

EFFECT OF GLYPHOSATE USED IN DESICCATION OF WHITE MUSTARD (*Sinapis alba* L.) ON THE VALUE OF THE SEED MATERIAL

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Abstract. In the years 2008-2010 the effect of glyphosate used before harvesting of white mustard at a dose of 1.0 and 2.0 kg a.s.·ha⁻¹ on the value of its seeds was studied. Evaluation included: weight of one thousand seeds, uniformity, weight test, energy and germination capacity as well as the initial sprout growth. Also plant emergence from seeds planted at the depth of 2 and 4 cm was determined. The effect of glyphosate on physical parameters of seeds, as well as on germination capacity and emergence capacity depended on its dose. Applied at a dose of 2.0 kg a.s.·ha⁻¹ it decreased uniformity and the weight of one thousand seeds, and because of the decrease of germination capacity below 87% and emergence from depth of 2 cm, it prevents their utilization as a seed material. Decrease of emergence from greater depths as a result of application of even 1.0 kg of glyphosate per ha, decreases the risk of self-sown plants as relative weeds.

Key words: seed germination, initial growth, self-sown plants, plant emergence, single-stage harvest

INTRODUCTION

Desiccation is one of the maintenance treatments used in plants cultivated for seeds. Desiccants prevent vegetation, activate and make maturation of crop plants uniform, decrease humidity of biomass of coexisting weeds and prepare the field for single-stage harvest. Active substances of pesticides, including glyphosate, may however remain in the seeds [Kucharski and Badowski 2006, Łozowicka and Kaczyński 2009] and influence their quality [Cakmak et al. 2009]. Glyphosate applied in the growing season, especially in the final stages of plant development is absorbed by them and included in metabolism, influencing biochemical properties of seeds [Bresnahan et al. 2003, Reddy et al. 2010]. One of the results of glyphosate application before harvest may be the

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decrease of the seed yield, though not in all environmental conditions it occurs [May et al. 2003]. However, producers of herbicides containing glyphosate do not recommend their application on seed plantations [www.monsanto-ag.co.uk, Paradowski 2006].

Therefore, it is assumed that this substance used in desiccation of white mustard will negatively influence on the value of harvested seeds. Decreased energy and germination capacity as well as emergence capacity will not only reduce their usage as a seed material, but they may as well decrease the risk of occurrence of relative weeds, such as self-sown mustard plants.

The aim of the research was determination of the effect of glyphosate used in preharvest desiccation of white mustard used at different doses on the seed germination and plant emergence.

MATERIAL AND METHODS

In the years 2008-2010 at the Experimental Station of the Faculty of Agriculture and Biotechnology in Mochełek belonging to the University of Technology and Life Sciences in Bydgoszcz, field experiment was carried out with preharvest desiccation of white mustard 'Nakielska'. Within the production plantation experimental units were selected with the area of 15 m² in randomized block design in four replications. At the stage of technical maturity of plants, BBCH 85, on these units desiccation treatment was conducted. Roundup Energy 450 SL preparation was applied at doses equivalent to the amount of the active substance: 0.0 kg·ha⁻¹ – control, 1.0 kg·ha⁻¹ and 2.0 kg·ha⁻¹ of glyphosate. The seeds were harvested at the stage of complete maturity. They constituted material for laboratory tests.

In laboratory tests the quality and the seed value were evaluated according to the Polish Standard, PN-R-65950 [1994]. Determination included: weight of one thousand seeds, weight test with the use of seed densimeter SH type, uniformity as a seed part $\phi > 1.6$ mm, energy and germination capacity in Szmal's growth cabinet. Also emergence capacity was evaluated from seeds planted at the depth of 2 and 4 cm in sand substrate. Tests of emergence were conducted in pots with the dimensions of 14 × 14 × 10 cm. Counting of plants and evaluation of seedling mass was conducted after 10 days since sowing.

The results were processed statistically. Package of ANALWAR-5.2.FR statistical programs was used. Evaluation of the variation of parameters concerning germinating seeds and emerging white mustard plants under the effect of glyphosate was evaluated with the use of test *F*, and the significance of differences between mean values of these traits at its particular doses was evaluated with Tukey's test on the significance level *P* = 0.05.

RESULTS AND DISCUSSION

Conducted experiments are the element of research on conditions and effect of glyphosate application in cultivation technology of different plant species. This substance applied before harvest usually unfavorably affects physical properties of seeds, their germination capacity and initial growth of F1 generation plants. These results occur especially when the preparation dosage is high, and the time of its

application is too early, allowing metabolic changes. However, observed reactions depend on the species and cultivar of the plants [Yenish and Young 2000, Baig et al. 2003, Blackburn and Boutin 2003].

In own research, glyphosate as an active substance of non-selective herbicide, applied in preharvest desiccation of white mustard, influenced the weight of one thousand seeds and their uniformity. However, it was not significant for the formation of the weight test of seed mass (Table 1). Unfavorable effect of glyphosate on the seed size expressed in the weight of one thousand seeds and uniformity occurred only in the case of application of 2 kg a.s.·ha⁻¹. This dose also substantially reduced seed germination (Table 2). Germination capacity of seeds from plants desiccated with a higher from the tested ones dosage of glyphosate was not only significantly lower than the germination capacity of seeds not desiccated and treated with 1 kg a.s.·ha⁻¹, but also lower than the value of this parameter determined by PN-R-65023 [1999] for the seed material of white mustard, 87%. With the dose of applied glyphosate also the number of abnormal seedlings increased.

Table 1. Effect of glyphosate on white mustard seeds plumpness (mean from 2008-2010)

Tabela 1. Wpływ glifosatu na dorodność nasion gorczycy białej (średnie z lat 2008-2010)

Rate of glyphosate Dawka glifosatu kg·ha ⁻¹	Weight of 1000 seeds Masa tysiąca nasion g	Weight test Gęstość usypowa nasion kg·hl ⁻¹	Seeds uniformity Wyrównanie nasion %
0.0	6.55	63.9	78.9
1.0	6.53	63.7	77.8
2.0	6.27	62.9	73.9
LSD _{0,05} – NIR _{0,05}	0.138	ns – ni	2.50

Table 2. Effect of glyphosate on white mustard seeds germination (mean from 2008-2010)

Tabela 2. Wpływ glifosatu na kiełkowanie nasion gorczycy białej (średnie z lat 2008-2010)

Rate of glyphosate Dawka glifosatu kg·ha ⁻¹	Germinative energy Energia kiełkowania %	Germination capacity Zdolność kiełkowania %	Abnormal germ Kielki anormalne %
0.0	63.8	88.9	0.92
1.0	60.7	88.1	2.50
2.0	51.7	80.8	6.33
LSD _{0,05} – NIR _{0,05}	3.62	5.78	0.840

Glyphosate used in plant desiccation before harvest of white mustard, influenced not only the energy and germination capacity of its seeds, but also the initial growth of shoot part of sprouts, especially the radicles – primary roots (Table 3). Applied at a dose of 2 kg a.s.·ha⁻¹ it reduced the length and mass of white mustard shoots at the stage of germination. Inhibition of radicle growth as a result of desiccation of the seed plantation with the use of glyphosate was even higher. Just after application of 1 kg a.s.·ha⁻¹, the roots were shorter by 36.7% and they had lower mass by 16.2% than those coming from not desiccated plants. As a result of application of 2 kg glyphosate per ha, the differences were even greater. The roots were over 1.5-times shorter and had by nearly 50% smaller mass than roots of plants from seeds from the non-desiccated plantation. Similar changes of the seed quality were observed in their research on soybean by Bennett and Shaw [2000a]. Glyphosate used for plant desiccation before harvest,

especially at earlier stages of maturity, caused decrease of the seed mass, reduced their germination capacity and initial seedling growth. On the other hand Mystek and Szukała [2007] emphasize the increase of the number of abnormally germinating seeds of lupine as a result of glyphosate application.

Table 3. Effect of glyphosate on growth of ten-day white mustard seedlings (mean from 2008-2010)

Tabela 3. Wpływ glifosatu na wzrost dziesięciodniowych siewek gorczycy białej (średnie z lat 2008-2010)

Rate of glyphosate Dawka glifosatu kg·ha ⁻¹	Lenght of shoot Długość pędu mm	Lenght of root Długość korzenia mm	Mass – Masa, g	
			shoots pędów	roots korzeni
0.0	54.8	67.6	10.8	4.02
1.0	51.9	42.8	10.5	3.37
2.0	42.8	25.5	9.2	2.23
LSD _{0,05} – NIR _{0,05}	6.26	7.59	0.38	0.447

Glyphosate effect on plant emergence depended on its dosage and depth of planting seeds in the substrate (Table 4). The result of plant desiccation with the use of 2 kg of glyphosate per ha was the decrease of emergences after planting seeds even at the depth of 2 cm. In this case, the shoot mass after 10 days since sowing was by 57.8% lower than the mass of test plants, though significantly lower shoot mass was also characteristic of plants from seeds coming from plants treated with 1 kg a.s.·ha⁻¹. This dose also caused significant decrease of emergence capacity of plants from a greater depth, 4 cm. It may be assumed that these seeds will decrease the risk of emergences and occurrence of self-sown plants as relative weeds. The possibility to use desiccation treatment for the regulation of weed infestation is also reported by other authors [Bennett and Shaw 2000b, Clay and Griffin 2000]. They emphasize that glyphosate decreases germination capacity of weed seeds and their further growth.

Table 4. Effect of glyphosate on white mustard emergence (mean from 2008-2010)

Tabela 4. Wpływ glifosatu na wschody gorczycy białej (średnie z lat 2008-2010)

Rate of glyphosate Dawka glifosatu kg·ha ⁻¹	Emergence from depth 2 cm Wschody z głębokości 2 cm %	Emergence from depth 4 cm Wschody z głębokości 4 cm %	Mass of shoots Masa pędów g
	0.0	82.8	61.8
1.0	81.6	51.3	6.02
2.0	71.9	32.8	3.31
LSD _{0,05} – NIR _{0,05}	4.87	10.41	0.903

CONCLUSIONS

1. Glyphosate used for desiccation of white mustard before harvest, influenced the properties of seeds determining its seed value.

2. Glyphosate effect on the physical parameters of seeds, germination capacity and emergence depended on its dosage.

3. Glyphosate used for desiccation of white mustard at a dose of 2 kg a.s.·ha⁻¹ decreased uniformity and weight of one thousand seeds, and because of the decrease of germination capacity and emergence, it prevents their utilization as a seed material. Decrease of emergences from greater depths as a result of application of only 1 kg of glyphosate per ha, may decrease occurrence of self-sown plants as relative weeds.

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WPLYW GLIFOSATU UŻYTEGO DO DESYKACJI GORCZYCY BIAŁEJ (*Sinapis alba* L.) NA WARTOŚĆ SIEWNĄ NASION

Streszczenie. W latach 2008-2010 badano wpływ glifosatu stosowanego przed zbiorem gorczycy białej w dawce 1,0 i 2,0 kg s.a. · ha⁻¹ na jakość jej nasion. Oceniono: masę tysiąca nasion, wyrównanie, gęstość w stanie zsypanym, energię i zdolność kiełkowania oraz początkowy wzrost kielków. Określono także wschody roślin z nasion umieszczonych na głębokości 2 i 4 cm. Oddziaływanie glifosatu na parametry fizyczne nasion, a także zdolność kiełkowania i wschodów zależało od jego dawki. Stosowany w dawce 2,0 kg s.a. · ha⁻¹ zmniejszył wyrównanie i masę tysiąca nasion, a z powodu ograniczenia zdolności kiełkowania poniżej 87% i wschodów już z głębokości 2 cm uniemożliwia ich wykorzystanie jako materiału siewnego. Ograniczenie wschodów z większych głębokości w wyniku aplikacji nawet 1,0 kg glifosatu na ha zmniejsza ryzyko występowanie samosiewów jako chwastów fakultatywnych.

Słowa kluczowe: kiełkowanie nasion, początkowy wzrost, samosiewy, wschody roślin, zbiór jednofazowy

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