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THE INFLUENCE OF WEEDS GROWTH STAGE AND CLIMATE CONDITIONS ON OPTIMIZING DOSE OF HERBICIDES

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Abstract: The outdoor pot experiments on the influence of weeds' growth stage and climate conditions on herbicides' effect were carried out in the Danish Institute of Agriculture Science in 2000–2001. The experiment concerning growth stage took into consideration three phases of *Galium aparine*: 1, 2 and 3 whorls. The influence of temperature was performed using climate simulator running at three temperatures: 8/2°C, 16.5/8°C, 24/16°C. The rain was applied using rain simulator 1, 3 and 6 hours after herbicides' treatment. Herbicides: Grodyl 75 WG (amidosulfuron 750 $g*kg^{-1}$), Aurora Super 61,5 WG (mecoprop 600 $g*kg^{-1}$ + carfentrazone-ethyl 15 $g*kg^{-1}$), Lintur 70 WG (dicamba 65.9 $g*kg^{-1}$, triasulfuron 4.1 $g*kg^{-1}$) and Chwastox Trio 540 SL (dicamba 40 $g*l^{-1}$, MCPA 200 $g*l^{-1}$, mecoprop 300 $g*l^{-1}$) were applied in four doses: full recommended, 1/2, 1/4 and 1/8 of full dose on *G. aparine*.
Grodyl 75 WG and Aurora Super 61,5 WG were the most efficient to the youngest plants of *G. aparine*. Differences in susceptibility among three growth stages (1, 2, 3 whorls) to Grodyl 75 WG were higher than to Aurora Super 61,5 WG. Effectiveness of tested herbicides tended to increase as temperature rose. The addition of adjuvant improved activity of herbicide Lintur 70 WG that showed satisfactory weed control even at four time reduced dose independently from temperature. The rain treatment 1, 3 and 6 hours after spraying caused reduction of Aurora Super 61,5 WG activity at 1/4 and 1/8 doses. The half dose gave a good result only when rain was applied 6 hours after treatment. Herbicide Grodyl 75 WG was efficient after rain application (1, 3, 6 HAT) only at full dose.

Key words: herbicide efficacy, weeds growth stage, air temperature, rainfall, reduced doses

INTRODUCTION

Under favorable conditions, the effect of herbicide used in dose lower than recommended can remain at high level, whereas unfavorable conditions affect the loss of herbicide efficacy even when applied in full dose (Kudsk 2001). Therefore the study on optimizing of herbicide dose should involve examinations concerning the influence of several factors on herbicides effect. The most important are weed growth stage and the weather conditions (Kudsk 1989).

It is well known that the most susceptible to herbicides are the youngest plants (cotyledon–2 leaves stage), however some of the weed species can be satisfactory controlled even at later growth stage (Domaradzki and Kieloch 2002). Climate conditions can modify herbicide activity by changing its absorption, retention, translocation and degradation in plants. Previous research demonstrated that the weather conditions in pre-spraying period, during herbicide application and just after it as well as in long-term post-spraying period influence herbicide action (Kudsk and Kristensen 1992).

The aim of this investigation was to determine the influence of weed growth stage, temperature and rainfall on the effect of full and reduced doses of selected herbicides used in weed control in cereals.

MATERIALS AND METHODS

The experiments were carried out in 2000 and 2001 in the Danish Institute of Agriculture Science – Flakkebjerg. Seeds of *Galium aparine* were sown into 2 l pots filled with a mixture containing sandy loam soil, sand and peat. For growth stage experiment seeds were sown in weekly intervals to give three different growth stages at the time of spraying. Directly after sowing the pots were placed outdoors on tables and stayed there until harvest. Plants were watered twice a day. One day prior to herbicide treatment the number of plants was reduce to 4 per pot. At the time of application *G. aparine* had 2 whorls (climate conditions experiments) and 1, 2 and 3 whorls (growth stage experiment).

The experimental design was completely randomized blocks (three replications). The results of each experiment were compared using analysis of variance.

The herbicides were applied using a laboratory pot sprayer fitted with a boom equipped with two Hardi-ISO F-02-110 flat fan nozzles. The nozzles were operated at speed of 5.3 km/ha and a pressure of 3 bars producing a spray volume of 150 $l*ha^{-1}$.

The experiments included herbicides: Aurora Super 61,5 WG (carfentrazon-ethyl 15 $g*kg^{-1}$, mecoprop-P 600 $g*kg^{-1}$), Grodyl 75 WG (amidosulfuron 75 $g*kg^{-1}$), Lintur 70 WG (dicamba 65.9 $g*kg^{-1}$, triasulfuron 4.1 $g*kg^{-1}$), Chwastox Trio 540 SL (dicamba 40 $g*l^{-1}$, MCPA 200 $g*l^{-1}$, mecoprop 300 $g*l^{-1}$) used in 4 doses (full dose, 1/2, 1/4 and 1/8 of full dose) that are presented in table 1. The plants were harvested 3 weeks after spraying and fresh weight was determined.

The temperature study

One day prior to herbicide application the pots were placed in climate simulators for six days running 3 different climates:

- min. 2°C, max. 8°C (mean temperature 5°C),
- min. 8°C, max. 16.5°C (mean temperature 12.5°C),
- min. 16°C, max. 24°C (mean temperature 20°C).

Table 1. Tested herbicides

Herbicides	Dose (g a.i./ha)		
	growth stage experiment	temperature experiment	rain experiment
Aurora Super 61,5 WG (carfentrazone- ethyl 15 g*kg^{-1}, mecoprop-P 600 g*kg^{-1})	615	369	492
Grodyl 75 WG (amidosulfuron 75 g*kg^{-1})	30	5,6	22.5
Chwastox Trio 540 SL (dicamba 40 g*l^{-1}, MCPA 200 g*l^{-1}, mecoprop 300 g*l^{-1})	–	1350	–
Lintur 70 WG (dicamba 65.9 g*kg^{-1}, triasulfuron 4.1 g*kg^{-1}) + Lissapol Bio 0.1 g*kg^{-1}	–	70 10	–

The rainfall study

The rain treatments were performed using a rain simulator and consisted of 5 mm of rain applied at an intensity of 20 mm/hour. Rain was applied 1, 3 and 6 hours after spraying and no rain treatment was included.

RESULTS AND DISCUSSION

The growth stage study

G. aparine was the most sensitive to full dose of herbicide Grodyl 75 WG when the plants at the time of spraying were at stage 1 and 2 whorls. The same dose revealed considerable lower efficacy when applied to the oldest plants. Generally, the significant loss of efficacy was observed only when applied to the oldest plants. Good level of weed control was observed as a result of herbicide treatment at half dose when weeds reached 1 and 2 whorls. Herbicide Aurora Super 61,5 WG applied in full dose effectively reduced all tested growth stages of *G. aparine* – 1, 2 and 3 whorls. After using half dose, the high level of weed control was achieved only in case of the youngest plants (Fig. 1).

The temperature study

The temperature did not affect activity of full dose of herbicide Grodyl 75 WG and significant differences between temperature regimes were found only at reduced doses level (1/2, 1/4, 1/8). The half dose treatment resulted in 10%–15% reduction of herbicide effectiveness without any clear variation among temperature regimes. Herbicide Aurora Super 61,5 WG applied at full and half dose caused high (93–100%) biomass reduction of *G. aparine* at all temperature levels. Its effectiveness was more affected by temperature at 1/4 and 1/8 dose. The similar response to the tested factor was observed also at Chwastox Trio 540 SL treatment. The results confirmed previous investigation (Kudsk; Kristensen 1992; Lundvikst 1997 and Olson et al. 2000), where the increase of several herbicides' activity as air temperature rose was observed.

Herbicide Lintur 70 WG attained high level of *G. aparine* control even after using in 1/4 dose independently from temperature regime. Such a good effect was probably due to addition of non-ionic surfactant Lissapol Bio 0.1 g*kg^{-1}. This assumption seems to be consistent with the research that demonstrated profitable impact of ad-

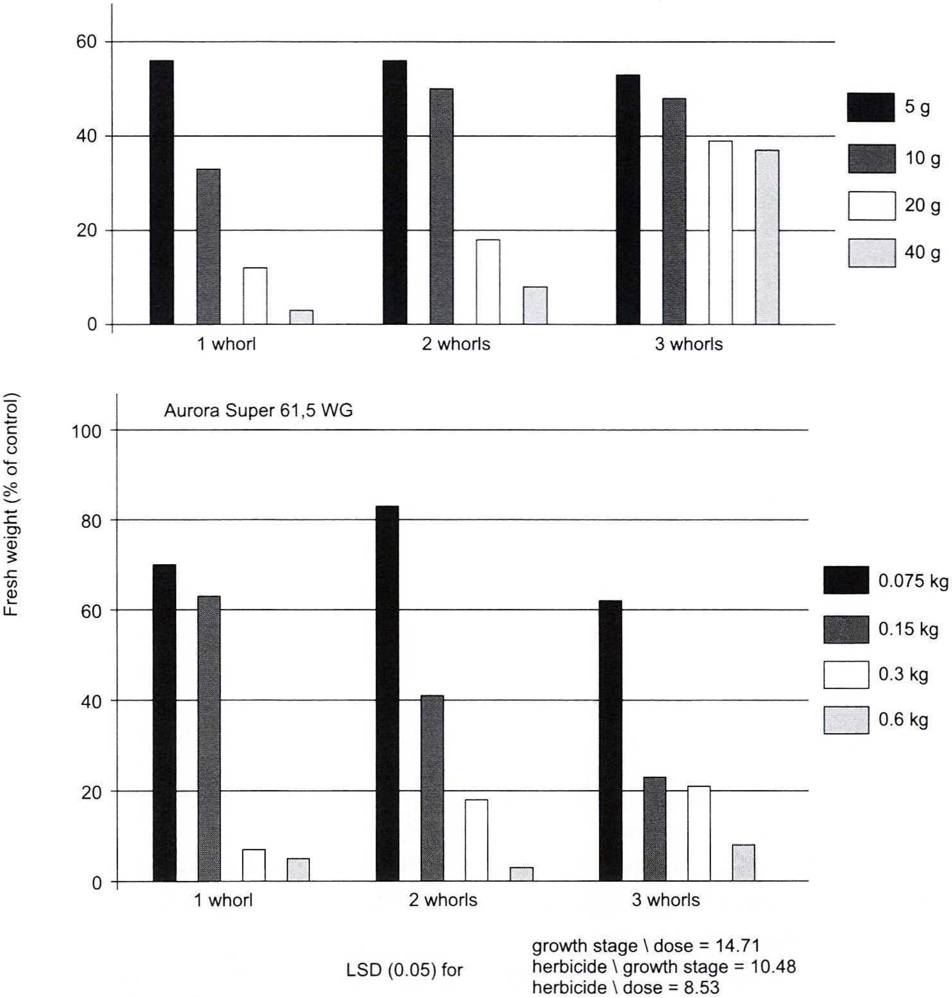
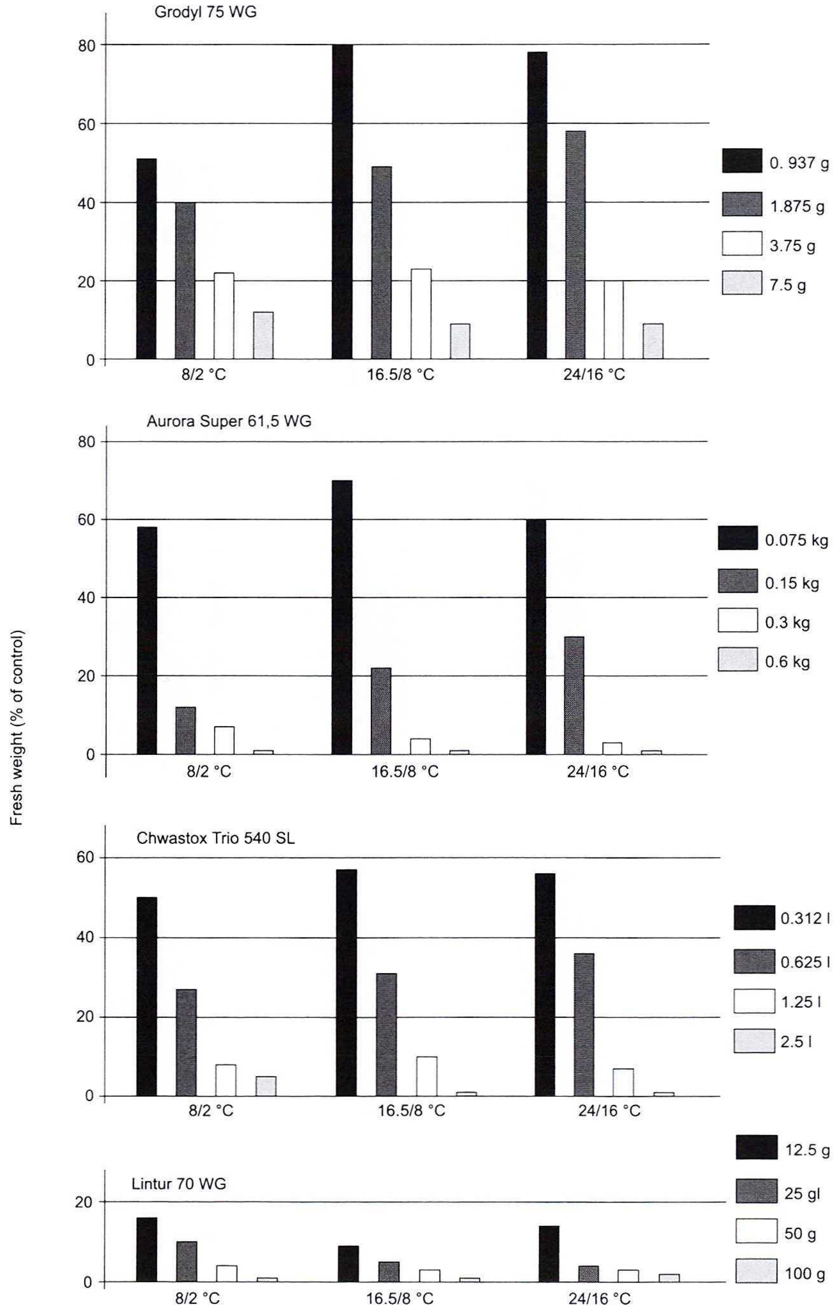


Fig. 1. Influence of growth stage of weeds on herbicides' activity

juvants on herbicides efficacy (Kudsk and Streibig 1993; Mathhiassen and Kudsk 1993) (Fig. 2).

The rain study

The rain treatment 1, 3 and 6 hours after spraying only slightly reduced efficacy of herbicide Grodyl 75 WG in full and lower rates (1/2 and 1/4) . The herbicide activity seems to be independent from various free rain periods. Rainfall did not affect efficacy of full dose herbicide Aurora Super 61,5 WG. Rain which occurred 1 hour after treatment significantly reduced its efficacy applied in all tested reduced doses. The rain treatment after 1 hour after quarter dose treatment markedly caused reduction of herbicide performance. The rain free period, which is required for herbicides to achieve a high level of weed control, is related to water solubility chemical



LSD (0.05) for herbicide \ temperature = 6.21
temperature \ dose = 7.16
herbicide \ dose = 7.53

Fig. 2. Influence of air temperature on herbicides' activity

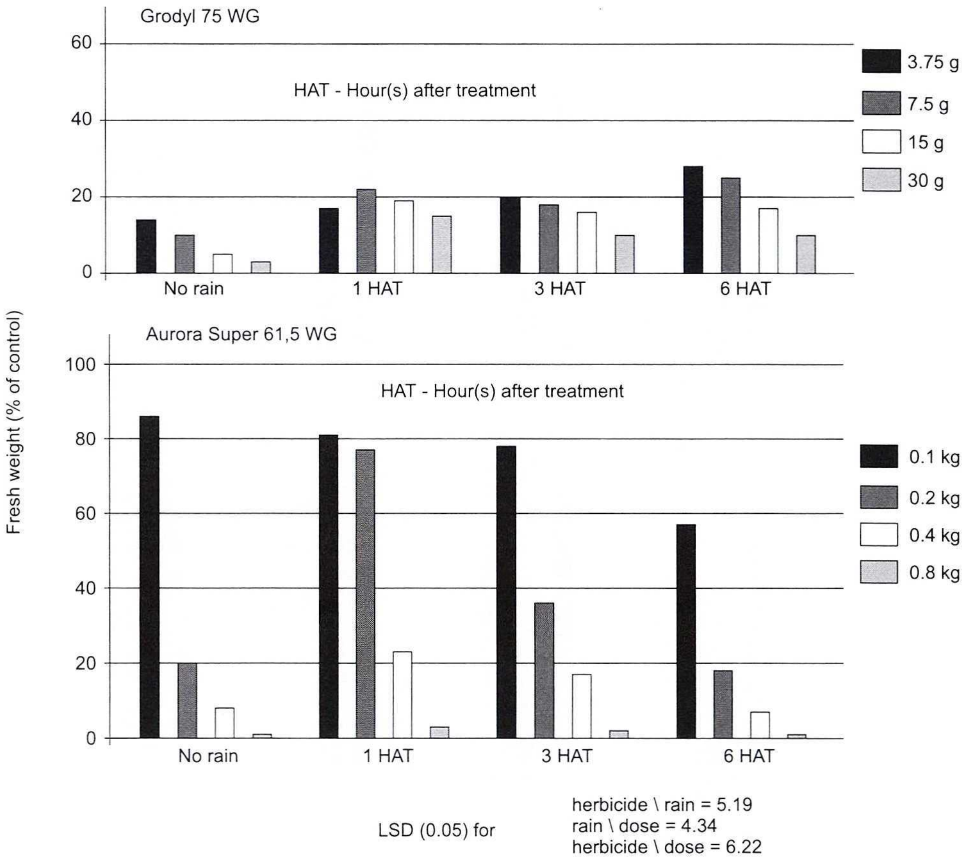


Fig. 3. Influence of rainfall on herbicides' activity

compounds. Water-soluble herbicides are more likely to be wash-off from leaves surface by rain (Caseley 1989) (Fig. 3).

CONCLUSIONS

Efficacy of weed control after herbicide application is dependent on the kind of herbicide, growth phase of weeds and weather conditions. Correct growth phase of weeds (1–2 whorls for *G. aparine*), higher temperature and the lack of rainfall just after treatment enables increase of herbicide effect. The significant influence of tested factors on herbicides efficacy was observed at reduced doses' levels.

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POLISH SUMMARY

WPŁYW FAZY ROZWOJOWEJ CHWASTÓW I WARUNKÓW POGODOWYCH W ŚWIETLE BADAŃ NAD OPTYMALIZACJĄ DAWKI HERBICYDÓW

Doświadczenia wazonowe nad wpływem fazy rozwojowej chwastów oraz warunków pogodowych na skuteczność herbicydów przeprowadzono w Duńskim Instytucie Nauk Rolniczych w latach 2000–2001. W doświadczeniu dotyczącym fazy rozwojowej uwzględniono trzy fazy *Galium aparine*: 1, 2 oraz 3 okółki. Wpływ temperatury określono używając symulatorów klimatycznych, gdzie temperatura powietrza wynosiła: 8/2°C, 16,5/8°C, 24/16°C. Deszcz aplikowano 1, 3 i 6 godzin po zabiegu za pomocą symulatora deszczu. Herbicydy: Grodyl 75 WG (amidosulfuron 750 $g*kg^{-1}$), Aurora Super 61,5 WG (mekoprop 600 $g*kg^{-1}$ + karfentrazon etylu 15 $g*kg^{-1}$), Lintur 70 WG (dikamba 65,9 $g*kg^{-1}$, triasulfuron 4,1 $g*kg^{-1}$) i Chwastox Trio 540 SL (dikamba 40 $g*l^{-1}$, MCPA 200 $g*l^{-1}$, mekoprop 300 $g*l^{-1}$) zastosowano w dawce pełnej oraz zredukowanych (1/2, 1/4 i 1/8 pełnej dawki).

Herbicydy Grodyl 75 WG i Aurora Super 61,5 WG najskuteczniej niszczyły *G. aparine* w najmłodszej fazie rozwojowej. Różnice we wrażliwości pomiędzy badanymi fazami (1, 2, 3 okółki) były większe w przypadku zastosowania herbicydu Grodyl 75 WG w porównaniu z herbicydem Aurora Super 61,5 WG. Skuteczność herbicydów Grodyl 75 WG, Aurora Super 61,5 WG i Chwastox Trio 540 SL wzrosła wraz ze wzrostem temperatury. Dodatek adjuwanta poprawił działanie herbicydu Lintur 70 WG gdzie stwierdzono wysoki stopień zniszczenia chwastów nawet po zastosowaniu dawki czterokrotnie niższej niezależnie od temperatury powietrza. Deszcz aplikowany 1, 3 i 6 godzin po opryskaniu roślin spowodował spadek skuteczności herbicydu Aurora Super 61,5 WG zastosowanego w dawkach obniżonych (1/4, 1/8). Dawka zredukowana o połowę była skuteczna tylko w przypadku, gdy deszcz miał miejsce 6 godzin po zabiegu. Herbicyd Grodyl 75 WG zachował wysoką skuteczność tylko w przypadku zastosowania pełnej dawki niezależnie od długości okresu pozbawionego opadów.