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Influence of prometryne ⟨Gesagard 50⟩ on pectic substances and calcium contents in the above-ground parts of the field pea ⟨*Pisum arvense* L.⟩

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Abstract

The content of pectic substances ⟨soluble pectins and fraction of protopectins⟩ and calcium ⟨free and bound⟩ in field pea ⟨*Pisum arvense* L.⟩ leaves and stems during budding and flowering in field conditions was determined. In this experiment Gesagard 50 ⟨S. A. – 50% prometryne⟩ was applied to the soil in a weed control dose ⟨2 kg/ha⟩. An insignificant decrease of the content of protopectins and total pectins in leaves of the investigated plants ⟨about 3-7% in relation to control⟩ after application of this herbicide was noted, but analogous changes in all years of the experiment were not observed in field pea stems. The influence of prometryne on the distribution of pectic substances in above-ground parts of the field pea and the degree of protopectins methylation were not corroborated. Neither did the total calcium content in the investigated plants change after application of the herbicide. These results show that application of Gesagard 50 in a weed control dose ⟨2 kg/ha⟩ in cultivation of field pea does not evoke changes in the investigated components content which might be of significance in the growth and development of plant cells and immunity reactions of plants.

INTRODUCTION

Investigations concerning various aspects of herbicide application comprise among other things qualitative and quantitative analysis of changes in the chemical composition of the plants subjected to the action of these substances. Investigations of this type not only afford a better knowledge of the mechanism of action of the herbicides, but make possible their appropriate choice ensuring preservation of the full value of the crop plants.

The field pea ⟨*Pisum arvense* L.⟩ is a plant enriching fodder in protein and other nutrient components. One of the chemical compounds which may be used for weed control in cultures of this plant is Gesagard 50 ⟨50% S. A.⟩ in which the active substance is prometryne ⟨2-methylthio-4, 6-di-isopropylamine

⟨-s-triazine⟩⟩ ⟨P a p r o c k i et al., 1973⟩. Up-to-date studies on the influence of this herbicide on the chemical composition of the field pea concerned such nutrient components as amino acids, proteins, sugars, carotenes and some microelements ⟨C i s z e w s k a and S z y n a l, 1978; M a k a r s k a, 1977; M a k a r s k a et al., 1978⟩, whereas the influence of prometryne on accumulation of pectin substances in these plants was not analysed. The latter compounds, belonging to sugar derivatives are considered as some of the most important substances included in the cell walls of plants and middle lamella which is the element cementing the particular cells. Numerous papers seem to indicate that pectin substances play a prominent role in processes of plant cell growth, they also affect the resistance of plants to mechanical factors, climatic conditions and some diseases ⟨B l a i m, 1968a; B o n n e r, 1961; W o r t h, 1967⟩. Changes in the metabolism of these compunds have been repeatedly noted after application of plant growth regulators of various type, retardants, herbicides and mineral fertilizers ⟨B l a i m, 1968a; B l a i m and P r z e s z l a k o w s k a, 1967; B l a i m et al., 1968; B l a i m et al., 1971; C i s z e w s k a and S z y n a l, 1977; 1979a, b; S a p o z h n i k o v a and A l b a, 1971⟩. For this reason investigations were undertaken to determine the content of pectin substances in the above ground parts of the field pea after prometryne ⟨Gesagard 50⟩ application in doses recommended for weed control. In view of the many sided role of pectin substances, and particularly in stiffening of the tissues, analyses of the plants were performed in the period of increased tendency to lodging ⟨phase of flower bud formation and flowering⟩.

In processes of growth and development of plant cells calcium ions also play an essential role ⟨B l a i m, 1968b⟩. This results from the participation of this element in the formation of insoluble protopectins. The lower the degree of methylation of protopectins the more calcium ions may be built into their structure. Therefore, in the studies performed, beside analyses of fractions of pectin compounds and determination of their degree of methylation, the free and bound calcium content was determined in the same experimental material. It should be noted that calcium belongs to the most important mineral components indispensable in nutrition, therefore, its determination in plants used as fodder is essential.

The present paper is a continuation of earlier ones concerning the influence of soil-applied herbicides ⟨triazine and urea type⟩ on the chemical composition of the field pea ⟨C i s z e w s k a and S z y n a l, 1977; 1978; 1979a, b⟩.

MATERIAL AND METHODS

The material for investigations consisted of leaves and stems of *Pisum arvense* L. from experimental plots of the Agricultural University in Lublin ⟨Experimental Station in Czesławice⟩. The experiments were carried out on plots of 3 m^2 area

in three replications by the method of randomised blocks. As fertilizer superphosphate and potassium chloride were applied. The phosphorus and potassium dose in kilogrammes of pure component per hectare was: 36 kg P_2O_5 and 60 kg K_2O. The field pea was sown in the amount of 160 kg/ha. For weed control on the plots Gesagard 50 ⟨S. A. – 50% prometryne⟩ was used in a dose of 2 kg/ha. Spraying of the plots with the herbicide was done two days after seeding of the pea. Material for analysis was collected at two vegetation phases of the plants: during flower bud formation and in the period of flowering. The leaves and stems collected were dried at 60 °C and comminuted in an electric mill. In this material the contents of the particular fractions of pectin substances were determined by the method based on the reaction of carbozole with the free carboxyl groups of pectins ⟨B l a i m and P r z e s z l a k o w s k a, 1968⟩. Isolation of soluble pectins was achieved by way of water extraction after previous removal of reducing sugars. Protopectins were extracted with the use of 0.02 M disodium versenate ⟨EDTA⟩ solution in neutral and alkaline medium. When extraction is run in alkaline EDTA solution, protopectin demethylation occurs with complete release of carboxyl groups, whereas extraction of the same compounds in a neutral medium makes possible isolation and determination of the content of the fraction containing free carboxyl groups. The differences which appear in the amount of the isolated fractions under these conditions indicate the content of methylated protopectins, and the ratio of their content to the total amount of protopectins is the measure of the degree of methylation of these substances.

Free and bound calcium contents were determined in the material by the manganometric method ⟨P e t e r b u r g s k i i, 1952⟩. Free calcium was determined in water-alcohol extract, and bound calcium in the residue left after separation of free calcium.

Analyses of the material from particular plots were performed in three replications ⟨the results given in tables are means from three replications of analyses of material collected from three analogous plots⟩.

RESULTS AND DISCUSSION

The data obtained indicate that application of Gesagard 50 under the conditions described did not cause noticeable changes in the content of the components determined. A tendency may be noted, however, in all the years of experiment to a slight depression of the total content of pectin substances in the leaves of the field pea after application of the herbicide ⟨Table 1⟩. No such tendency was observed in the stems ⟨Table 2⟩. The depression of the total pectin substances content in the leaves in the phase of flower bud formation was connected with a decrease in the amount of soluble pectins and protopectins, and in the flowering phase the decrease of the total pectin content was solely the result

Table 1

Content of pectic substances and degree of their methylation in the leaves of field pea (*Pisum arvense* L.) from prometryne (Gesagard 50) treated and control plots

Variant of experiment	Stage of vegetation	Year of vegetation	Soluble pectins	Fractions of protopectin			Total pectin substances	Degree of methylation of protopectins
				extraction		methylated protopectins		
				neutral	alkaline			
Control	budding	1972	1.40	3.76	7.04	3.28	8.44	0.46
		1973	1.92	4.26	6.79	2.53	8.71	0.37
		1974	1.79	4.46	7.15	2.69	8.94	0.37
		means	1.70	4.16	6.99	2.83	8.69	0.40
	flowering	1972	1.15	5.21	8.51	3.30	9.66	0.38
		1973	1.75	5.02	7.92	2.90	9.67	0.37
		1974	1.00	5.71	9.06	3.35	10.06	0.37
		means	1.30	5.31	8.49	3.18	9.79	0.37
Prometryne	budding	1972	1.20	3.75	6.52	2.77	7.71	0.42
		1973	1.75	3.92	9.21	2.29	7.96	0.37
		1974	1.41	4.41	7.11	2.70	8.52	0.38
		means	1.45	4.03	6.61	2.59	8.01	0.39
	flowering	1972	1.25	4.69	8.11	3.42	9.36	0.42
		1973	1.35	4.79	7.79	3.00	9.14	0.39
		1974	1.15	5.49	8.66	3.17	9.81	0.37
		means	1.25	4.99	8.19	3.20	9.44	0.39

Table 2

Content of pectic substances and degree of their methylation in the stems of field pea (*Pisum arvense* L.) from prometryne (Gesagard 50) treated and control plots

Variant of experiment	Stage of vegetation	Year of vegetation	Soluble pectins	Fractions of protopectin			Total pectin substances	Degree of methylation of protopectins
				extraction		methylated protopectins		
				neutral	alkaline			
Control	budding	1972	0.83	3.71	6.77	3.06	7.60	0.45
		1973	1.64	4.53	7.73	3.20	9.37	0.41
		1974	0.96	3.83	6.53	2.70	7.49	0.41
		means	1.14	4.02	7.01	2.99	8.15	0.43
	flowering	1972	0.90	4.23	8.24	4.01	9.14	0.48
		1973	1.14	5.02	8.35	3.33	9.49	0.39
		1974	0.73	5.20	8.07	2.87	8.80	0.35
		means	0.92	4.82	8.22	3.40	9.14	0.41
Prometryne	budding	1972	1.28	4.15	7.32	3.17	8.60	0.43
		1973	1.03	4.92	8.43	3.51	9.46	0.42
		1974	0.78	3.48	5.86	2.38	6.64	0.41
		means	1.03	4.18	7.20	3.02	8.23	0.42
	flowering	1972	1.12	4.78	8.40	3.62	9.52	0.43
		1973	1.20	4.91	7.62	2.71	8.82	0.36
		1974	0.63	4.66	8.73	4.06	9.36	0.47
		means	0.98	4.78	8.25	3.47	9.23	0.42

of a depression of the protopectin level. Both in leaves and stems of the plants major changes were not found after prometryne application in the methylated protopectins content and the degree of methylation of this fraction. In analogous investigations concerning the influence of simazine ⟨Gesatop 50⟩ an inhibitory effect was observed on accumulation of pectin compounds ⟨mainly protopectins⟩ in field pea leaves, with a simultaneous tendency to an increase in their concentration in stems ⟨C i s z e w s k a and S z y n a l, 1979b⟩. In this case simazine in the amount of 0.5 kg/ha caused more distinct changes in the content of the studied compounds than did prometryne in a dose of 1 kg/ha. Disturbances were found in earlier studies, when analysing the reducing sugars content in the above ground parts of the field pea from control plots and those treated with triazine herbicides, in accumulation of these sugars higher after the use of Gesatop 50 than after Gesagard 50 in field crops of *Pisum arvense* ⟨C i s z e w s k a and S z y n a l, 1978⟩.

The data in Tables 1 and 2 indicate that prometryne has no effect on the distribution of pectin compounds in the above ground parts of the analysed plants. Both leaves and stems of the plants from the plots sprayed with the herbicide and the control ones contained similar amounts of the tested substances. The higher content of protopectins and of the total content of pectin substances in field pea leaves in the flowering phase as compared with that in leaves of plants in the phase of flower bud formation was observed in all the years of the experiment, both in plants from the control plots and those treated with prometryne.

In the further part of the investigations free and bound calcium content was determined in the experimental material. The data ⟨Table 3⟩ indicate that the application of prometryne in the doses recommended for weed control in field pea crops did not produce any distinct changes in the total calcium content in the leaves and stems of the analysed plants. Only in the flowering phase was a tendency to a depression of bound calcium content observed in the leaves of field pea from the plots sprayed with the herbicide. Moreover, a higher bound calcium content was found in the leaves as compared with the content of this fraction in the stems. This finding agrees with our results to-date concerning calcium accumulation in particular organs of field pea ⟨C i s z e w s k a and S z y n a l, 1979a, b⟩, it also confirms analogous data obtained for other plants ⟨N o w o t n y - M i e c z y ń s k a, 1976⟩.

It seems, on the basis of the here presented results, that prometryne in the doses recommended for weed control in field pea crops ⟨under the described experimental conditions⟩ does not cause major changes either in the content of pectin compounds or in the calcium fractions determined. The described tendencies to a slight depression of the amount of some fractions of the components determined, occurring in the field pea leaves do not seem to be of major practical consequence. It should be noted that in the investigations

Table 3

Content of calcium fractions in field pea (*Pisum arvense* L.) from prometryne (Gesagard 50) treated and control plots

Variant of experiment	Stage of vegetation	Years of vegetation	Leaves			Stems		
			Ca-free	Ca-bound	Ca-total	Ca-free	Ca-bound	Ca-total
Control	budding	1972	0.14	0.84	0.98	0.16	0.48	0.64
		1973	0.12	0.74	0.86	0.24	0.60	0.84
		1974	0.21	0.77	0.98	0.18	0.69	0.87
		means	0.16	0.78	0.94	0.19	0.59	0.78
	flowering	1972	0.17	0.89	1.06	0.24	0.46	0.70
		1973	0.15	1.08	1.23	0.19	0.66	0.85
		1974	0.20	0.80	1.00	0.17	0.57	0.74
		means	0.17	0.92	1.10	0.20	0.56	0.76
Prometryne	budding	1972	0.11	0.81	0.92	0.14	0.54	0.68
		1973	0.14	0.72	0.86	0.20	0.64	0.84
		1974	0.21	0.75	0.96	0.22	0.53	0.75
		means	0.15	0.76	0.91	0.19	0.57	0.76
	flowering	1972	0.10	0.90	1.00	0.19	0.54	0.73
		1973	0.17	0.70	0.87	0.21	0.60	0.81
		1974	0.12	0.92	1.04	0.10	0.60	0.70
		means	0.13	0.84	0.97	0.17	0.58	0.75

concerning the influence of prometryne ⟨Gesagard 50⟩ on the content of nutrient components in the field pea ⟨Makarska, 1977; Makarska et al., 1978; Ciszewska and Szynal, 1978⟩ no unfavourable influence of this herbicide on the content of such compounds as amino acids, proteins, sugars, carotenes and some microelements was noted. These data confirm the usefulness of Gesagard 50 for weed control in field pea crops.

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Wpływ prometryny ⟨Gesagardu 50⟩ na zawartość substancji pektynowych oraz wapnia w częściach nadziemnych peluszki ⟨*Pisum arvense* L.⟩

Streszczenie

Oznaczono zawartość substancji pektynowych ⟨pektyn rozpuszczalnych i fakcji protopektyn⟩ oraz wapnia wolnego i związanego w liściach i w łodygach peluszki ⟨*Pisum arvense* L.⟩, w fazie tworzenia pąków kwiatowych oraz w fazie kwitnienia roślin uprawianych w warunkach polowych. W doświadczeniu do odchwaszczania zasiewów peluszki stosowano Gesagard 50 ⟨S. A. – 50% prometryny⟩, który wprowadzano doglebowo w dawce 2 kg/ha. Po stosowaniu tego herbicydu stwierdzono nieznaczny spadek zawartości protopektyn i sumy substancji pektynowych ⟨ok. 3-7% w stosunku do kontroli⟩ w liściach analizowanych roślin. Nie obserwowano powtarzających się we wszystkich latach doświadczenia analogicznych zmian w łodygach peluszki. Nie stwierdzono wpływu prometryny na rozmieszczenie związków pektynowych w częściach nadziemnych peluszki oraz na stopień zmetylowania protopektyn. Zawartość wapnia w badanych roślinach po stosowaniu herbicydu nie ulegała zmianom.

Uzyskane dane pozwalają sądzić, że przedwschodowe stosowanie Gesagardu 50 w uprawie peluszki, w dawkach zalecanych do zwalczania chwastów ⟨2 kg/ha⟩, nie wywołuje zmian w zawartości badanych składników, posiadających istotne znaczenie we wzroście i rozwoju komórek roślinnych i niektórych reakcjach odpornościowych roślin.