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THE EFFECT OF HERBICIDES ON *CHENOPODIUM ALBUM* L. PHENOLOGY IN FODDER BEET, SPRING WHEAT AND FABA BEAN CROPS

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S u m m a r y

The objective of the study was to determine the time of occurrence of the emergence, budding, fruiting and seed shed ding stages, as well as the degree of advancement of the white goosefoot fruiting and diaspores shedding stages in fodder beet, spring wheat and faba bean crops under mechanical and chemi cal weed control. Phenological observations were conducted in the years 2000 2002 at 10 day intervals, starting from the day of crop sowing on alluvial soil made of light loam. Chemically weed controlled objects were treated with herbicides: fodder beet le nacil 80%; spring wheat MCPA 30% + dicamba 4%; faba bean linuron 50%. It was proven that the times of occurrence and the scale of the studied phenological stages of white goosefoot de pended on the crop species, the in crop weed control method and the pattern of weather conditions in the study years. White goose foot had the most favourable conditions of growth in the fodder beet crop. The herbicides in the fodder beet and faba bean crops delayed the emergence and the time of occurrence of successive white goosefoot growth stages. These agents also decreased the degree of diaspores shedding by the weed species studied. The most white goosefoot specimens shed fruits on the mechanically weed controlled plots. The diaspores dissemination was promo ted by a warm and moist growing season.

Key words: *Chenopodium album*, phenological stages, herbicides

INTRODUCTION

White goosefoot (*Chenopodium album* L.) belongs to the most common segetal weeds (Joint publication, 1988). It most frequently infests root plants and related plants in terms of agricultural practice, where it forms different-rank syntaxonomic units (K a p e l u s z n y, 1979; W n u k, 1990). Lately, this species has also appeared more and more frequently and with a large cover in cereal crops (S k r z y c z y ń s k a et al. 2002). Such a situation results from the fact that white goosefoot fruits are the main component of the soil weed seed bank (W e s o ł o w s k i, 1984; W e s o ł o w s k i, 1986). In the opinion of J ę d r u s z c z a k (1992), K u ź n i e w s k i (1981) and P a w ł o w s k i et al. (1991), the knowledge of the growth pattern of weeds may be helpful in the selection of rational methods and measures of control of these plants. This paper also serves this goal. The growth pattern of white goosefoot is presented here in fodder beet, spring wheat and faba bean crops, under mechanical weed control and treated by using herbicides.

METHODS

The phenological development of white goosefoot was observed in the years 2000-2002 on alluvial soil made of light loam. The observation site was located in an agricultural district, Zakrzów, situated in the northwestern part of the city of Tarnobrzeg, at a distance of 1 km from the main channel of the Vistula River. Alluvium deposited there was characterised by a very acid reaction, a low content of available forms of phosphorus, a high content of magnesium and a very high content of potassium. The humus content was 2.05%. In each year of study, a 1-ha field was divided into 3 parts which were sown with crop plants, maintaining the following sequence of the plants: fodder beet-spring wheat-faba bean. The designated plots with an area of about 30 ares each were divided into 2 parts which were treated either mechanically or by using herbicides. The plots with herbicides were sprayed with the following preparations: fodder beet – Buracyl 80 WP (lenacil 80%) in a dose of 1 $kg \cdot ha^{-1}$; spring wheat – Chwastox Turbo 340 SL (MCPA 30% + dicamba 4%) in a dose of 2 $l \cdot ha^{-1}$; foba bean – Afalon 50 WP (linuron 50%) in a dose of 1.5 $kg \cdot ha^{-1}$. In beet and faba bean, the herbicides were applied right after the sowing, whereas in spring wheat in the tillering-shooting interstage. For herbicide application, a field sprayer was used under a pressure of 0.25 MPa, using 250 l of liquid per 1 ha. Tillage and mineral fertilisation for particular plants were typical. But

mechanical treatment of fodder beat involved the hoeing of the crops at the 2-leaf stage, and after the thinning, the use of hoes twice. In the spring wheat crop, harrowing was used twice on the mechanically treated plots, (at the stage of germination and 4-5-leaves of the crop plant), whereas on the plot with the faba bean crop, mechanical treatment involved the use of harrows before the emergence, and after the emergence, the use of an inter-row hoe. The times of sowing and harvesting were as follows, respectively: fodder beet – the 3rd decade of March (2002) and the 1st decade of April (2000-2001) and the 3rd decade of September; spring wheat – the 2nd (2002) or 3rd decade of March (2000) and the 3rd decade of July (2002) and the 2nd decade of August (2000); faba bean – the 2nd decade of March and the 3rd decade of August (2000-2001) and the 1st decade of September (2002). In 2001, as a result of a catastrophic spring drought, the emergence, and then the canopy density and the rate of the initial growth of spring wheat were so small that at the end of May it was decided to eliminate the wheat crop.

The occurrence of the phenological stages of white goosefoot was recorded at six permanent sites with an area of 0.5 m^2, designated in each plot. It was done at 10-day intervals, starting from the day of sowing of the crop plants. The following white goosefoot growth stages were observed: emergence (seedlings up to 4 leaves), budding, green fruits and fruit shedding. The nut shedding stage was estimated each year on the date of harvesting of particular crops. On the observation dates, the percentage shares of particular white goosefoot growth stages were estimated. The study results from the whole growing period of the crop plants served to calculate the average share of a given phonological stage at a particular observation time. The start of each stage was marked by the occurrence of its typical symptoms in 10% of white goosefoot specimens, and the full stage after 50% was exceeded (S o k o ł o w s k a , 1980). In this paper, the times of occurrence of particular phenophases mean the achievement of full development by them.

To characterise the pattern of weather conditions in the study period, it should be indicated that in the years 2000-2001 significantly more rainfall was noted than over the multi-year period (Tab. 1). In this period, July was particularly wet, then March, September and August. The growing period in 2002 proved to be definitely dry compared to the multi-year period. A rainfall deficit was recorded at that time in each month, and in the period of March – September it was about 100 mm. All the months of each year of study, with the exception of September, were warmer compared to the multi-year period. The hottest weather was in the dry year of 2002.

RESULTS AND DISCUSSION

White goosefoot proved to be a species which occurred each year in all the crop plants, irrespective of the applied forms of weed control. The times of its emergence were always later than those of the crop plants (Tab. 2).

In the fodder beet and faba bean crops, the studied species sprouted definitely earlier on the mechanically weed controlled plots. Its seedlings emerged there in the 1st decade of May, and only once in the 2nd decade (2001).

Table 1
Total precipitation and air mean temperatures according to the weather station in Sandomierz.

Months	Rainfall in mm				Temperature in °C			
	2000	2001	2002	Period 1881 1980	2000	2001	2002	Period 1881 1990
III	47.9	50.1	20.2	30.0	3.5	2.9	5.3	1.7
IV	38.5	71.6	35.1	42.0	12.5	8.6	8.8	7.5
V	54.0	33.6	45.8	61.0	15.6	14.7	17.1	13.3
VI	65.1	85.4	76.7	80.0	16.3	15.2	17.4	16.6
VII	201.1	187.5	82.9	99.0	16.7	20.1	21.0	18.3
VIII	50.2	55.9	35.9	77.0	18.7	19.2	20.2	17.2
IX	50.8	92.0	38.7	47.0	12.1	12.1	13.1	13.5
III IX	507.6	576.1	335.3	436.0	13.6	13.3	14.7	12.6

Table 2
Times of emergence of crop plants and occurrence of phenological stages of white goosefoot.

Field crop	Years	Objects	Crop emergence	Stages			
				emergence	budding	green fruits	fruits shedding
Fodder beet	2000	without herbicide	21 IV	10 V	29 VI	18 VII	17 VIII
		with herbicide	21 IV	9 VI	8 VII	17 VIII	6 IX
	2001	without herbicide	28 IV	18 VI	17 VI	27 VII	26 VIII
		with herbicide	28 IV	27 VI	–	–	–
	2002	without herbicide	19 IV	9 V	28 VI	18 VII	27 VIII
		with herbicide	19 IV	18 VI	8 VII	7 VIII	6 IX
Spring wheat	2000	without herbicide	24 IV	24 V	24 V	23 VI	–
		with herbicide	24 IV	24 V	23 VI	2 VIII	–
	2002	without herbicide	16 IV	6 V	26 V	25 VI	–
		with herbicide	16 IV	6 V	26 V	25 VI	–
Faba bean	2000	without herbicide	24 IV	4 V	13 VI	23 VII	–
		with herbicide	24 IV	14 V	3 VI	12 VIII	–
	2001	without herbicide	29 IV	9 V	29 V	28 VII	–
		with herbicide	29 IV	29 V	28 VI	–	–
	2002	herbicide	27 IV	7 V	16 VI	16 VII	25 VIII
		with herbicide	27 IV	17 V	16 VI	5 VIII	4 IX

On the plots treated with herbicides, the emergence of *Chenopodium album* was delayed by at least 10 days, and even by over 1 month. This phenomenon was seen in the fodder beet crop where the emergence of the taxon in question on the mechanically weed controlled plot outstripped the emergence on the plot with herbicides by over 4 weeks, and in the wet and cold year of 2001 even by 6 weeks. In the faba bean crop, the herbicide Afalon delayed the emergence of white goosefoot by 10 days, and in the year 2001 by 3 weeks. In the case of spring wheat, the emergence of the studied taxon was noted at the same time on both surfaces. It was obvious since the foliar herbicide Chwastox TURBO was used in the crop of this plant not earlier than at the spring wheat tillering-shooting interstage.

The herbicides applied in the fodder beet crop (Buracyl) and in the faba bean crop (Afalon) also had an adverse effect on the further growth of white goosefoot. As a result of that, white goosefoot budded, set fruits and shed nuts later on the surfaces treated with them (Tab. 2).

White goosefoot reached the final growth stages, that is, fruiting and diaspores shedding, to a different degree (Tab. 3). In the spring wheat crop, it only reached the fruiting stage. It behaved similarly in the faba bean crop, since in the three-year study period it started nut shedding only once (2002), but on both types of the plots (without herbicides and with herbicides). In the fodder beet canopy, white goosefoot reached both final phonological stages in all the years of study.

The degree to which the fruit shedding stage was reached by white goosefoot, important from the point of view of potential weed infestation of succeeding crops, also depended on the weather pattern in particular growing seasons. In the warm and wet year of 2000, 80% of white goosefoot specimens shed fruits on the

Table 3
Fruiting and shedding specimens of white goosefoot during crop harvesting in %.

Field crop	Years	Objects	Stages in %	
			fruiting	shedding
Fodder beet	2000	without herbicide	20	80
	2001	with herbicide	57	18
		without herbicide	69	17
	2002	with herbicide	–	–
		herbicide	80	20
Spring wheat	2000	with herbicide	52	21
		without herbicide	73	0
	2002	with herbicide	30	0
		without herbicide	63	0
Faba bean	2000	with herbicide	37	0
		without herbicide	50	0
	2001	with herbicide	25	0
		bez herbicydu without herbicide	30	0
	2002	z herbicydem with herbicide	–	0
		bez herbicydu without herbicide	65	20
		z herbicydem with herbicide	55	10

mechanically weed controlled surface of beet, and on an identical area it was only 17% in the cool and wet year of 2001. Moreover, the number of shedding white goosefoot individuals was mostly smaller on the plots with herbicides than on the mechanically treated surfaces (Tb. 3).

To sum up this study, it should be stated that the growth of white goosefoot depended on the crop plant, the method of weed control and the weather pattern in the growing period of the crop plants. The species in question best developed in the fodder beet crop, since there the largest percentage of its specimens shed fruits. A favourable effect of root plants on the phenology of white goosefoot is also documented by other authors (Jędruszczak, 1992; Pawłowski et al. 1991; Pawłowski and Wesołowski, 1989). Research devoted to phenological problems also informs about the modifying effect of weather conditions on the growth pattern of weeds (Hoffman-Kąkol and Biniak, 1981; Pawłowski et al. 1991; Sychowa, 1959). But there are few data in available literature on the phenology of weeds under the conditions of herbicide application. Only studies of Wesołowski (2004) show that weed killers weakened the growth rate, including the fruiting of field thistle.

CONCLUSIONS

1. The times of occurrence and the scale of the studied phenological stages of white goosefoot depended on the crop species, in-crop weed control method and the pattern of weather conditions in the study years.

2. White goosefoot had the most favourable conditions of growth in the fodder beet crop, worse in the faba bean crop, and the worst in the spring wheat canopy.

3. The herbicides applied in the fodder beet crop (Buracyl) and in the faba bean crop (Afalon) delayed the emergence and the time of occurrence of successive white goosefoot growth stages. These agents also decreased the degree of diaspores shedding by the weed species studied.

4. The most white goosefoot specimens shed fruits on the mechanically weed controlled plots. The diaspores dissemination in this species was also promoted by the warm and moist growing season in 2000.

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Wpływ herbicydów na fenologię komory białej w zasiewach buraka pastewnego, pszenicy jarej i bobiku

Streszczenie

Celem badań było określenie terminu pojawu fazy wschodów, pąkowania, owocowania i osypywania nasion, a także stopnia zaawansowania faz owocowania i osypywania diaspor komosy białej w zasiewach buraka pastewnego, pszenicy jarej i bobiku, odchwaszczanych mechanicznie i chemicznie. Obserwacje fenologiczne prowadzono w latach 2000-2002 w odstępach 10-dniowych, począwszy od dnia siewu roślin uprawnych, na madzie właściwej wytworzonej z glin lekkich. Obiekty odchwaszczane chemicznie pielęgnowano herbicydami: burak pastewny – lenacyl 80%; pszenica jara – MCPA 30% + dicamba 4%; bobik – linuron 50%. Dowiedziono, że terminy pojawu i wielkość badanych faz fenologicznych komosy białej zależały od gatunku rośliny uprawnej, sposobu odchwaszczania zasiewów oraz układu warunków pogodowych w latach badań. Najkorzystniejsze warunki rozwoju znajdowała komosa biała w uprawie buraka pastewnego. Herbicydy w uprawie buraka pastewnego i bobiku opóźniały wschody i termin pojawienia się kolejnych faz rozwojowych komosy białej. Środki te zmniejszały również stopień osypywania diaspor przez badany gatunek chwastu. Najwięcej egzemplarzy komosy białej osypywało owoce na poletkach odchwaszczanych mechanicznie. Disseminacji diaspor sprzyjał ciepły i wilgotny sezon wegetacyjny.