JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 42, No. 1 (2002)

EFFECT OF ADJUVANTS ON BIOLOGICAL EFFICACY OF FENOXAPROP-P-ETHYL FOR GRASS WEED CONTROL IN CEREALS

Kazimierz Adamczewski

Institute of Plant Protection
Miczurina 20, 60-318 Poznań, Poland
e-mail: K.Adamczewski@ior.poznan.pl

Accepted: January 17, 2002

Abstract: Field experiments were conducted to determine the influence of adjuvants on fenoxaprop-P-ethyl bioefficacy against wind grass (*Apera spica-venti*), wild oats (*Avena fatua*) and barnyard grass (*Echinochloa crus-galli*). The commercial product Puma Universal 069 EW, which contains 69 g/l of fenoxaprop-P-ethyl, was applied with different adjuvants in springtime in winter barley, winter triticale, winter wheat and spring wheat. The adjuvants have improved efficacy of Puma Universal 069 EW. Mineral paraffin oil (Atpolan 80 EC) was the most effective adjuvant.

Key words: fenoxaprop-P-ethyl, adjuwants, *Apera spica-venti*, *Avena fatua*, *Echinochlia crus-galli*, winter and spring cereals

INTRODUCTION

The most important grass weeds in cereals are *Apera spica-vent*, *Avena fatua* and sometimes in spring cereals *Echinochloa crus-galli*. In Poland about 60–70% of winter cereals is infested with *Apera spica-venti*. The common weed in some regions in spring cereals is *Avena fatua* and occasionally *E. crus-galli*. Sometimes wind grass emergency increases with moist soil in autumn after cereals sowing what is a trouble problem to cereal growers. For chemical control of *A. spica-venti* farmers should use herbicides which can reduce abundance of this weed. One of the herbicide recommended for grass weed control is Puma Universal 069 EW, Avents CropScience product, which contains 69 g/l of fenoxaprop-P-ethyl and 75 g/l safener mefenpyr-dietyl. This herbicide can be used in winter and spring cereals enclosed winter barley. Brink and Weinmann (1996) presented this product with a new safener for the first time. Research carried out by Santier and Chamel (1996) showed that fenoxaprop-ethyl penetration through the cuticles can be increased by adding MEO methyl oleate (seed oil). So far number of conducted field experi-

ments including a treatment fenoxaprop-P-ethyl with adjuvants is small. The aim of the field experiments was to determine the influence of few different type oil adjuvants on increase efficacy of Puma Super 069 EW in controlling wind grass (*A. spica-venti*) in winter cereals and wild oat (*A. fatua*) as well as barnyard grass (*E. crus-galli*) in spring wheat.

MATERIAL AND METHODS

The field experiments were conducted in 1999 and 2000 at the Experimental Station of Institute of Plant Protection in Winna Góra and on the field farms, heavy infested with *A. spica-venti* (L.) P.B. located near Bialystok, Toruń and Trzebnica. Winter barley (*Hordeum vulgare* L. cv. Gregor) was sown in the middle of September, winter wheat (*Triticum vulgare* Vill. cv. Almary, Koda) and winter triticale (*Triticale* cv. Fidelio) at the end of September, and spring wheat (*Triticum vulgare* Vill. cv. Banti) was sown on sandy loan soil in the beginning of April. The size of plots was 16.5 m^2. Applications were made at the end of tillering of cereals in spring at 28/29 growth stage in scale BBCH using a small plot spraying equipment with XR 11003 flat-fan nozzle with a water volume of 300 l ha^{-1} at 300 kPa. The herbicide Puma Universal 069 WE, Aventis CropScience product containing 67 g/l fenoxaprop-P-ethyl ((R)-2-[4-[(6-chloro-2-benzoxazolyl) oxy] phenoxy] propanoic acid) as the ethyl ester), containing the 75 g a/l safener mefenpyr-diethyl, was used. The purpose of the field experiments was to determine the influence of few adjuvants on the increase efficacy of Puma Super 069 EW in controlling *A. spica-venti, A. fatua* and *E. ceus-galli*. The following adjuvants were used: Adpros 85 SL (modified vegetable oil; Varichem), Aero 030 SL (ethoxylated cocoamine oxide and ethoxylated cocoammonium hydroxide blend: Monsanto), Atpolan 80 EC (mineral paraffin oil; Agromix), Olbras 88 EC (fatty acid rape seed oil; Obrol), Toil methylated rape seed oil; IAAS). For dicotyledonous weed control MCPA + dicamba 10–12 days before graminicide application was used. The efficacy of treatment was expressed as percentage of control compared to the untreated plots. Percentage of *A. spica-venti, A. fatua* and *E. crus-galii* control was calculated by counting the weeds on area of 1m^2 of each plot after heading. In all experiments a completely randomised design with four replications per treatment was used. Before harvest 25 ears from each plot were taken for counting grains in an ear. The yield of crops was determined at harvest and the weight of 1,000 grains was made after harvest. Data was subjected to an analysis of variance. Means were compared using Fisher's Least Significant Difference (LSD) Test at the 5% level.

RESULTS AND DISCUSSION

Winter barley (Tab. 1). In Polish weather condition winter barley can be cultivated only in west part of the country and should be sown early, not later then 10–15 of September. Therefore at springtime *A. spica-venti* can be well developed and the chemical control of this weed by herbicide is not so easy. The population of *A. spica-venti* on experimental plots was high i.e. 125 plants/1m^2. The control of this weed with Puma Universal 069 WE ranged from 93% at the dose 1.0 l ha^{-1} to 65% for 0.5 l ha^{-1}. The positive influence of adjuvants on Puma Universal 069 EW effec-

Table 1. *Apera spica-venti* control with Puma Universal 069 EW, weight of 1,000 grains, no. of grains in ear and yield of winter barley as influenced by adjuvants (average from 2 experiments)

Treatments	Dose g,l/ha	*A. spica-venti* control in%	Weight of 1,000 grains	No. of grains in ear	Yield t/ha
1. alone	1.0	93	42.5	48.5	5.99
2. alone	0.5	65	40.8	47.6	5.37
3. + Adpros 85 SL	0.5 + 1.5	83	41.8	48.8	5.97
4. + Areo 30 SL	0.5 + 1.5	89	42.7	48.6	5.78
5. + Atpolan 80 EC	0.5 + 1.5	94	42.9	49.6	6.12
6. + Olbras 88 EC	0.5 + 1.5	87	42.1	49.4	5.81
7. + Toil	0.5 + 1.5	91	42.6	49.5	6.02
8. Untreated (No./sq.m)	–	(125)	39.5	45.1	4.84

LSD (0.05) = 0.217

tiveness was observed for all treatments. Destruction of wind grass (*A. spica-venti)* using a lower rate of Puma Universal 069 EW with paraffin oil (Atpolan 80 EC) as adjuvant was the same when the herbicide was used alone but at higher dose. Other adjuvants increased the phytotoxicity of Puma Universal 069 EW but less than Atpolan 80 EC. The result of *A.* spica-*vent* control by used Puma Universal 069 EW with Toil adjuvant was satisfactory. The least effective adjuvant was Adpros 85 SL. The obtained results of yield, weight of 1,000 grains and number of grains in ear were correlated with control of *A. spica-venti.*

Winter triticale (Tab. 2). The experimental plots of winter triticale were not so heavy weedy, as there were 38 plants of wind grass/1m^2. All adjuvants used with Puma Universal 069 EW in winter triticale increased the effectiveness of this herbicide against wind grass (*A. spica-venti*). However, Puma Universal 069 EW + Atpolan 85 EC and Puma Universal 069 EW + Toil gave the best wind grass control (99%) while others only satisfactory. The adjuvants used with herbicide significantly increased yields of winter triticale in comparison with Puma Universal 069 EW use alone and untreated plot.

Table 2. *Apera spica-venti* control with Puma Universal 069 EW, weight of 1,000 grains, no. of grains in ear and yield of winter triticale as influenced by adjuvants (average from 2 experiments)

Treatments	Dose g,l/ha	*A. spica-venti* control in %	Weight of 1,000 grains	No. of grains in ear	Yield t/ha
1. alone	1.0	100	49.7	48.9	8.37
2. alone	0.5	81	48.5	47.3	7.93
3. + Adpros 85 SL	0.5 + 1.5	92	49.5	47.9	8.24
4. + Areo 30 SL	0.5 + 1.5	94	48.8	47.7	8.31
5. + Atpolan 80 EC	0.5 + 1.5	99	49.7	48.8	8.42
6. + Olbras 88 EC	0.5 + 1.5	95	49.1	47.5	8.30
7. + Toil	0.5 + 1.5	99	49.5	47.3	8.39
8. Untreated (No./sq.m)	–	(38)	46.2	46.8	7.73

LSD (0.05) = 0.317

Winter wheat (Tabs. 3, 4). Five field experiments were conducted in winter wheat. The result from four experiments were quite similar so the table 3 presents the averages from these trials. In northeast part of the country where (Białystok, where the 5th experiment was conducted) spring generally begins late and is rather cold. Therefore the results from this experiment were different and are given in the table 4. Wind grass (*A. spica-venti*) density in Białystok was very heavy (132 plants/m^2), while in other experiments an average density of this weed was 48 plants/m^2. However, the results from all 5 experiments showed that Puma Universal 069 EW used at full dose alone, 1.0 l/ha gave the same *A. spica-venti* control as the herbicide used at half dose with Atpolan 80 EC (Tabs. 3, 4).

The other applied adjuvants also increased control of Puma Universal 069 EW to wind grass (*A. spica-venti*) but the differences between used additives were larger in Białystok (Tab. 4) than in other experiments (Tab. 3). The results obtained from the field experiment carried out in Białystok showed that the Adpros 85 SL was the worst additive to Puma Universal 069 EW. However, Puma Universal 069 EW ap-

Table 3. *Apera spica-venti* control with Puma Universal 069 EW, weight of 1,000 grains, no. of grains in ear and yield of winter wheat as influenced by adjuvants (average from 4 experiments)

Treatments	Dose g,l/ha	*A. spica-venti* control in %	Weight of 1,000 grains	No. of grains in ear	Yield t/ha
1. alone	1.0	100	50.2	36.3	6.83
2. alone	0.5	80	50.0	32.1	6.17
3. + Adpros 85 SL	0.5 + 1.5	91	49.8	34.5	6.44
4. + Areo 30 SL	0.5 + 1.5	97	50.3	35.8	6.72
5. + Atpolan 80 EC	0.5 + 1.5	99	50.8	36.1	6.84
6. + Olbras 88 EC	0.5 + 1.5	95	50.1	36.4	6.53
7. + Toil	0.5 + 1.5	96	50.4	36.2	6.78
8. Untreated	–	(48)	48.6	32.2	5.88
(No./sq.m)					

LSD (0.05) = 0.257

Table 4. *Apera spica-venti* control with Puma Universal 069 EW, weight of 1,000 grains, no. of grains in ear and yield of winter wheat as influenced by adjuvants, results from Białystok region

Treatments	Dose g,l/ha	*A. spica-venti* control in %	Weight of 1,000 grains	No. of grains in ear	Yield t/ha
1. alone	1.0	96	51.1	28.5	6.31
2. alone	0.5	63	48.9	27.6	5.25
3. + Adpros 85 SL	0.5 + 1.5	74	50.2	28.0	5.82
4. + Areo 30 SL	0.5 + 1.5	82	50.5	28.1	5.85
5. + Atpolan 80 EC	0.5 + 1.5	95	50.9	28.6	6.27
6. + Olbras 88 EC	0.5 + 1.5	83	49.9	28.7	6.02
7. + Toil	0.5 + 1.5	86	50.9	29.1	6.25
8. Untreated	–	(132)	46.8	24.5	4.36
(No./sq.m)					

LSD (0.05) = 0.319

plied with other adjuvants such as: Aero 30 SL, Olbras 88 EC and Toil provided much better wind grass control. Nevertheless, their control in comparison with Atpolan 80 EC applied in Białystok experiment was much worse than at other sites (Tabs. 3, 4). The obtained results of yield, weight of 1,000 grains and number of grains in ear were correlated with control of *A. spica-venti*. Moreover, in Białystok (Tab. 4) the yield on treated plots increased much more than on other experimental fields (Tab. 3).

Table 5 presents the average wind grass control obtained in experiments conducted in winter cereals. The results show that Atpolan 80 EC was the best adjuvants applied with Puma Universal 069 EW and the Toil took the second place. Amongst five tested adjuvants Atpros 85 SL appeared as the worst one.

Spring wheat. (Tab. 6). The control of *A. fatua* through Puma Universal 069 EW was not at satisfactory level. The adjuvants used with Puma Universal 069 EW increased the control of this weed but the efficiency was not as good as *A. spica-venti* control in winter cereals. It can be assumed that the used rate of this herbicide was not enough high. The control of *E. crus-galli* was better then *A. fatua* and the used adjuvants increased the efficacy of Puma Universal 069 EW. The difference between

Table 5. *Apera spica-venti* control with Puma Universal 069 EW in winter cereals as influenced by adjuvants, (average from 9 experiments)

Treatments	Dose g,l/ha	*A. spica-venti* control in %
1. alone	1.0	97
2. alone	0.5	72
3. + Adpros 85 SL	0.5 + 1.5	85
4. + Areo 30 SL	0.5 + 1.5	91
5. + Atpolan 80 EC	0.5 + 1.5	97
6. + Olbras 88 EC	0.5 + 1.5	90
7. + Toil	0.5 + 1.5	93
8. Untreated (No./sq.m)	–	(86)

Table 6. *Avena fatua* and *Echinochloa crus-galli* control with Puma Universal 069 EW, weight of 1,000 grains, no. of grains in ear and yield of spring wheat as influenced by adjuvants (average from 2 experiments)

Treatments	Dose g,l/ha	Control in %		Weight of 1,000 grains	No. of grains in ear	Yield t/ha
		A. fatua	*E. crus-galli*			
alone	1,0	74	78	38.0	28.4	4.35
alone	0,5	55	66	38.7	28.9	4.09
+ Adpros 85 SL	0.5 + 1.5	56	78	38.9	28.8	4.27
+ Aero 30 SL	0.5 + 1.5	72	88	39.2	28.5	4.32
+ Atpolan 80 EC	0.5 + 1.5	73	81	40.0	30.4	4.42
+ Olbras 88 EC	0.5 + 1.5	68	84	38.3	29.5	4.23
+ Toil	0.5 + 1.5	71	83	38.8	29.2	4.33
Untreate (No/sq.m)	–	(15)	(18)	38.0	27.7	3.66

LSD (0.05) = 0.237

the adjuvants used in this experiment was not so large. The obtained results of yield, weight of 1,000 grains and number of grains in ear were correlated with the control of *A. fatua* and *E. crus-galli*.

The results from conducted field experiments indicate that adjuvants used with Puma Universal 069 EW improved the efficacy of wind grass (*A. spica-venti*) control in winter cereals. Among five tested adjuvants the best additives to fenoxaprop-P-ethyl proved to be the Atpolan 80 EC (mineral paraffin oil). Research performed by Salemabier (1992) and by Wolff and Gavanier (1992) indicates that fenoxaprop-P-ethyl used with mineral paraffin oil increases the control of Alopecurus myosuroides. Boothroyd et al. (1993) applied mineral oil with fenoxaprop-ethyl to increase control of *A. myosuroides*. In the presented experiments the herbicidal effectiveness of Puma Universal 069 EW used alone and with adjuvants was lower while applied during weather conditions with low temperatures than with higher. Langeluddeke (1990) obtained the same results in model trial experiment. Literature review shows that more work was done with fenoxaprop-ethyl than with fenoxaprop-P-ethyl (Arvidsson 1992; Boothroyd et al. 1993; Langeluddeke 1990; Santier and Chamel 1996; Parmentier 1991).

CONCLUSION

The addition of modified vegetable oil (Adpros 85 SL), ethoxylated cocoamine oxide and ethoxylated cocoammonium hydroxide blend (Aero 30 SL), mineral paraffin oil (Atpolan 80 EC) and fatty acid rape seed oil (Olbras 88EC) methylated rapeseed oil (Toil) to Puma Universal 069 EW (fenoxaprop-P-ethyl) treatment improved the effectiveness against wind grass (*A. spica-venti*) and barnyard grass (*E. crus-galli*). The adjuvants increased the performance of Puma Universal 069 EW against wild oats (*A. fatua*) but not so much than other weeds. The most effective adjuvants was the mineral paraffin oil (Atpolan 80 EC), which performance was more apparent when the treatment was done in winter barley and during cold weather conditions in winter wheat (Białystok). The evaluated adjuvants did not affect the selectivity of herbicide towards winter cereals and spring wheat.

Some results were presented on 6th International Symposium on Adjuvants for Agrochemicals, Amsterdam 2001.

REFERENCES

Arvidsson T. 1992. Swedish Crop Protection Conf. Weeds and cont., No. 33: 89–102.

Boothroyd D., Clarke J., Ickeringill D., Mackay J. 1993. Brighton Crop Protection Conference, Weeds 2: 601–606.

Brink A, Weinmann J. 1996. Z. PflKrankh. PflSchutz, Sonderh., XV: 485–490.

Langeluddeke P. 1990. Z. PflKrankh. PflSchutz, Sonderh. XII: 473–480.

Parmentier J. 1991: Mededelingen-nan-de Faccultiet-Landbowwetenschappen 56: 833–842.

Salembier J.F. 1992: ANPP – Quinzieme Conference Columa Journees Internationales Sur La Lutte Contre Les Mauvaises Herbes Versailles: 575–584.

Santier S., Chamel A. 1996. Weed Research 36: 167–174.

Wolff J.M., Gavanier G. 1992. ANPP – Quinzieme Conference Columa Journees Internationales Sur La Lutte Contre Les mauvaises Herbes Versailles: 585–592.

POLISH SUMMARY

WPŁYW ADIUWANTÓW NA SKUTECZNOŚĆ DZIAŁANIA FENOXAPROP-P-ETHYLU W ZWALCZANIU CHWASTÓW JEDNOLIŚCIENNYCH W ZBOŻACH

Przedmiotem badań była biologiczna ocena fenoxaprop-P-ethyl (herbicydu Puma Uniwersal 069 EW) stosowanego z adiuwantami Adpros 85 SL, Aero 30 SL, Atpolan 80 EC, Olbras 88 EC i Toil. Doświadczenia polowe wykonano w latach 1999–2000 w Rolniczym Zakładzie Doświadczalnym w Winnej Górze oraz na polach produkcyjnych w rejonie Białegostoku, Torunia i Trzebnicy. Doświadczenia przeprowadzono w uprawie pszenicy ozimej i jarej, pszenżyta ozimego i jęczmienia ozimego. Herbicyd Puma Uniwersal 069 EW stosowano na wiosnę w dawce 1,0 i 0,5 l/ha sam oraz w dawce 0,5 l/ha z adiuwantami w dawce 1,5 l/ha. Uzyskane wyniki wskazują, że wszystkie zastosowane adiuwanty wpłynęły na wzrost skuteczności zwalczania miotły zbożowej, owsa głuchego i chwastnicy jednostronnej. Najlepszym adiuwantem dla herbicydu Puma Uniwersal okazał się Atpolan 80 EC (mineralny olej parafinowy). Uwidoczniło się to szczególnie wyraźnie wówczas, gdy miotła zbożowa była bardziej posunięta w rozwoju, tj. w jęczmieniu ozimym oraz, gdy zabieg opryskiwania był w pszenicy ozimej opóźniony (rejon Białegostoku). Najgorszym adiuwantem dla Pumy Uniwersał 069 EW okazał się Adpros 85 SL.