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THE OCCURRENCE OF *Papaver rhoeas* L. IN AGROCENOSES OF THE BUFFER ZONE OF THE ROZTOCZE NATIONAL PARK COMPARED TO OTHER REGIONS OF POLAND

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Abstract

The paper tries to determine the environmental amplitude as well as the optimal conditions for the vegetation of *Papaver rhoeas* in the agrocoenoses of the Roztocze National Park's buffer zone, as compared to other Polish regions. The analysis is based on certain habitat and anthropogenic factors. Based on the author's own research and the data quoted in the literature, it has been found that *Papaver rhoeas* occurs in the associations and communities of the *Caucalidion* and *Aperion* alliances accompanying cereal and rape crops as well as in the *Polygono-Chenopodion* and *Panico-Setarion* alliances accompanying root crops. *Papaver rhoeas* demonstrates a large environmental scale, as its presence has been noted in low- and highlands, in foothills, in river valleys as well as on slopes. Moreover, it teams up with various types of soils (of a wide range of acidity, moisture as well as trophic and thermal conditions) and complexes. *Papaver rhoeas* occurs most often and in the largest numbers in winter crops in the *Lathyro-Melandrietum* and *Caucalidio-Scandicetum* association which belongs to the *Caucalidion* alliance and in the *Consolido-Brometum*, *Vicietum tetraspermae papaveretosum* and *V. t. consolidetosum* association from the *Aperion* alliance. As far as root crops are considered, *Papaver rhoeas* shows up in the *Lamio-Veronicetum politae* association from the *Polygono-Chenopodion* alliance. It prefers chalky and Jurassic rendzinas containing $CaCO_3$ and other fertile loam and loess soils which belong to wheat complexes, with their pH ranging from slightly acid to alkaline (Eutric Vertisols, chernozem, brown soil, alluvial soil) and which are moderately moist, warm, medium-rich in nitrogen and with good soil biological activity. In the foothill areas, it dominates on alluvial soils in the river valleys; rarely has it been spotted on the slopes. *Papaver rhoeas* rarely occurs on the lightest sandy soils of the weak and very weak rye complexes and weak cereal-fodder complexes. The distribution of *Papaver rhoeas* reflects the soil conditions in a given area.

Key words: *Papaver rhoeas*, phytoindication, chemical properties of soil, relevé, plant associations, ecological scale

INTRODUCTION

Papaver rhoeas, red poppy, occurs in the warm and temperate parts of Europe, becoming less and less frequent when moving to the North of the continent (Markow, 1978). In Poland it grows in the lowland and foothills, usually up to 600 m a.s.l. (Hochół, 2001; Łabza, 1994; Wójcik, 1977; 1998). The poppy is an archeophyte originating from the Mediterranean and Irano-Turanian zone. As early as at the beginning of the Neolithic Age, it was a weed of cereal crops on the territory of today's Poland (Lityńska-Zając, 2005).

Papaver rhoeas is an annual, mainly winter plant, occurring in winter and spring cereal crops, rape and root crops, in addition on fallows, near farm buildings, along fences and train rails (Fijałkowski, 1978). In cereal crops it blossoms from May to August and in root crops from August to October (Markow, 1978). It belongs to the layer created by cereals or slightly overgrows them. While dominating in agrocenoses, *Papaver rhoeas* contributes to their colourful aspect during the bloom period (Siciński, 1993). In Lubelszczyzna, E Poland, in winter crops the red poppy enters the phase of maturing and seed dispersal from the end of June to August, in spring cereals from the end of July to the end of August, and in root plant crops in September up to the second decade of October (Jędruszczak, 1993). It belongs to the most prolific and short-lived weeds (Pawłowski et al. 1970) and it is included in the eighth ecological group of short-lived archeophytes commonly found on calcareous and other nutrient-rich and moderately moist soils (Hilbig et al. 1962). It is a characteristic species for the *Centauretalia cyani* order and the *Stellarietea mediae* class (Matuszkiewicz, 2005).

Reviewing rich Polish literature on segetal flora, Warcholińska (1994) mentioned *Papaver rhoeas* among 100 other species on the list of threatened and disappearing weed species in Poland. She assigned to it the status of a species of unidentified threat, which was backed up by numerous other studies, including the one estimating that the population of *Papaver rhoeas* shrank in the 1990s by 30-50% compared to the period 1947-1967 (Fijałkowski and Nycz, 1998). Similarly Skrzyczyńska (1994) observed a lower constancy class and species cover index of *Papaver rhoeas* in various associations on the Siedlce Plateau (north from the Lublin Region). Also Pawlak (1998) draws attention to the extinction threat of this species. On the other hand, however, *Papaver rhoeas* is not considered a disappearing weed species on the Miechów Upland (Dąbkowska et al. 2007) and Silesian Upland (Urbisz et al. 1998), and in Opole Silesia (Anioł-Kwiatkowska and Nowak, 2006).

The goal of the present study was an attempt to define the ecological amplitude and optimal conditions for *Papaver rhoeas* in the buffer agrocenoses of the Roztocze National Park as compared to other Polish regions, depending on the selected site and anthropogenic factors. This analysis was also inspired by the lack of wide ecological studies on the ecology of rare and disappearing weeds of agricultural crops, including *Papaver rhoeas*.

STUDY AREA

The Roztocze National Park (RNP) was established in 1974. The area of its buffer zone amounts to 38,096 hectares. Its diversified geological substratum, hydrological conditions and relief determine the spatial variability of soils in the park and its buffer zone. On the slopes and ridges, the dominating soil types are brown soils on loess, leached brown soils on gaizes, composed of loams and sands, as well as chalky rendzinas. While vast areas are covered by grey-brown podzolic soils developed from sands with different grain-size distribution, loamy grey-brown podzolic soils occupy only a small portion of the study area. The climate conditions are chiefly determined by insolation and atmospheric circulation modified by the altitude, exposure of slopes, type of substratum and its cover (Turski et al. 1993).

From the physiographic point of view, the northern part of the RNP belongs to the Zamość Valley, the central part to Roztocze, while the north-western part to the Biłgoraj Plain.

MATERIALS AND METHODS

Among 574 phytosociological relevés taken in 1991-1995 on plots of approximately 100 m^2 each in agrocenoses of the RNP buffer zone, 306 represented cereal crops, 240 root crops, and the rest – fallow and idle lands. In cereals the releves were taken in two replicates: at the end of May and in the first half of July, and in root crops at the end of August/beginning of September, whilst on fallow and idle land in the first half of July. From the total of 574 relevés, 196 were selected where *Papaver rhoeas* was present. Based on the species composition of those relevés, the following ecological indicators were calculated on a five-point scale of Ellenberg (1950): T (thermal conditions), W (soil humidity), R (soil acidity), N (nitrogen availability), and G (soil biological activity). Only the presence of species in relevés (not their cover-abundance) was considered. The results of phytoindication evaluation were subject to statistical analysis carried out with Statistica software. The frequency distributions of the ecological indicators T, W, R, N and G with medians are shown in the charts. The soil type was defined in the field with the use of agricultural soil maps at a scale of 1:5000. The granulometrics, pH, content of humus, calcium carbonate and basic nutrients were determined in the laboratory in forty-six collective soil samples collected from the arable layer of crop fields, fallow and idle lands, wherever red poppy occurred. The evaluation of soil macronutrient availability was done according to the threshold numbers proposed by the Institute of Soil Science and Plant Cultivation (IUNG) in Puławy (Fertilising recommendations, 1985). The study area and the distribution of the locations with *Papaver rhoeas* are displayed on the map (Fig. 1). In Tables 2 and 3, only communities with the poppy present are presented.

RESULTS

Extensive farming as well as soil and microclimate diversity provide favourable conditions in the RNP buffer zone for the development of floristically diverse agrophytocenoses with *Papaver rhoeas*. Among 196 relevés, this species was considerably more frequent (approximately 70% of relevés) in cereal crops, on fallow and idle ground, than in root crops (Tab. 1). The biggest number of relevés (more than 43%) represented *Vicietum tetraspermae*, an association that dominated in cultivated fields of the RNP buffer zone on various soil types and of different granulometric composition, ranging from the lightest sands to dusts and loams. In the root crops, most of the relevés (more than 16%) represented the *Lamio-Veronicetum politae* association (Tab. 1) and only 2% *Echinochloo-Setarietum* which, similarly like *Vicietum tetraspermae*, was the most widespread in the study area.

Almost 60% of the samples was represented by patches in which *Papaver rhoeas* occurred with the

Table 1
Per cent of relevés with *Papaver rhoeas* L. in agrocenoses of the RPN buffer zone.

Association, community	Subassociation	% relevés
Vicietum tetraspermae	*typicum*	15.31
	papaveretosum	14.80
	consolidetosum	13.27
Total:		43.38
Lathyro-Melandrietum		14.79
Caucalido-Scandicetum		6.12
Avena fatua		2.55
Elymus repens		1.02
Echinochloo-Setarietum		2.05
Galinsogo-Setarietum		1.53
Lamio-Veronicetum politae	*typicum*	14.28
	fumarietosum	2.04
Stellaria media		4.08
Convolvulus arvensis		2.04
Veronica persica		2.55
Amaranthus retroflexus		3.57

degree of cover-abundance of "+", and only 8.7% with the cover-abundance value of 3-4 in the Braun-Blanquet scale (Fig. 2). The cover-abundance of 1-4 was reached by *Papaver rhoeas* exclusively in the association *Vicietum tetraspermae papaveretosum*, often in *Caucalidio-Scandiecetum*, *Lathyro-Melandrietum* and in *Vicietum tetraspermae consolidetosum* and least frequently (only 6% of relevés) in *Vicietum tetraspermae typicum*. Among the segetal communities accompanying root crops, *Papaver rhoeas* at the cover-abundance level of 1-4 was most commonly found in *Lamio-Veronicetum politae typicum*, however, when *Fumaria officinalis* occurred in the association, the cover-abundance of *Papaver rhoeas* was only "+" (Fig. 3). The highest constancy classes and cover-abundance values of *Papaver rhoeas* in the mentioned associations are a consequence of the above phenomena (Tabs 2 and 3). In the RNP buffer zone, *Papaver rhoeas* was not found in several associations and communities accompanying cereal and root crops. They were phytocenoses occurring mainly on lighter, acid soils, or species-poor phytocenoses on fertile sites in intensive wheat cropping, treated with herbicides.

Considering the type and granulometric composition of soils in the RNP buffer zone, it was found that *Papaver rhoeas* was the most frequent on rendzinas (more than 50% of relevés) and brown soils formed from gaize loams and loamy sands (more than 25%), located on elevations exposed to south and south-west. It was less frequent on other types and kinds of soils, sporadically on grey-brown podzolic soils developed from slightly loamy sands (Fig. 4).

Papaver rhoeas occurred in almost all lowland complexes of soil agricultural use (Fig. 5), but most frequently (more than 50% of relevés) in the defective wheat complex, usually composed of rendzinas. The largest areas of such soils occur in the Zamość Valley. The studied species exhibited the lowest frequency on soils of the weak rye and strong cereal-fodder complexes (Fig. 5).

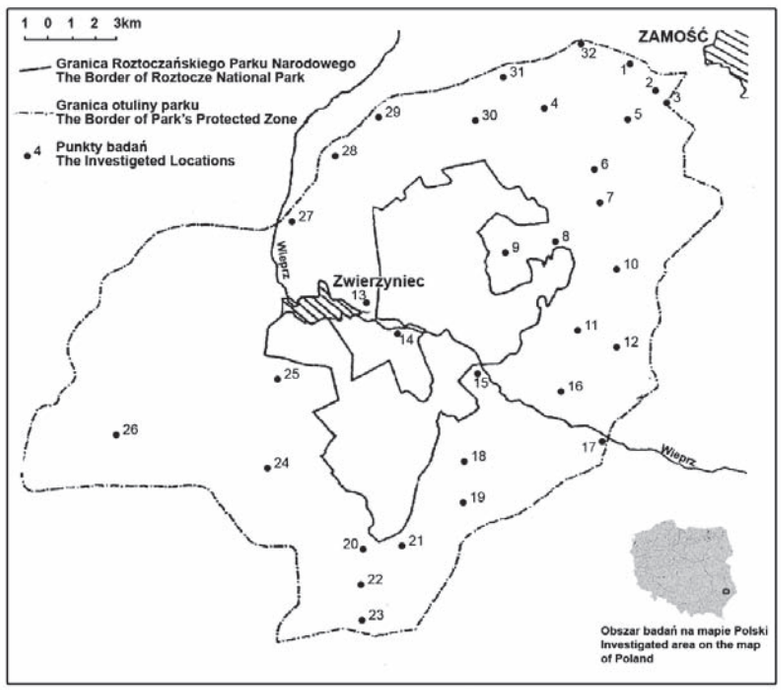

Fig. 1. *Papaver rhoeas* L. distribution in the buffer zone of the Roztocze National Park.
1 – Płoskie, 2 – Mokre, 3 – Żdanówek, 4 – Kąty II, 5 – Hubale, 6 – Wychody, 7 – Zarzecze, 8 – Wólka Wieprzecka, 9 – Kosobudy, 10 – Szewnia Dolna, 11 – Bliżów, 12 – Adamów, 13 – Rudka, 14 – Obrocz, 15 – Guciów, 16 – Trzepieciny, 17 – Kaczórki, 18 – Stara Huta, 19 – Potok Senderki, 20 – Górecko Stare, 21 – Majdan Kasztelański, 22 – Brzeziny, 23 – Tarnowola, 24 – Tereszpol Kukiełki, 25 – Sochy, 26 – Bukownica, 27 – Żurawnica, 28 – Brody Małe, 29 – Brody Duże, 30 – Kolonia Niedzieliska, 31 – Niedzieliska, 32 – Siedliska.

Table 2
Constancy and cover index of field poppy *Papaver rhoeas* L. in segetal communities of cereal agrocenoses and fallows.

Association, community	Subassociation	Number of relevés	S* D**
Vicietum tetraspermae	*typicum*	51	III 152
	papaveretosum	30	V 1637
	consolidetosum	26	V 487
Lathyro-Melandrietum		26	V 821
Caucalido-Scandicetum		12	V 1508
Avena fatua		10	III 296
Elymus repens		5	III 770

S* – *constancy*; D** – *cover index*

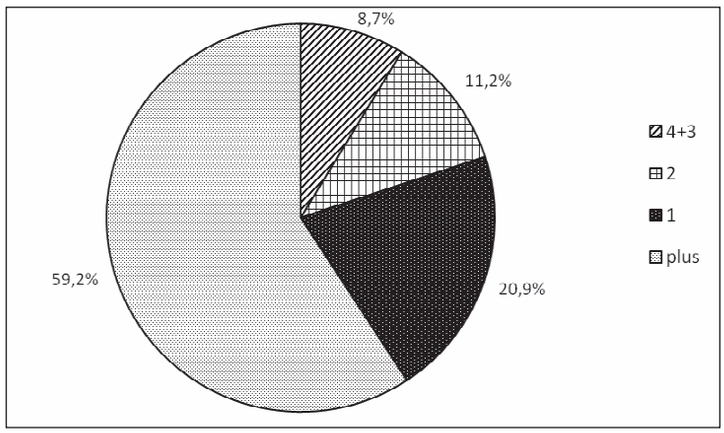

Fig. 2. Relative frequency of cover-abundance in relevés with *Papaver rhoeas.*

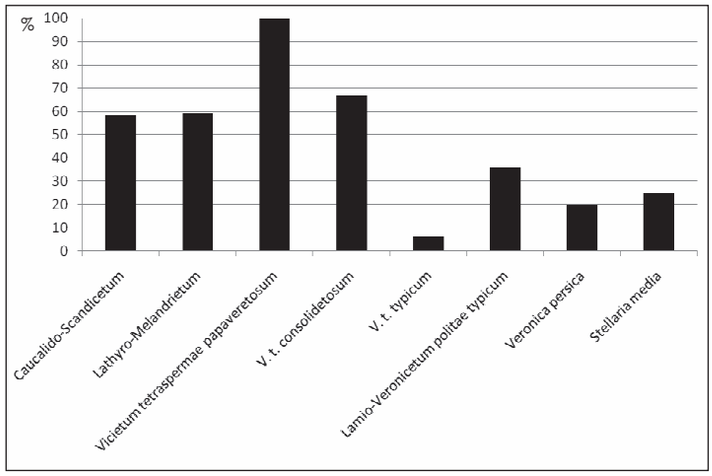

Fig. 3. *Papaver rhoeas* L. percentage proportion in cover-abundance (1-4) with reference to community type.

Table 3
Constancy and cover index of field poppy Papaver rhoeas L. in segetal communities of root plant agrocenoses.

Association, community	Subassociation	Number of relevés	S* D**
Echinochloo-Setarietum		18	I 11
Galinsogo-Setarietum		22	II 10
Lamio-Veronicetum politae	*typicum*	42	V 720
	fumarietosum	10	II 20
Stellaria media		17	III 47
Convolvulus arvensis		12	III 27
Veronica persica		8	IV 40
Amaranthus retroflexus		12	IV 67

S* – *constancy*; D** – *cover index*

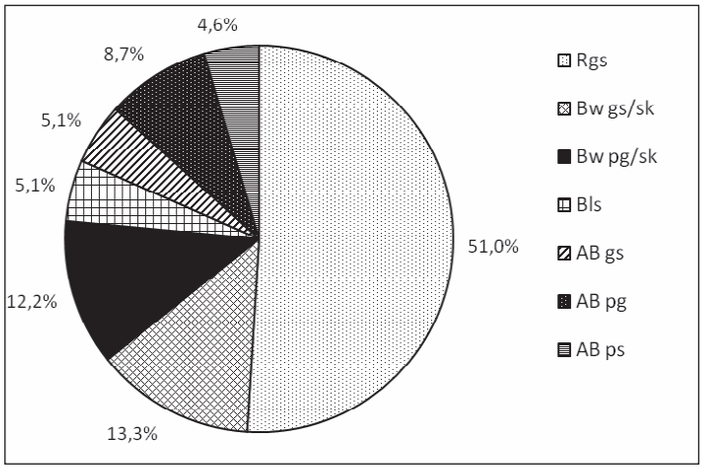

Fig. 4. Per cent of relevés with *Papaver rhoeas* in reference to soil type and granulometric composition of the arable layer. Explanations: R – rendzic; Bw – leached brown soils; B – brown soils; AB – grey–brown podzolic; gs – medium clay; pg – loamy sand; ls – less; ps – slightly loamy; sk – rock.

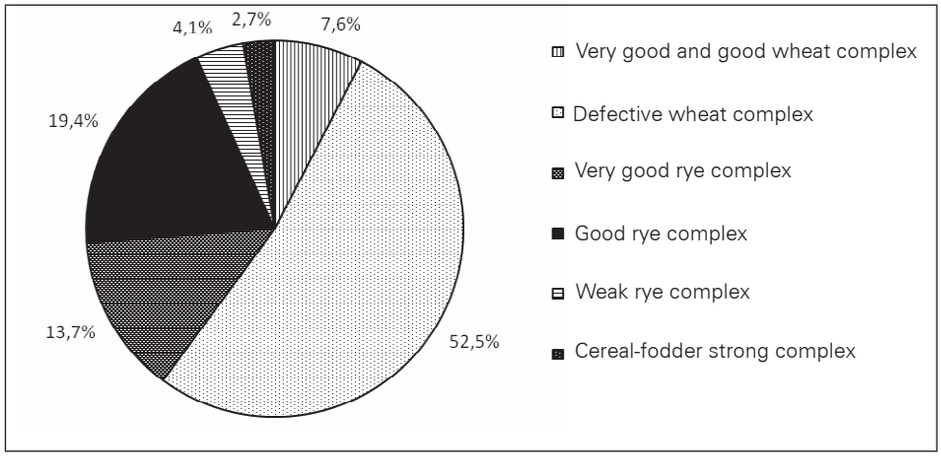

Fig. 5. Per cent of relevés with *Papaver rhoeas* in reference to the soil-agricultural complex.

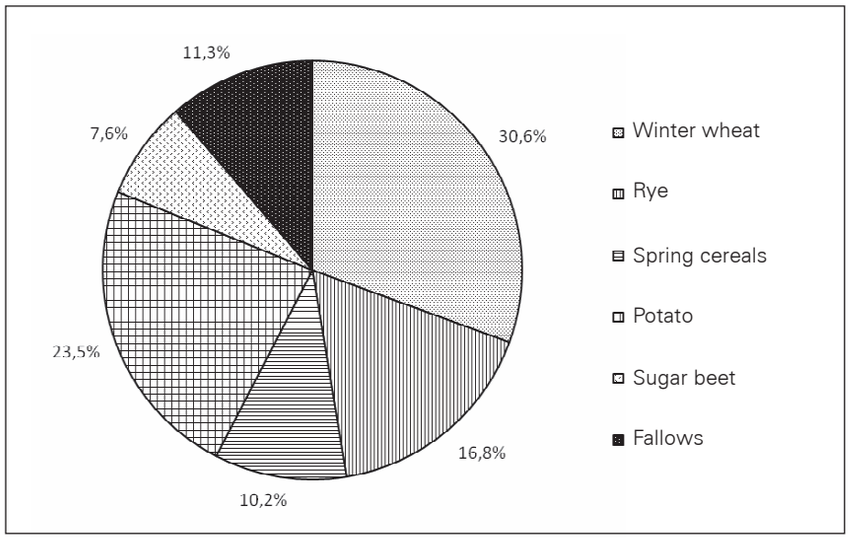

Fig. 6. Per cent of relevés with *Papaver rhoeas* in reference to crop.

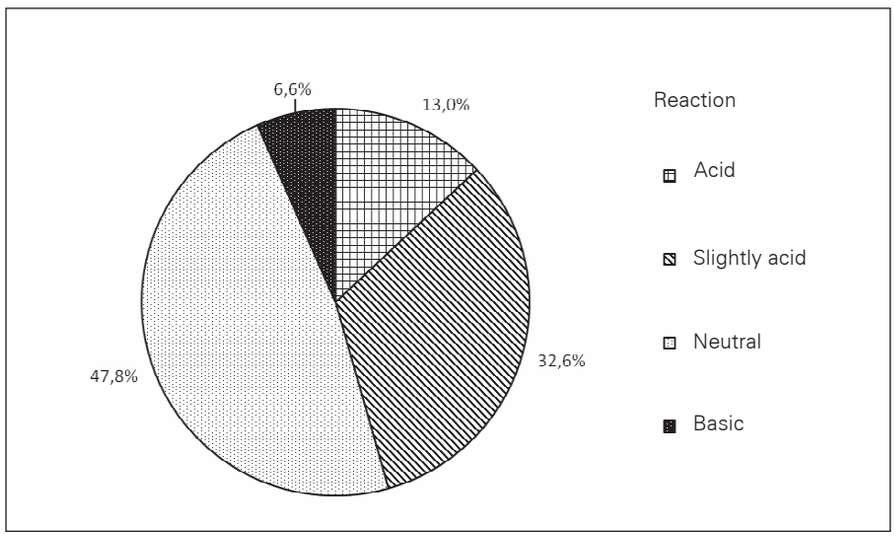

Fig. 7. pH of soil samples representing agrocenoses with *Papaver rhoeas* L. (%samples).

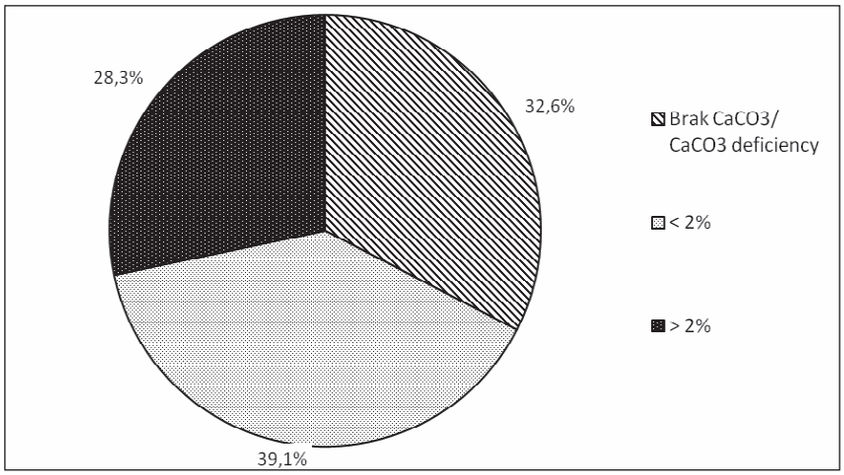

Fig. 8. $CaCO_3$ content in soil samples representing agrocenoses with *Papaver rhoeas* L. (% samples).

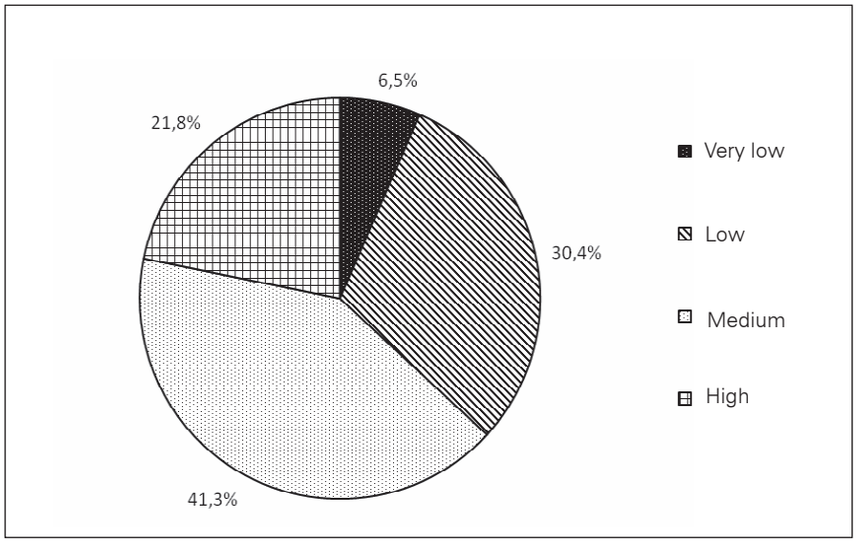

Fig. 9. Phosphorus content in soil samples representing agrocenoses with *Papaver rhoeas* L. (% samples).

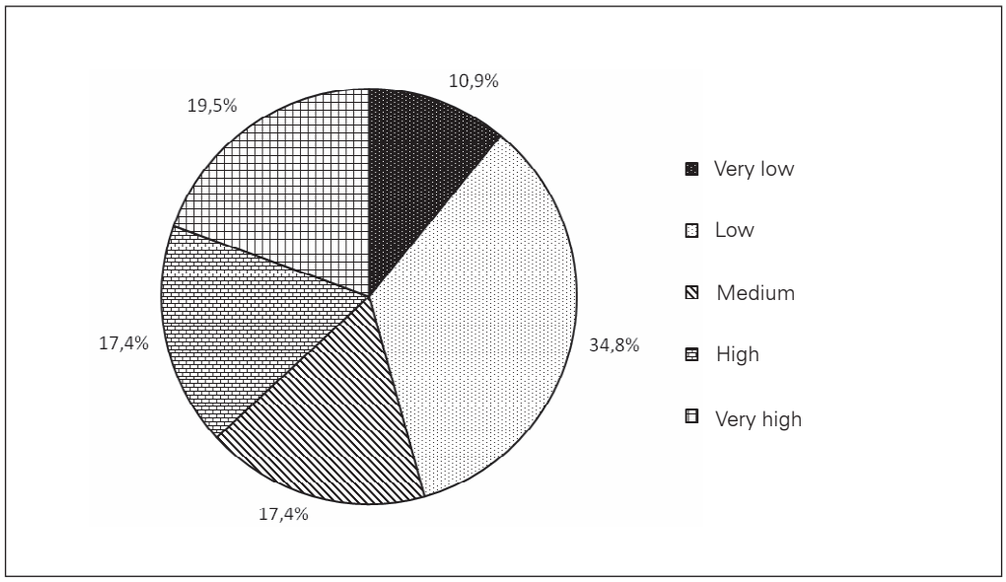

Fig. 10. Potassium content in soil samples representing agrocenoses with *Papaver rhoeas* L. (% samples).

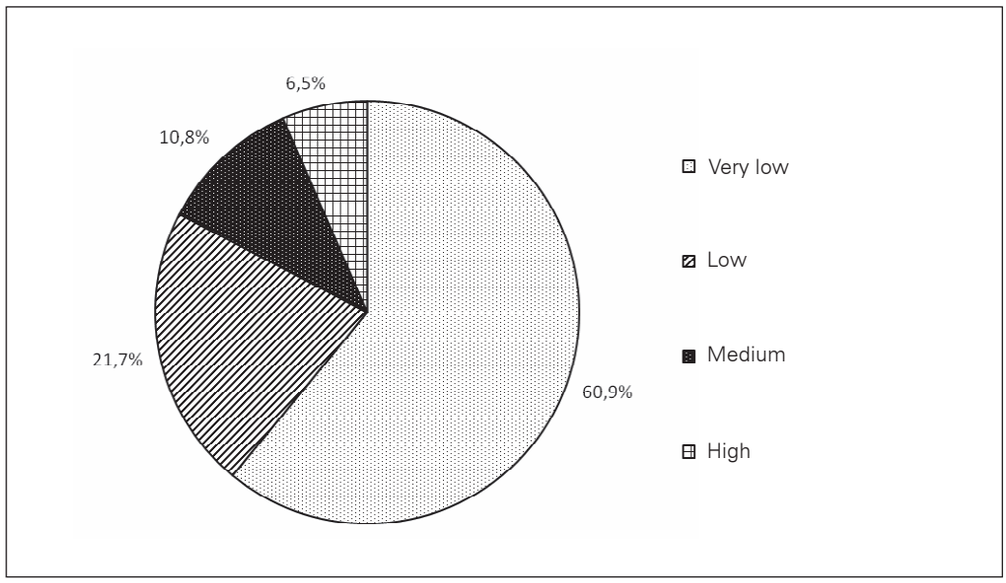

Fig. 11. Magnesium content in soil samples representing agrocenoses with *Papaver rhoeas* L. (% samples).

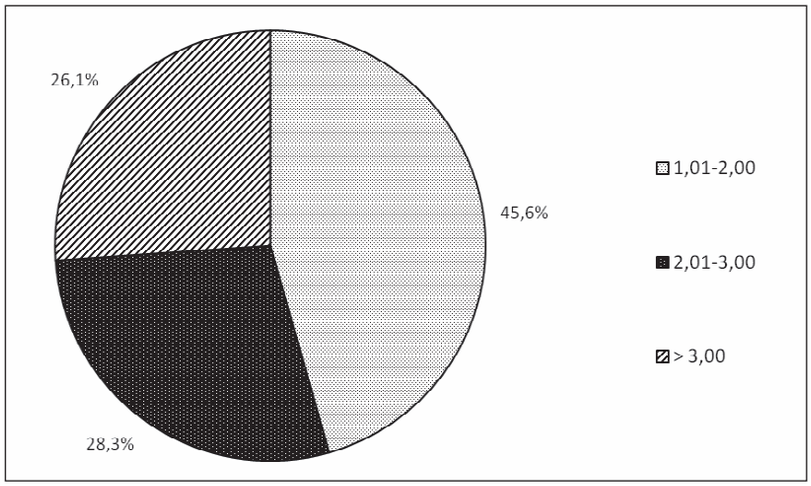

Fig. 12. Humus content in soil samples representing agrocenoses with *Papaver rhoeas* L. (% samples).

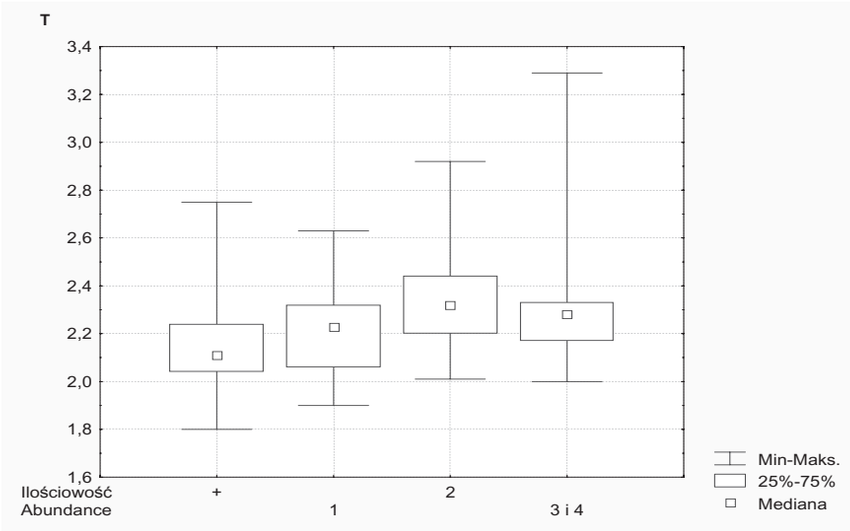

Fig. 13. The temperature T index range and medians.

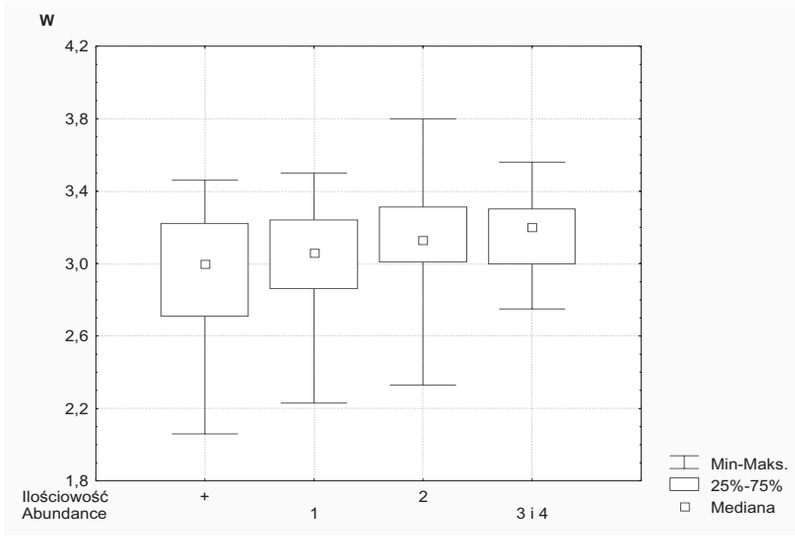

Fig. 14. The soil moisture W index range and medians.

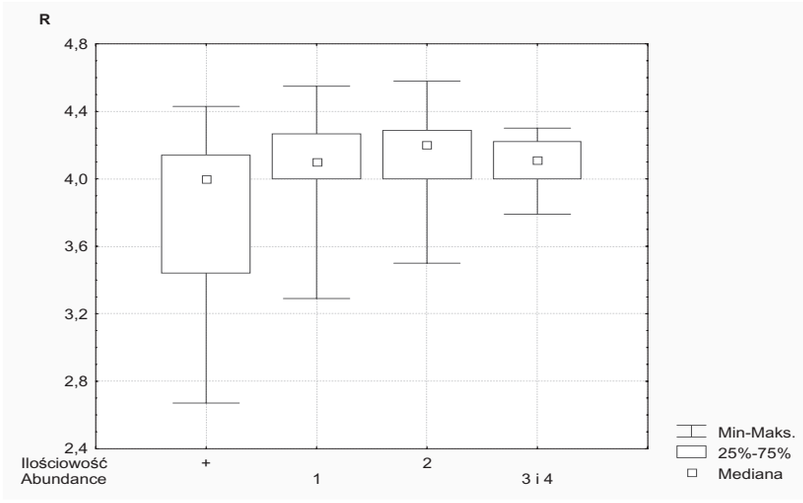

Fig. 15. The soil acidity R index range and medians.

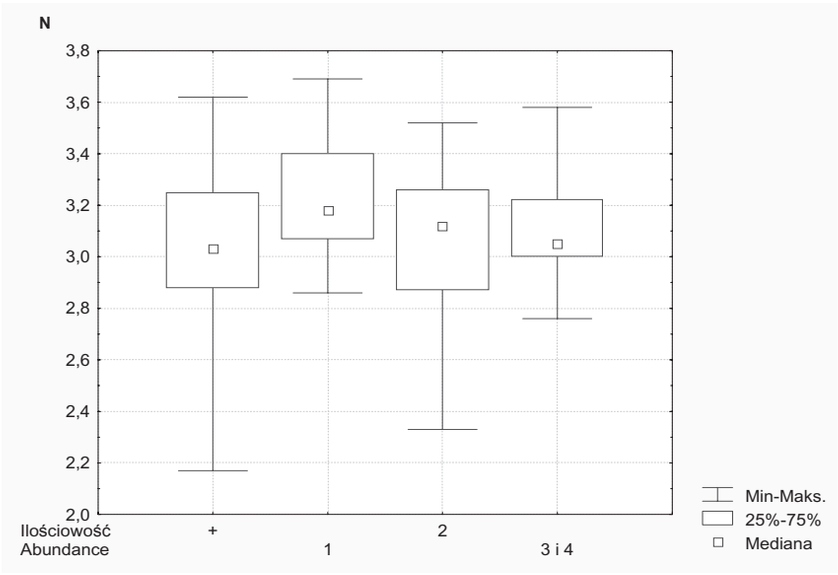

Fig. 16. The nitrogen content N index range and medians.

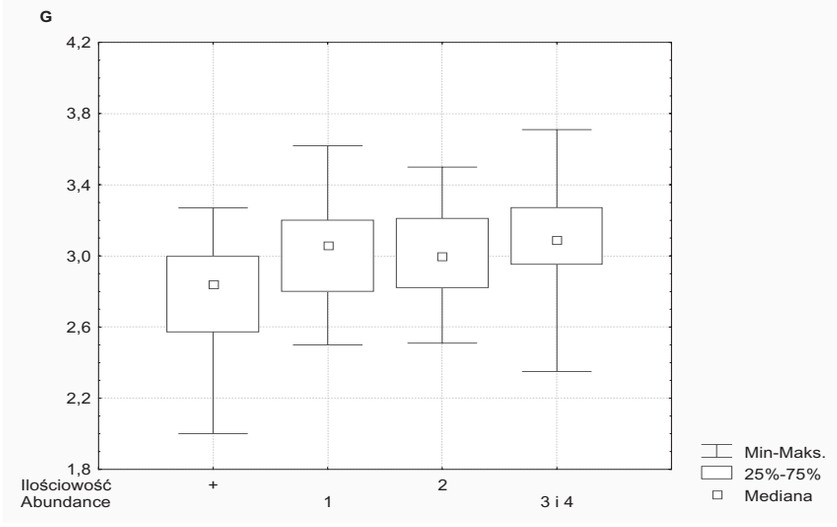

Fig. 17. The range and medians of the soil biological activity G index.

Most of the relevés with *Papaver rhoeas* represented winter crops (more than 47%), in particular wheat (30%). As to the root crops, there were three times more relevés with red poppy in potato than in sugar beet fields (Fig. 6), reflecting the crop structure in the RNP buffer zone in the first half of the 1990s and the fact that herbicides are applied much less frequently in potato crops compared to sugar beet crops. The studied species occurred in the highest degrees of cover-abundance chiefly on rendzinas, gaizes and other loamy soils, on idle land and recently fallowed fields, as well as in winter wheat crops.

The soil pH indicates that *Papaver rhoeas* tolerates substrates of various acidity. However, the smallest number of soil samples collected in the fields with this species was acidic (15%) and basic (6.54%). Almost 80% of the samples represented slightly acidic and neutral soils (Fig. 7).

The chemical analyses of 46 samples showed that *Papaver rhoeas* was considerably more frequent on the soils with calcium carbonate (approximately 67% of samples), even in small quantities (under 2%), than on the soils without this compound in the arable layer (Fig. 8). The soils on which *Papaver rhoeas* occurred in the RNP buffer zone were characterised by a wide range of potassium and phosphorus content, with the prevalence of moderate and high phosphorus content, and moderate, high and very high potassium content (Fig. 10). Low and very low concentration of magnesium was found in more than 60% of the samples (Fig. 11). The content of humus varied, but samples containing more than 2% of humus dominated (Fig. 12).

The average values of Ellenberg indicator T ranging from 1.8 to 3.3 suggest that *Papaver rhoeas* may equally occur in cold and warm sites, with the highest cover-abundance degrees found in the latter locations (Fig. 13). In most of the cultivated fields infested with poppy, T varied from 2 to 2.5, i.e. from cold to moderately warm sites. This is also proved by the medians. The T values mainly depended on the type of soil, its granulometric composition and the location of fields in terrain relief. Rendzinas and brown soils developed from gaizes on southerly and south-westerly exposed slopes, and the lightest grey-brown podzolic soils were among the warmest ones. The range of the W indicator was equally wide, ranging from 2 to 3.8. However, regardless its cover-abundance, poppy occurred most frequently on optimally moist soils (W=2.7-3.3) (Fig. 14). Regarding the soil pH, poppy was found within the whole range of pH, from acid to basic soils, with at least the minimum cover-abundance "+." However, for higher degrees (1-4), the pH spectrum is far narrower, as revealed by the inter-quartile range and mid values corresponding to slightly acidic, neutral and basic habitats (Fig. 15). Obviously, the fact was taken into account that the study area was dominated by rendzinas and loamy brown soils, containing at least small amounts of $CaCO_3$, for which the same value of R corresponds to a different pH from that in the case of light soils (Ellenberg, 1950). Also the average values of N representing nitrogen availability vary from almost 2.2 (poor) to 3.7 (rich). The values of the medians indicate that the species considered prefers soils moderately rich in nitrogen (Fig. 16). The average G values for the cultivated fields with red poppy in the RNP buffer zone varied from 2.0 to 3.7. In the least biologically active soils, the studied species was present in the lowest cover-abundance degree "+." The medians for the cover-abundance values of 1-4 indicate that red poppy prefers sites with biologically active soils (Fig. 17).

The distribution of *Papaver rhoeas* in the study area reflects the variability of the soil cover. In the northern, eastern and central part of the RNP buffer zone (Zamość Valley, Roztocze), where the species had most of its locations, there are the largest areas of rendzinas and brown soils developed from gaizes and loess (Fig. 1). In the south-western part of the buffer zone (Biłgoraj Plain), with light and acidic soils dominating, *Papaver rhoeas* was seldom found.

According to the recent studies carried out on rendzinas of the Zamość Valley (unpublished data), rich in *Papaver rhoeas*, flowery fields disappear, and *Papaver rhoeas*, though still common, occurs sparsely, usually along the field edges, less intensively treated with herbicides. One can guess that in the coming years *Papaver rhoeas* will join the group of species contributing to the list of weeds threatened in that area and the entire RNP buffer zone.

DISCUSSION

The results of the study on the occurrence of *Papaver rhoeas* in agrocenoses of the RNP buffer zone largely converge with the data presented by other authors from the Lublin region and other regions of Poland.

Already thirty years ago, Fijałkowski (1978) demonstrated the dominance of *Papaver rhoeas* in *Caucalido-Scandicetum* and *Lathyro-Melandrietum* of cereal crops on rendzinas of the Zamość Valley and in other associations of Lubelszczyzna on rich and compact soils.

In the Kazimierz Landscape Park *Papaver rhoeas* reached the constancy class V, but varying cover-abundance values in the associations *Caucalido-Scandicetum* and *Consolido-Brometum* (Kucharczyk, 1999), floristically similar to *Vicietum tetraspermae consolidetosum* from the RNP buffer zone. Its dominance in the *Caucalido-Scandicetum* association was confirmed by Siciński (1993). In

the *Lathyro-Melandrietum* association of the study area, *Papaver rhoeas* occurred more frequently and more abundantly than, for instance, in the Lower Vistula River valley (Szmeja, 1987), Czarnorzeki-Strzyżów Landscape Park (Towpasz and Barabasz-Krasny, 2006). The abundance and frequency of *Papaver rhoeas* were also high in *Delphinio consolidae-Brometum papaveretosum* in the Przemyśl Foothills (Wójcik, 1998).

The presence of *Papaver rhoeas* in various variants of *Vicietum tetraspermae* (most abundant in *V. t. consolidetosum*) was confirmed by Skrzyczyńska (1994). The species concerned revealed the highest frequency and abundance in *V. t. papaveretosum* not only in the RNP buffer zone, but also in other regions of Poland (Głazek and Wolak, 1991; Towpasz and Barabasz-Krasny, 2006; Wójcik, 1977). Similarly like in the RNP buffer zone, frequently, but sparsely, this species was observed in *Vicietum tetraspermae typicum* (Kucharczyk, 1999; Anioł-Kwiatkowska and Nowak, 2006), and in montane variants of the association (Hochół, 2001; Wójcik, 1977).

The influence of relief and intensity of nitrogen fertilization on weed infestation of rape and winter wheat crops treated with herbicides was proved by Jędruszczak et al. (1994). On loess soils, *Papaver rhoeas* occurred more abundantly in winter wheat and in valleys than in rape and on southerly exposed slopes. The increase of the nitrogen dose above the level of 100 kg ha^{-1} reduced the participation of *Papaver rhoeas* in weed infestation of both kinds of crops.

In Poland, according to the review made by Wnuk (1987), *Papaver rhoeas* occurs on chalk and Jurassic rendzinas in all variants of the *Lamio-Veronicetum politae* associations. In the typical subassociation, it reached the constancy classes II-V and, as in the RNP buffer zone, high cover-abundance values. This subassociation is an indicator of sites rich in $CaCO_3$ (Skrzyczyńska, 1994; Towpasz and Barabasz-Krasny, 2006; Wnuk, 1987). On poorer soils with lower pH values, *Lamio-Veronicetum politae* with *Fumaria officinalis* develops in Poland. Depending on the region, *Papaver rhoeas* either does not occur at all or it is frequent and abundant (Wnuk, 1987), or, as in the RNP buffer zone, in the constancy class V, but with low cover. In *Echinochloo-Setarietum*, similarly to the RNP buffer zone, it was infrequent in the Przemyśl Foothills (Towpasz and Barabasz-Krasny, 2006; Wójcik, 1998) and in the Siedlce Plateau (Skrzyczyńska, 1994), and more frequent in the *Galinsogo-Setarietum typicum* association in Opole Silesia (Anioł-Kwiatkowska and Nowak, 2006). The species was not found in these associations in the Kazimierz Landscape Park (Kucharczyk, 1999).

Among other associations accompanying cereal crops in Poland, which do not occur in the RNP buffer zone, *Papaver rhoeas* was found in the association *Aphano-Matricarietum* (Anioł-Kwiatkowska and Nowak, 2006; Ratszniak and Sobisz, 2001), *Papaveretum argemones* (Jackowiak et al. 1999; Ratuszniak and Sobisz, 2001; Skrzyczyńska, 1994) and in the montane association *Holco-Galeopsietum* (Hochół, 2001). In root crops, the studied species occurred in the constancy classes I-V almost in all varieties of *Oxalido-Chenopodietum polyspermi*, equally in the lowland and foothills, in river and stream valleys (Wójcik, 1998; 2001).

The cultivation method has an important influence on the occurrence of *Papaver rhoeas* (Zawieja et al. 2000). According to other authors and our own studies, it is more frequent and abundant in cereal crops, in particular winter crops, than in root crops (Łabza, 1994; Trąba and Wolański, 2003; Ziemińska-Smyk and Trąba, 2004). It grows very abundantly, as in the RNP buffer zone, on idle and recently fallowed land (Korczyński, 1998; Rola and Rola, 2003). In winter rape crops of Lubelszczyzna, it reached far higher constancy classes and cover indices than in spring rape (Kapeluszny, 2003).

The influence of the farming system on weed infestation (including red poppy) of winter wheat crops on grey-brown podzolic soils developed from loamy sand and light loam was shown by Feledyn-Szewczyk and Duer (2004). In the third year of the study, the species in question persisted only in wheat grown in an organic farming system. It was not found in conventionally grown wheat crops or in monoculture. The high degree of *Papaver rhoeas* weed infestation of crops on rich soils in organic farms was found, among others, by Rola and Rola (2003).

The wide ecological scale of *Papaver rhoeas* in the RNP buffer zone regarding type of soil, its granulometric composition and soil-agricultural complexes was confirmed by Hochół (2001), Łabza (1994), Rola and Rola (2003), Wnuk (1996) and others. In the Kraków region (Łabza, 1994) and in Beskid Wyspowy (Hochół, 2001), it dominated on alluvial soils of mountain complexes, while it was less frequent on slopes. In both cases, it infested cereal crops in a very high or high degree. On rendzinas of the wheat defective complex in the Kraków region, *Papaver rhoeas* infested crops at a moderate level, while on rendzinas of the good and very good wheat complex it occurred sporadically. It was not found in that region on the weak and very weak rye complex as well as on

the weak cereal-fodder complexes (Łabza, 1994). The research by Rola and Rola (2003) indicates that the species concerned grows in masses on soils of wheat complexes and sporadically in rye complexes. Wnuk (1996) mentions *Papaver rhoeas* among burdensome agricultural weeds in the Częstochowska Upland on soils of the good wheat, defective wheat, and very good rye complexes. Warcholińska (1998) determined that the highest concentration of *Papaver rhoeas* stands was in the river valleys of central Poland.

In the RNP buffer zone, *Papaver rhoeas* infested winter cereals in a very high degree on chalk rendzinas developed from loams and on leached loamy brown soils on gaizes, in a high degree spring cereal crops on rendzinas, and in a moderate degree root crops on those soils. The dominating complex was the defective wheat complex. The mentioned types of crops on other soil units were infested in a small or very small degree. *Papaver rhoeas* was not recorded on the lightest sandy soils and in the case of potato cultivation also on loess (Ziemińska-Smyk and Trąba, 2004).

Jędruszczak (1998) found high constancy classes of *Papaver rhoeas* in cereal stubble fields of the Kielce region, central Poland, on rendzinas, alluvial soils, chernozem, Eutric Vertisols and loess brown soils. According to the author, the abundant *Papaver rhoeas* seed bank in the arable layer of these rich soils substantiates the commonness of the species.

As in the RNP buffer zone, *Papaver rhoeas* was widespread on heavy rendzinas of the Kazimierz Landscape Park. It occurred abundantly on loamy soils of the Przemyśl Foothills (Wójcik, 1998) and Siedlce Plateau (Skrzyczyńska, 1994). On the contrary, it was rare on loess soils of the Przemyśl Foothills (Wójcik, 1998) and the Rzeszów Foothills (Trąba, Wolański, 2003), and it was absent on sandy soils of the Kolbuszowa Plateau (Trąba and Wolański, 2003).

Kapeluszny (1988) proved that on rendzinas of the Lublin Upland the increased infestation of winter wheat with *Papaver rhoeas* caused a reduction in yield. He determined the critical weed density threshold before wheat harvest, substantially reducing its yield, at a level of 6-10 poppy individuals per 1 m^2 and approximately 10% of other weeds.

Numerous weed species evidently react to soil pH (Ellenberg, 1950). Among them there are those that occur exclusively or predominantly on rendzinas, particularly in the southern and central regions of Poland, which are the warmest (Fijałkowski and Nycz, 1998; Siciński, 1993; Trąba and Ziemińska-Smyk, 1998; Wnuk, 1987). There are also less specialized species, moderately calciphilous, neutrophilous. The results presented in the present paper and in the literature data (Głazek and Wolak, 1991; Wnuk, 1987; Korniak and Hołdyński, 2001; Skrzyczyńska, 1994; Jackowiak et al. 1999; Anioł-Kwiatkowska and Nowak, 2006) support the thesis that *Papaver rhoeas* belongs to such a group.

In the RNP buffer zone, *Papaver rhoeas* found optimal growth conditions on slightly acidic and neutral soils, although it was also spotted on acid and basic soils. Its wide ecological scale, regarding soil pH, was revealed by several studies (e.g. Fijałkowski, 1978; Wnuk, 1987).

An important supplement to laboratory soil analyses is phytoindication, confirming the wide ecological amplitude of *Papaver rhoeas* in the RNP buffer zone, on the one hand, and optimal growth conditions, on the other hand. The importance of segetal plants as bioindicators in the assessment of arable sites has been stressed by numerous authors, including Borowiec (2003), Hochół (2001), Łabza (1994), Trąba (2001), Wójcik (1977), and Aftek-Starczewska (2007) in her review paper. Warmth and good soil structure can partially compensate the calcium deficit, a favourable circumstance for *Papaver rhoeas* and other calciphilous species, enabling them to grow even on acid soils (Aftek-Starczewska, 2007).

Latowski (2002), on the basis of comparative analysis of floristic monographs, containing data from nine macroregions covering the entire Polish territory, showed that *Papaver rhoeas* was relatively common or rare only in five macroregions located in the central and southern part of the country. Ratyńska and Boratyński (2000) suggested that active conservation measures should be taken in order to protect plant communities with a high proportion of threatened species, including *Papaver rhoeas*. Such protection is possible, among others, in organic farms, agro-reserves, ethnographic parks, national and landscape parks.

In the 1990s *Papaver rhoeas* was frequent and abundant in the buffer zone of the Roztocze National Park (Ziemińska-Smyk and Trąba, 2004) and for this reason it was not placed on the list of threatened weed species of that area (Trąba and Ziemińska, 1998).

CONCLUSIONS

1. Based on our own studies and the information from the literature, it was found that *Papaver rhoeas* occurred in associations and communities belonging to the *Caucalidion* and *Aperion* alliances accompanying cereal and rape crops, and to the *Polygono-Chenopodion* and *Panico-Setarion* alliances in root crops.

2. The wide ecological spectrum of *Papaver rhoeas* in the RNP buffer zone and other Polish regions is confirmed by its presence in lowland as well as in uplands and foothills, in river valleys and on slopes, on different soil units, lowland and mountain complexes, with a wide spectrum of soil pH, trophic and thermal conditions as well as moisture content.
3. *Papaver rhoeas* occurs most frequently and abundantly in winter crops of the *Lathyro-Melandrietum* and *Caucalido-Scandicetum* associations of the *Caucalidion* alliance, and in *Consolido-Brometum*, *Vicietum tetraspermae papaveretosum* and *V. t. consolidetosum* of the *Aperion* alliance, while in root crops in the *Lamio-Veronicetum politae* association of the *Polygono-Chenopodion* alliance. It prefers chalk and Jurassic rendzinas containing calcium carbonate and other rich loamy and loess soils, from slightly acidic to basic (Eutric Vertisols, chernozems, brown soils, alluvial soils), moderately moist, warm, medium-rich in nitrogen, biologically active, belonging to wheat complexes. In piedmont areas, it dominates in river valleys on alluvial soils, less frequently on slopes.
4. Red poppy usually does not occur on lighter, acid sandy soils of the weak rye and very weak complex as well as the cereal-fodder complex.
5. Based on the results achieved in the RNP buffer zone, one can suppose that the species distribution and abundance of its population reflect the soil conditions.

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Występowanie *Papaver rhoeas* L. w agrocenozach otuliny Roztoczańskiego Parku Narodowego na tle innych regionów Polski

Streszczenie

W pracy podjęto próbę ustalenia amplitudy ekologicznej oraz warunków optymalnych w jakich rośnie *Papaver rhoeas* w agrocenozach otuliny Roztoczańskiego Parku Narodowego na tle innych regionów w Polsce, w zależności od niektórych czynników siedliskowych i antropogenicznych. Na podstawie badań własnych i danych z literatury stwierdzono, że *Papaver rhoeas* występuje w zespołach i zbiorowiskach zarówno ze związku *Caucalidion*, jak i *Aperion* towarzyszących uprawom zbóż i rzepaku oraz ze związku *Polygono-Chenopodion* i *Panico-Setarion* w uprawach okopowych. O szerokiej skali ekologicznej *Papaver rhoeas* świadczy jego obecność na niżu, w pasie wyżyn i podgórzy, w dolinach rzecznych i na stokach, na różnych glebach i kompleksach niżowych oraz górskich, o szerokim zakresie odczynu gleb, warunków troficznych, termicznych i uwilgotnienia. Najczęściej i w największych stopniach ilościowości gatunek ten występuje w oziminach w zespołach *Lathyro-Melandrietum* i *Caucalido-Scandicetum* ze związku *Caucalidion* oraz *Consolido-Brometum, Vicietum tetraspermae papaveretosum* i *V. t. consolidetosum* ze związku *Aperion*, a w okopowych w zespole *Lamio-Veronicetum politae* ze związku *Polygono-Chenopodion*. Preferuje rędziny kredowe i jurajskie zawierające $CaCO_3$ i inne żyzne gleby gliniaste lub lessowe o odczynie od lekko kwaśnego po zasadowy (czarne ziemie, czarnoziemy, brunatne, mady) umiarkowanie wilgotne, ciepłe, średnio zasobne w azot i o dobrej aktywności biologicznej zaliczane do kompleksów pszennych. W terenach podgórskich dominuje na madach w dolinach rzek, a rzadziej spotykany jest na stokach. *Papaver rhoeas* przeważnie nie występuje na najlżejszych glebach piaskowych kompleksów żytniego słabego i bardzo słabego oraz zbożowo-pastewnego słabego. Rozmieszczenie tego gatunku jest odzwierciedleniem warunków glebowych na danym terenie.