu plonu ziarna owsa) (%)	
			2002	2003	2002	2003
1	Propoxycarbazone-sodium + Superzwilżacz	42 + 0.1%	2.27 c	–	80.42	–
2	Propoxycarbazone-sodium + Olbras Super 90 EC	42 + 1.0	2.17 bc	–	71.89	–
3	Propoxycarbazone-sodium + Atpolan 80 EC	42 + 1.5	1.87 bc	–	48.39	–
4	Propoxycarbazone-sodium + Break Thru S 240	42 + 0.1%	1.84 bc	7.50 a	46.25	37.61
5	Propoxycarbazone-sodium	42	1.75 b	6.80 a	38.74	24.77
6	Control Kontrola	–	1.26 a	5.45 b	–	–

Means denoted with identical letters do not differ significantly at the level of significance $\alpha = 0.05$ according to Duncan's test.

Średnie oznaczone tą samą literą nie różnią się istotnie na poziomie istotności $\alpha = 0{,}05$ wg testu Duncana.

adjuvant Superzwilżacz. This increase amounted to 80.42% in comparison to the control, for which no plant protection measures were applied. A high efficiency was also observed for Olbras Super 90 EC. In the combination of the herbicide with the addition of this adjuvant the increase in grain yields was 71.89%. The lowest increase in the wheat grain yield was obtained after the application of Break Thru S 240, as it amounted to 46.25% in comparison to the control.

The results showed the significance of differences in the combinations of the herbicide with and without adjuvants added while comparing them with those for the control combination, where no weeding was performed.

Discussion

The investigations conducted by the author of this study showed an increase in the efficiency of propoxycarbazone-sodium in the control of a monocotyledonous weed at the simultaneous use of adjuvants. After their application the efficiency of the tested herbicide was found to increase in the cultivation of spring wheat (*Triticum aestivum* spp. *vulgare* Mac Key) cv. 'Helia' in the control of common oat (*Avena sativa* L.), considered in the experiment to be a monocotyledonous weed.

High efficiency was found for such adjuvants as Superzwilżacz, Break Thru S 240 and Olbras Super 90 EC. A joint application in the common oat control of propoxycarbazone-sodium together with one of the above mentioned adjuvants caused a significant increase in the yields of spring wheat in comparison to the object protected with the herbicide with no adjuvants added. Moreover, a considerable decrease was found in the fresh weight of oat and the number and weight of its grain.

Similar studies with the use of propoxycarbazone-sodium and adjuvant Olbras Super 90 EC applied in the doses of 42 g a.i. and 1.0 l per hectare were carried out by **Snarska** and **Szczygielski** (2003). In their investigations a 73.80% efficiency of the herbicide was found when it was used at the simultaneous application of the adjuvant in the control of wind grass (*Apera spica – venti* L.) in the cultivation of winter wheat, whereas propoxycarbazone-sodium alone gave the efficiency of 58.80%. This adjuvant applied jointly with sulfosulfuron (Apyros 75 WG) increased the number of destroyed weeds by 18.70% in comparison to the combination treated with the herbicide alone.

Adamczewski et **al.** (2000) in field trials investigated also the effect of a joint application of adjuvants with herbicides, including propoxycarbazone-sodium, in the control of quack grass (*Elymus repens* L. Gould.) in the cultivation of spring wheat. In the objects, on which adjuvant Olbras 88 EC was used together with propoxycarbazone-sodium, the efficiency of the preparation in the control of quack grass increased by 27.00% in comparison to the action of the herbicide alone. Spring wheat yield in plots, on which a mixture of propoxycarbazone-sodium with adjuvant Olbras 88 EC was applied, was 2.80 t/ha, whereas in the combination protected with the herbicide alone it was 2.72 t/ha.

In other studies **Adamczewski** and **Paradowski** (2002) also found that adjuvant Olbras 88 EC caused an increase in the efficiency of propoxycarbazone-sodium and additionally that of sulfosulfuron in the control of wind grass in the cultivation of winter wheat. The efficiency of propoxycarbazone-sodium increased by 8.00% at its joint ap-

plication with adjuvant Olbras 88 EC, while in case of sulfosulfuron the number of destroyed weeds increased by 4.00%. Spraying with herbicides with the addition of an adjuvant resulted in a simultaneous increase in the grain yield of winter wheat. It increased from 6.09 t/ha obtained in the combination of herbicide propoxycarbazone-sodium without an adjuvant to 6.56 t/ha at the simultaneous application of adjuvant Olbras 88 EC, whereas for herbicide sulfosulfuron it was from 6.07 t/ha to 6.56 t/ha, respectively. Similar results were obtained by **Snarska** and **Szczygielski** (2003). In the experiments conducted by those authors, the addition of adjuvant Olbras 88 EC caused a 2.30% increase in the efficiency of sulfosulfuron in the control of wind grass in the cultivation of winter wheat.

In the investigations conducted by the author of this study a lower effectiveness of oil adjuvant Atpolan 80 EC was found in comparison to Olbras Super 90 EC. Atpolan 80 EC used in the combination with propoxycarbazone-sodium relatively effectively decreased the common oat fresh weight and grain weight. However, this adjuvant to a moderate degree caused an increase in the yield of spring wheat.

Studies on the action of adjuvant Atpolan 80 EC at its simultaneous application with herbicide propoxycarbazone-sodium were also conducted by **Adamczewski** et **al.** (2000). A mixture of the herbicide with an adjuvant at the doses of 42 g a.i. and 1.5 l per hectare, respectively, exhibited a 64.00% efficiency in the control of wind grass in the cultivation of spring wheat, whereas the herbicide alone with no adjuvant added gave the efficiency of 42.00%. Much better results in the control of wind grass were obtained by the authors at the simultaneous application of herbicide and adjuvant in case of winter triticale and winter wheat, i.e. 96.00% and 98.00%, respectively, whereas in the combination with the herbicide alone it was 88.00% and 94.00%. **Adamczewski** and **Paradowski** (2002) showed high efficiency of adjuvant Atpolan 80 EC at its simultaneous application with propoxycarbazone-sodium in the control of monocotyledonous weeds in the cultivation of winter wheat. An 11.00% increase in the efficiency of the herbicide was reported, while grain yield increased by 0.39 t/ha. Those authors investigated the efficiency of Atpolan 80 EC at its joint application with sulfosulfuron. The combination of the herbicide with the adjuvant showed the efficiency of 95.00% in the control of dicotyledonous weeds in the cultivation of winter wheat, while the efficiency of the herbicide alone was 88.00%.

In other studies **Woźnica** et **al.** (1997) tested Atpolan 80 EC in combination with nicosulfuron (Milagro 040 SC) and rimsulfuron (Titus 25 DF) in the control of quack grass and white goose-foot (*Chenopodium album* L.) in the cultivation of maize (*Zea mays* L.). The addition of the adjuvant caused an increase in the herbicidal efficiency of herbicides in comparison to the applications without the adjuvant added. Using adjuvant Atpolan 80 EC the efficiency of nicosulfuron increased by 7.00% at the herbicide dose of 0.5 l/ha and by 5.00% at the dose of 1.0 l/ha, while in case of rimsulfuron this increase was as high as 20.00%. In the studies conducted by **Krawczyk** et **al.** (2002) the combination dicamba + triasulfuron mixture (Lintur 70 WG) and adjuvant Atpolan 80 EC applied for winter cereals (winter wheat – *Triticum aestivum* spp. *vulgare* Mac Key and winter rye – *Secale cereale* L.) showed a 94.00% efficiency in the control of dicotyledonous weeds (white goose-foot – *Chenopodium album* L., field violet – *Viola arvensis* Murr.), whereas the herbicide alone reduced the number of weeds by 92.00%.

Many publications report on the effects of organosilicone surfactans on the herbicide performance. More than 20 herbicides of various herbicide families have been tested with organosilicones on different weed species in the field and greenhouse. Generally,

the efficacy of herbicides is increased by organosilicones. The results are equal to or better than those with conventional adjuvants. However, antagonism occurred when glyphosate was combined with organosilicones on several grass species (**Field** and **Tisdall** 1990, **Field** et **al.** 1992). Organosilicone surfactans can either improve or reduce the retention of spray, dependent on their concentration and the target plant/leaf characteristics (**Stevens** et **al.** 1994). According to **Beyer** et **al.** (1988), little is known about how environmental factors influence the phytotoxicity of sulfonylureas. Usually, environmental conditions favoring growth after treatment enhanced the herbicide activity of chlorsulfuron. For example, when chlorsulfuron was used to control green foxtail [*Setaria viridis* (L.) Beauv.] and kochia [*Kochia scoparia* (L.) Schrad.], chlorsulfuron phytotoxicity was greater at high (95 to 100%) than low (40% to 50%) relative humidity (**Nalewaja** and **Woźnica** 1985). Temperature was less important than relative humidity in this experiment. Soil moisture conditions favoring growth also enhanced chlorsulfuron phytotoxicity. If plants were water-stressed after chlorsulfuron treatment, they were less damaged than if they had not been water stressed or had been water stressed only before treatment. The biochemical and physiological mechanisms underlying these environmental effects are still not known.

The non-ionic organosilicon surfactant Break Thru S 240 tested in the investigations conducted by the authors of this study in the application jointly with propoxycarbazone-sodium resulted in different effect on the efficiency of monocotyledonous weed control and the grain yield of spring wheat. In 2002 addition of surfactant Break Thru S 240 to propoxycarbazone-sodium gave a very good effect on oat control, but in the next season resulted in the smallest increase in the efficacy of oat control and the grain yield of spring wheat. Reason of this is probably connected with effect of weather condition after treatments in both growing seasons. Generally, in 2002 the weather conditions were better for activity of propoxycarbazone-sodium applied with organosilicone surfactant (higher rainfall and soil humidity, higher relative air humidity) (Fig. 1 and 2). Numerous studies have shown that organosilicone surfactants improved the rainfastness of herbicides by inducing stomatal infiltration (**Kudsk** 1992, **Roggenbuck** et **al.** 1993). Simulated rainfall applied 2 h after spray application of glyphosate had no effect on the response of perennial ryegrass (*Lolium perenne* L.) in the presence of Silwet L-77, but in the absence of organosilicone surfactant, rain reduced herbicide effectiveness for up to 10 h after herbicide application (**Field** and **Bishop** 1988).

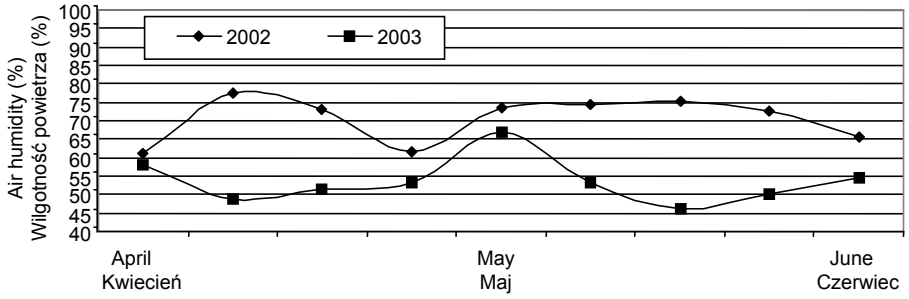

Fig. 1. Average air humidity between April-June in 2002-2003
Ryc. 1. Średnie dobowe wartości wilgotności powietrza w okresie kwiecień-czerwiec w latach 2002-2003

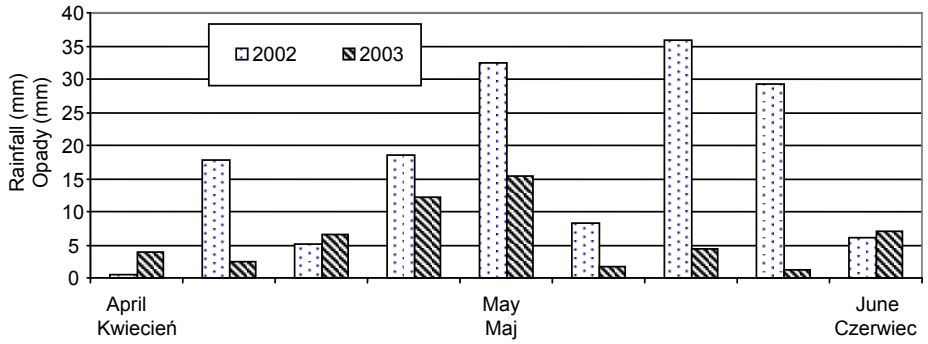

Fig. 2. Rainfall in decades between April-June in 2002-2003
Ryc. 2. Dekadowe opady deszczu w okresie kwiecień-czerwiec w latach 2002-2003

Other information may be found in literature on the efficiency of various non-ionic surfactants. Studies on non-ionic surfactant Trend 90 EC were carried out by **Woźnica** et **al.** (1997). A joint application of this surfactant with rimsulfuron in the control of quack grass and white goose-foot in the cultivation of maize caused an increase in the efficiency of the herbicide by 20.00%. In glasshouse experiments **Woźnica** et **al.** (2003) in the control of green bristlegrass (*Setaria viridis* L.) used non-ionic surfactants such as Activator 90, Silwet L – 77 and Alfonic 1412 – 60, jointly with sulfosulfuron. The efficiency of the herbicide after the addition of respective adjuvants increased by 21.00% for Activator 90, by 17.00 % for Alfonic 1412 – 60 and by 14.00% for L – 77.

Another adjuvant from the group of surfactants, investigated for several years, is Adbios 85 SL. Very good results were obtained while using it jointly with herbicide Titus 25 DF. This adjuvant increased the efficiency of quack grass control by 22.00% and panicgrass weeds by 23.00% in the cultivation of maize (**Adamczewski** et **al.** 1992). The application of adjuvant Adbios 85 SL jointly with Apyros 75 WG in the control of wind grass in the cultivation of winter wheat caused increased herbicide efficiency by 22.00%. In turn, winter wheat yield increased from 4.48 t/ha obtained for the combination protected with the herbicide alone to 4.96 t/ha after the addition of adjuvant Adbios 85 SL (**Adamczewski** et **al.** 1996). Similar experiments were conducted by **Woźnica** et **al.** (1998). They emphasized the effect of Adbios 85 SL on the improved efficiency of herbicide Apyros 75 WG in the control of wind grass in the cultivation of winter wheat. The addition of the adjuvant increased the efficiency of the herbicide by 15.00%.

Conclusions

1. The application of adjuvants enhances the herbicidal activity of propoxycarbazone-sodium. After their application an increase was found in the efficiency of this herbicide in the control of common oat (*Avena sativa* L.) in the cultivation of spring wheat (*Triticum aestivum* spp. *vulgare* Mac Key) cv. 'Helia'.

2. In case of propoxycarbazone-sodium it is recommended to apply such adjuvants as Superzwilżacz and Olbras Super 90 EC. The control of common oat using propoxy-

carbazone-sodium with the addition of one of the above mentioned adjuvants resulted in a significant increase in the grain yields of spring wheat in comparison to the object protected with the herbicide with no adjuvants added. At the same time a considerable decrease was observed in the fresh weight of oat and in the grain number and weight of oat.

References

Adamczewski K., Miklaszewska K., Praczyk T., Urban M. (1992): Adbios – nowy adiuwant do herbicydów. In: Materiały 32 Sesji Naukowej IOR. Cz. 2. Poznań.: 158-163.

Adamczewski K., Ratajczyk G., Kuzior S. (1996): Ocena przydatności sulfosulfuronu w uprawie pszenicy ozimej. Progr. Plant Prot./ Post. Ochr. Rośl. 36, 2: 261-264.

Adamczewski K., Banaszak K., Snarska K. (2000): Biologiczna ocena preparatu Attribut 70 WG w zbożach ozimych. Progr. Plant Prot./ Post. Ochr. Rośl. 40, 2: 775-779.

Adamczewski K., Paradowski A. (2002): Wpływ herbicydów Apyros 75 WG i Attribut 70 WG stosowanych z adiuwantami na zniszczenie chwastów w pszenicy ozimej. Progr. Plant Prot./ Post. Ochr. Rośl. 42, 2: 501-503.

Amann A. (2002): Propoxycarbazone-sodium – the chemical cornerstone of integrated brome-grass management in Germany. Pflanzenschutz-Nachr. Bayer 55, 1: 87-100.

Beyer E.M., Duffy M.J., Hay J.V., Schlueter D.D. (1988). Sulfonylureas. Herbicides: Chemistry, Degradation, and Mode of Action, 3: 117-189.

Fandrich L., McDonald S.K., Nissen S.J., Westra P., Santel H.J. (2001): Absorption and fate of BAY MKH 6561 in jointed goat grass and downy brome. Weed Sci. 49: 717-722.

Feucht D., Mueller K.H., Wellmann A., Santel H.J. (1999): BAY MKH 6561 – A new selective herbicide for grass control in wheat, rye and triticale. In: Proceedings of the Brighton Crop Protection Conference – Weeds: 53-58.

Field R.J., Bishop N.G. (1988): Promotion of stomatal infiltration of glyphosate by an organosilicone surfactant reduces the critical rainfall period. Pestic. Sci. 24: 55-62.

Field R.J., Tisdall L.J. (1990): The mechanism of organosilicone surfactantinduced antagonism of glyphosate uptake. Proc. Aust. Weeds Conf. 9: 332-335.

Field R.J., Dobson N.N., Tisdall L.J. (1992): Species-specific sensitivity to organosilicone surfactant-enhancement of glyphosate uptake. In: Adjuvants for Agrichemicals. Ed. C.L. Foy. CRC Press Inc., Boca Raton: 423-431.

Kafiz B.J.P., Caussanel P. (1989): Interaction between diclofop-methyl and 2,4D in wild oat (*Avena fatua* L.) and cultivated oat (*Avena sativa* L.), and fate of diclofop-methyl in cultivated oat. Weed Res. 29, 4: 299-305.

Kibite S., Harker K.N. (1995): Inheritance of resistance to diclofop-methyl and fenoxaprop-p-ethyl in two *Avena sativa* and *A. fatua* populations. Can. J. Plant Sci. 75, 1: 81-85.

Krawczyk R., Górniak J., Adamczewski K. (2002): Wpływ adiuwantów i innych preparatów na działanie herbicydu Lintur 70 WG w uprawie zbóż. Progr. Plant Prot./ Post. Ochr. Rośl. 42, 2: 557-559.

Kudsk P. (1992): The effect of adjuvants on the rainfastness of thifensulfuron and tribenuron. In: Adjuvants for Agrichemicals. Ed. C.L. Foy. CRC Press Inc., Boca Raton: 441-444.

Matysiak R., Woźnica Z., Pudełko J., Skrzypczak G. (1995): Adiuwanty do herbicydów - mechanizm działania. In: Materiały 35 Sesji Naukowej IOR. Cz. 1. Poznań.: 67-71.

Nalewaja J.D., Woźnica Z. (1985): Environment and chlorsulfuron phytotoxicity. Weed Sci. 33: 395-399.

Pontzen R. (2002): Propoxycarbazone-sodium (BAY MKH 6561): systemic properties and basis of selectivity in wheat. Pflanzenschutz-Nachr. Bayer 55, 1: 37-52.

Roggenbuck F.C., Penner D., Burow R.F., Thomas B. (1993): Study of the enhancement of herbicide activity and rainfastness by an organosilicone adjuvant utilizing radiolabelled herbicide and adjuvant. Pestic. Sci. 37: 121-125.

Snarska K., Szczygielski M. (2003): Wpływ herbicydów Apyros 75 WG i Attribut 70 WG, zastosowanych w zbożach, na zniszczenie chwastów i żywotności rozłogów perzu. Progr. Plant Prot./ Post. Ochr. Rośl. 43, 2: 928 -931.

Stevens P.J.G., Walker J.T.S., Shaw P.W., Suckling D.M. (1994): Organosilicone surfactants: toolsfor horticultural crop protection. In: Proceedings of the Brighton Crop Protection Conference – Pests: 755-760.

Woźnica Z., Miłkowski P., Waniorek W. (1997): Adiuwanty a skuteczność chwastobójcza herbicydów. Progr. Plant Prot./ Post. Ochr. Rośl. 37, 2: 190-192.

Woźnica Z., Miłkowski P., Kuzior S., Śpitalniak J. (1998): Wpływ adiuwantów na skuteczność chwastobójczą herbicydu Apyros 75 WG. Progr. Plant Prot./ Post. Ochr. Rośl. 38, 2: 692-694.

Woźnica Z., Messersmith C., Nalewaja J. (2003): Wpływ adiuwantów na skuteczność chwastobójczą sufosulfuronu. Zesz. Probl. Post. Nauk Roln. 490: 313 -319.

Xiao-Yong L., Matsumoto H., Usui K. (2001): Comparison of physiological effects of fluazifop-butyl and sethoxydim on oat (*Avena sativa* L.). Weed Biol. Management 1, 2: 120-127.

WPŁYW ŚRODKÓW MODYFIKUJĄCYCH WŁAŚCIWOŚCI CIECZY UŻYTKOWEJ NA DZIAŁANIE PROPOKSYKARBAZONU SODOWEGO (ATTRIBUT 70 WG)

S t r e s z c z e n i e

Badania przeprowadzono w latach 2002 i 2003, na terenie Rolniczego Zakładu Doświadczalnego Instytutu Ochrony Roślin w Winnej Górze, w uprawie pszenicy jarej (*Triticum aestivum* spp. *vulgare* Mac Key), odmiany ‘Helia’. Określono wpływ wybranych adiuwantów (Superzwilżacz, Atpolan 80 EC, Olbras Super 90 EC oraz Break Thru S 240), na poprawę jakości cieczy użytkowej herbicydu propoksykarbazonu sodowego (Attribut 70 WG) w zwalczaniu owsa siewnego (*Avena sativa* L.), który w doświadczeniu uznano za chwast jednoliścienny.

Do zabiegów stosowano zalecaną dawkę propoksykarbazonu sodowego, tj. 42 g s.a./ha. Surfaktanty, Superzwilżacz i Break Thru S 240 zastosowano w stałym stężeniu 0,1%, natomiast środki Atpolan 80 EC i Olbras Super 90 EC w dawkach odpowiednio 1,5 i 1,0 l/ha.

W przeprowadzonych badaniach stwierdzono wpływ testowanych adiuwantów na wzrost skuteczności działania herbicydu propoksykarbazonu sodowego w zwalczaniu owsa siewnego w uprawie pszenicy jarej, odmiany ‘Helia’.

Duży wpływ na efektywność herbicydu miały adiuwanty Superzwilżacz i Olbras Super 90 EC. Użycie propoksykarbazonu sodowego z dodatkiem jednego z wyżej wymienionych adiuwantów spowodowało w zwalczaniu owsa siewnego znaczący wzrost plonu ziarna pszenicy jarej w porównaniu z obiektem chronionym herbicydem bez środków wspomagających. Jednocześnie zaobserwowano znaczny spadek świeżej masy owsa oraz liczby i masy jego ziaren.