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Species composition of weeds in wheat and barley

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Abstract. *During the period 2008-2009 investigation was performed to determine the species composition and density of weeds in the main cereals (wheat and barley). The aim of study was to establish the weed species diversity and the background of weed infestation in wheat and barley in the region. The number of weeds in wheat and barley was established in three regions west, east and south from Stara Zagora by itinerary method in 10 points for each region. Weed infestation and domination of weed species was established by Statistica for Windows. In the eastern region of Stara Zagora (the land of Dalboky) the most propagate weed was Veronica hederifolia L. - 37,2 and Convolvulus arvensis L. - 10,3 plants per m^2. In the western area of the municipality (the land of Bogomilovo) prevail mainly Avena fatua L. - 16,4; Veronica hederifolia L. - 12,8 and Galium aparine L. - 6,6 plants of m^2. In the southern region (the land of Malko Kadievo) winter cereals have higher weed infestation compared to the other 2 regions. The most propagated weeds in this region were Chenopodium album L. - 36,2; Convolvulus arvensis L. - 7,3 plants per m^2 etc. The type of weed infestation of wheat and barley in the investigated areas was as a whole the typical for these crops.*

Keywords: wheat, barley, weeds, density

Introduction

In recent years the problem of weed infestation of agricultural crops is becoming more important. The changes that have taken place in the country have led to changes in the technology of growing of agricultural crops. Nitrogen fertilization alone of wintering cereal crops, the reduction of soil cultivation brought to several surface treatments (disc harrowing) immediately before sowing, and the absence of effective crop rotation, led to a decreasing of yields, the deterioration of production and increasing the density of weed background. In the crops particular types of non-indigenous weeds have emerged, which in turn impede the fight against them. Weeds are one of the main factors determining the yield of agricultural crops including annual cereals for grain (Sabev, 2000; Tonev, 2000). That is why combating weeds is an extremely important element in the technology for cultivation of cereal grain. For proper display of the weeds control, the choice of appropriate herbicide and establishing weed species, composition and background play an important role. Mapping of weeds accumulates data about the type and extent of weed infestation of the areas, which makes possible predicting the weeds in the coming years (Fetvadzhieva 1976; Trankov 1989). Data from the annual mapping can help to draw up the optimum plan for accommodation of the cultures in the crop rotation system, for the planning of the necessary herbicides and cultivation. The route method and the visual evaluation of the weed infestation is used throughout the world (Konesky et al., 1989; Fetvadzhieva and Dechkov, 1981; Zenek, 1976; Chesalin 1975) for the purposes of full and representative mapping of the production areas. Maximum true information by this method can be obtained, if tracing the dynamics of weed infestation of fixed plots of a rotation (Zenek, 1976; Higgins, 1976). For establishing the scope of distribution of some species of weeds (*Avena, Alopecurus, Sinapis, Brassica, Matricaria, Papaver*, etc.) contrast divergence measurements of weeds in cereal crops can be made quickly, roughly, but more thoroughly by logging of weed infestation (Fetvadzhieva and Dechkov, 1981; Sharma, 1979). Satisfactory results have been obtained from the use of aviation in mapping weed infestation of cereals with wild oats of large areas (Fetvadzhieva and Dechkov, 1981). In the conditions of our country wheat and barley are weeds infested from more than 160 species of weeds, 78 of which are constant. In biological groups they can be separated as follows: ephemeric-18; spring-26; winter-spring and winter-30; perennial-9. Spring species are prevailing in the total amount (Andreeva-Fetvadzhieva and Dechkov,1973). For the conditions of Bulgaria the mid degree of weed infestation reduced yields of winter cereals by 15-20%, and in the strong infestation especially with *Sinapis, Avwna, Cirsium, Galium*, etc., the losses reach 60-70% (Andreeva - Fetvadzhieva and Dechkov, 1973; Lyubenov, 1996; Tonev 2000; Trankov, 1989).

The aim of the present study was to establish the specific diversity of weeds in winter cereals (wheat and barley) in the municipality of Stara Zagora and to give full and clear picture of the weed background of these crops in the region.

Material and methods

During the period 2008-2009 a survey for establishing the species composition and the extent of weeds in cereals (wheat and barley) in the territory of Stara Zagora municipality was performed. The study of areas was carried out in accordance with the procedure for reporting and mapping the main arable crops by the methods of Fetvadzhieva and Dechkov (1981). Crops of wheat and barley in the area of 3-15 km from the town of Stara Zagora in three geographical directions have been examined. East (territory of Dalboky) is situated 10 km east of the town of Stara Zagora and 3 km north of the road for the town Nova Zagora. Two plots of wheat, respectively 150

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ha and 82,5 ha and two plots of barley with dimensions respectively 32 and 45 ha have been examined; West (territory of Bogomilovo) is situated 3 km west of the town of Stara Zagora. The terrain of the land is flat with the exception of areas located in the northern part, where the hilly terrain dominates. Two plots of wheat, respectively 38 ha and 24,5 ha, have been investigated; South (territory of Malko Kadievo) located 15 km south of Stara Zagora. The relief of this land is completely flat. One plot of wheat - 100 ha and one plot of barley - 15 ha have been investigated. In the northern part of the municipality with permanent crops, vineyards and orchards a study is not carried out due to the lack of wheat and barley crops. To avoid differences caused by soil fertility studies were carried out on the Chromic Luvosols (WRBSR, 1998).

Monitoring and reporting of previously selected plots (at random) was carried out in accordance with the abovementioned methodology of Fetvadzhieva and Dechkov 1981. Tested areas were traced by diagonal route. Ten points for observation for each reference parcel were situated. Monitoring and reporting of each of the points included measuring the density of the weed plants in a number of $1m^2$ plots, species composition and phenological stage of development of weeds. The average weed infestation of each culture in regions, the most common weeds in the culture and multiplication of weeds in the observed area was calculated. Weeds were established in 2 terms: early springtime reporting–March, before treatment of crop with herbicides against dicotyledonous weeds; springtime reporting–April, 30 days after treatment of a crop with herbicides.

All data obtained from the investigation concerning weed number, propagation in the region and specific crop weed infestation by grouping were calculated by statistical software STAISTICA 6 for Windows.

Results and discussion

Climate conditions during the period of investigation could be defined as warmer and more humid compared to the average for 29 years former period (Table 1). The lower precipitation in March of 2008 in comparison with those for the multi-annual period does not slow down the development of crop and weeds occurring in them. The meteorological situation in March and the next month allowed weeds to develop well and they were clearly distinguishable in the crop. The crops normally completed in stage "node forming". The rain at the end of March disturbed treatment of crops by growing herbicides, which led to the delay of this event and weeds clearly went in more advanced stages in the development, increasing their resistance to applied herbicides. In June and July the weather situation was characterized by temperatures close and similar to those for a multiannual former period. This contributed to the early ripening and harvest of wheat. Rainfall in June (80 mm), however, was significantly more compared to multi-annual period (22 mm). This disturbed harvesting barley, but dry July favoured harvesting of winter cereals as a whole. At the same time, early spring and late spring ephemeras unexploded input herbicides had successfully completed their development and gave seed, which remained in the soil. After the harvest stubble remained relatively free of weeds, which is due to the high temperatures and the small quantity of precipitation in August (15.7 mm).

Table 1. Meteorological characteristic during the study period

Months	Monthly amount of rain in mm					Average air temperature C°				
	Ten days			Average for month	Average 1978- 2007	Ten days			Average for month	Average 1978- 2007
	1	2	3			1	2	3		
03.2008	10.1	9.7	1.5	21.3	35.2	9.2	9.5	8.7	9.1	5.7
04.2008	70.7	19	10.4	100.1	45.8	11.1	14	13.7	12.9	11.8
05.2008	9.7	0.4	35.5	45.6	50.4	13.3	17.2	19.3	16.7	20.7
06.2008	57.4	22.7	-	80.1	23.6	17.9	21.6	25.6	21.7	23.2
07.2008	9.5	3.5	40.3	53.3	57	24.7	24.2	22	23.6	23.1
08.2008	-	15.7	-	15.7	44.0	24.2	26.3	25.5	25.3	23.2
09.2008	-	63.6	41.4	105	33.2	23.5	17.5	13	18	18.8
10.2008	17.2	0	0.5	17.7	45.5	15	13.7	11.2	13.2	12.8
11.2008	2.1	0.7	7.8	10.6	57	13.4	6.8	4.6	8.2	7.0
12.2008	2	13.8	0.5	16.3	52	7.6	7.4	0.3	4.7	1.4
01.2009	16	12.9	39.9	68.8	46.6	4.1	2.5	6.3	0.1	0.2
02.2009	1.3	57.4	1.7	60.4	38.5	6.3	2.5	0.4	3.3	1.7
03.2009	8.5	7.6	23	39.1	35.2	7.3	4.4	7.1	6.3	5.7
04.2009	1.8	4.1	4.4	10.3	45.8	11.5	12.4	11.4	11.7	11.8
05.2009	12.8	6.3	3.2	22.3	54.3	15.6	19.9	19.6	18.4	20.7
06.2009	27.2	7.6	38.8	73.6	53.2	22.2	22.7	21.9	22.3	23.2
07.2009	17.1	57.9	0.1	75.1	44.4	23.8	24.5	25.5	24.6	23.1

In wheat crops located in the three areas of the municipality, the tested weeds were as usual often occurring in winter cereal crops (Table 2). The table shows that of weed species identified in the survey, the most common in all three districts are: *Polygonum convolvulus* L.*; Veronica hederifolia* L. and *Convolvulus arvensis* L., respectively, with 22,5 n/m^2, 18.4 n/m^2 and 7,8 n/m^2. The differences in these species are statistically significant in the three explored areas. From an economic point of view, the most highly spread weeds in this crop in the three regions were: *Avena fatua* L. and *Cirsium arvense* L (Scop.) with numbers/m^2, respectively, 6,7 and 3,6 and the differences were statistically significant at P<0,05.

Table 2. Wheat weeds number by regions (Incl. variations)

Parameters	Average				Range**			Variance	SD	SEM
Weed Species	West	East	South	Mean	West	East	South			
1. Capsella	1.1a*	5.6^a	0^a	2.2	7.0	50.0	0.0	83.9	9.2	1.7
2. Fumaria	1.1^a	1.1^a	0^a	0.7	6.0	7.0	0.0	3.0	1.7	0.3
3. Veronica	12.8^a	37.2	5.3^a	18.4	34.0	78.0	17.0	455.3	21.3	3.9
4. Buglosoides	0^a	0.1^a	0^a	0.03	0.0	1.0	0.0	0.03	0.2	0.0
5. Convolvulus	5.8a	10.3^a	7.3^a	7.8	22.0	30.0	33.0	102.0	10.1	1.8
6. Matricaria	0^a	0.4^a	1.6^a	0.7	0.0	3.0	4.0	1.5	1.2	0.2
7. Papaver	1.8^a	0.8^a	0^a	0.9	7.0	6.0	0.0	3.9	2.0	0.4
8. Poligonum	4.1^a	7.5^a	55.8	22.5	25.0	40.0	170.0	1737.2	41.7	7.6
9. Cirsium	1.9^a	7.7	1.1^a	3.6	16.0	22.0	6.0	36.3	6.0	1.1
10. Galium	6.6^a	0.7^a	3.9^a	3.7	22.0	6.0	35.0	62.1	7.9	1.4
11. Vicia	0^a	1.2^a	0^a	0.4	0.0	12.0	0.0	4.8	2.2	0.4
12. Avena	16.4	0.3^a	3.3^a	6.7	33.0	3.0	33.0	119.3	10.9	2.0
13. Stelaria	4.6^a	0^a	0^a	1.5	19.0	0.0	0.0	18.9	4.3	0.8
14. Cardaria	0.1^a	0^a	0.2^a	0.1	1.0	0.0	2.0	0.2	0.4	0.1
15. Chenopodium	0^a	0^a	36.2^a	12.1	0.0	0.0	150.0	1319.1	36.3	6.6
16. Lamium	0^a	0^a	1.7^a	0.6	0.0	0.0	12.0	4.9	2.2	0.4
17. Ranunculus	0^a	0^a	2.2^a	0.7	0.0	0.0	8.0	4.6	2.1	0.4
18. Consolida	0^a	0^a	0.9^a	0.3	0.0	0.0	3.0	0.5	0.7	0.1
Mean	3.13	4.05	6.64	4.6	10.7	14.3	26.3	219.9	8.9	1.6

*Differences among values by rows are statistically signifficant at P<0,05 if they have no equal letter
** In range (Min=0, Max=presented values); SD – standard deviation; SEM – Standard error of mean.

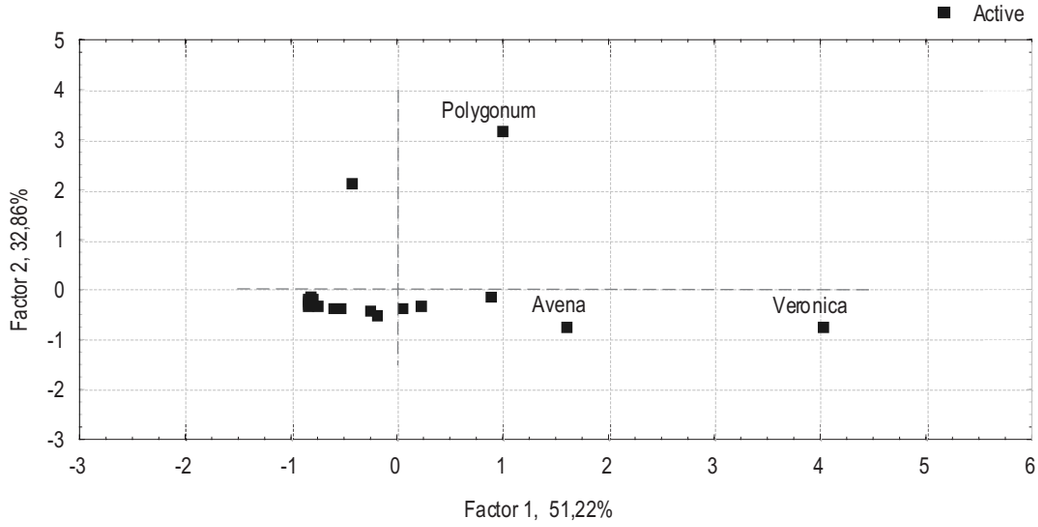

Figure 1. Distribution of weeds in Wheat crop Cases with sum of cosine square ≥ 0,00

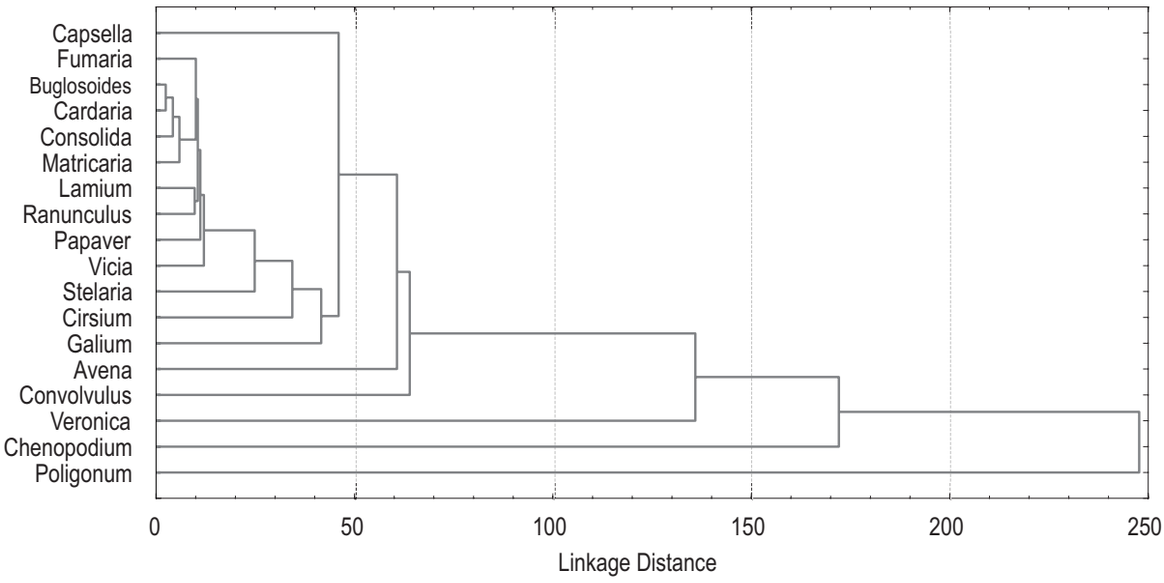

Figure 2. Grouping of weeds in Wheat crop Single Linkage Euclidean distances

The region with the greatest weed infestation is south with an average of 6,64 n/m^2 and the frequency of occurrence of weeds was maximum 26.3 n/m^2. The east region of Stara Zagora with an average of 4.05 number of weeds per square meter and average frequency of occurrence of weeds 14.3 n/m^2 is second. With the cleanest wheat crops was the western part of the municipality with 3.13 n/m^2.

The PC analyzes for multiplication of weed species in wheat in the three regions and their domination show that 5 weeds are main factors in wheat cultivation (Figure 1). With the greatest density and frequency of occurrence is (*Polygonum convolvulus* L.). Also high density has *Chenopodium album* L., but it develops only in one of the regions (the South). With large proportion were *Convolvulus arvenses* L., *Avena fatua* L. and *Veronica hederifolia* L., but their density is substantially less than that of the above 2 types. Weeds of the type *Veronica, Avena, Polygonum* and *Chenopodium* are predominant and described as the two main factors of the wheat weed infestation.

Cluster analysis of wheat weeds shows that weed species occurring in this crop are grouped in 3 groups according to the density (Figure 2). With the highest density of weed occurrence is a group formed by the following types: *Polygonum convolvulus* L., *Chenopodium album* L. and *Veronica hederifolia*. The second group by frequency of occurrence includes weed species *Convolvulus arvensis* L. and ends with *Lamium. amplexicaule* L. In this group economically significant weed species such as *Avena fatua* L., *Cirsium arvense* L., *Galium aparine* L., etc. are included. The last group in the analysis includes species with low density and insufficient degree of spreading.

Table 3. Barley weeds number by regions (incl. variations)

Parameters	Average			Range**		Variance	SD	SEM
Weed Species	East	South	Mean	East	South			
1.Capsella	0.6[a]	0[a]	0.4	4.0	0.0	1.1	1.1	0.2
2. Lamium	8.1	1.5	5.9	20.0	10.0	41.4	6.4	1.2
3. Veronica	13.6	6.4	11.2	24.0	26.0	71.4	8.4	1.5
4. Conium	0.25[a]	0[a]	0.17	3.0	0.0	0.4	0.6	0.1
5. Cirsium	2.2[a]	0[a]	1.5	14.0	0.0	8.5	2.9	0.5
6. Convolvulus	2.9[a]	1[a]	2.3	16.0	4.0	16.3	4.0	0.7
7. Consolida	1.6[a]	2.1[a]	1.8	7.0	7.0	4.8	2.2	0.4
8. Matricaria	1.05[a]	0[a]	0.7	8.0	0.0	3.1	1.8	0.3
9. Avena	0.4[a]	0[a]	0.3	6.0	0.0	1.3	1.1	0.2
10. Polygon.avic.	0[a]	10.9[a]	3.6	0.0	60.0	156.4	12.5	2.3
11. Polygon.conv.	4.4	9.9	6.2	20.0	20.0	53.5	7.3	1.3
12. Chenopodium	0[a]	0.2[a]	0.07	0.0	1.0	0.1	0.3	0.0
13. Galium	0[a]	0.3[a]	0.1	0.0	2.0	0.2	0.4	0.1
14. Ranunculus	0[a]	6.8[a]	2.3	0.0	30.0	43.0	6.6	1.2
15. Ornitogalum	0[a]	0.5[a]	0.2	0.0	2.0	0.2	0.5	0.1
Mean	2.3	2.6	2.4	8.1	10.8	26.8	3.7	0.7

*Differences among values by rows are statistically signifficant at P<0,05 if they have no equal letter
** In range (Min=0, Max=presented values); SD – standard deviation; SEM – Standard error of mean.

In barley crop high density of weeds has been established for Veronica hederifolia, with an average of 13,6 n/m^2 and *Lamium amplexicaule* L. 8,1 n/m^2 in the East region (Table 3). Of the economically important weeds with the greatest density was reported *Polygonum aviculare* L. with a density of 2,9 n/m^2. The maximum frequency of occurrence of Veronica was 24 n/m^2 and *Lamium amplexicaule* L. with 20 n/m^2. As a whole, the average weed infestation of the crop was 2,3 plants per m^2. In the southern region weed infestation of barley was different. With the greatest density was late spring developed *Polygonum aviculare* L., which was propagated on average by 10,9 plants per m^2. The second distributed type established in the crop was *Polygonum convolvulus* L., which was at the rate of 9,9 plants per m^2. The third distribution type, which was reported in the southern part of the municipality was *Ranunculus arvensis* L., reported in density medium 6,8 plants per square meter.

The frequency of occurrence of weeds ranged from 0 to 60 plants per m^2 for *Polygonum aviculare* L. and from 0 to 30 plants per m^2 for *Ranunculus arvensis* L. The average weed infestation of the southern region was 2.6 plants per m^2. PC analysis for barley weed infestation shows that, according to the distribution, five species are dominant *Lamium amplexicaule* L.*, Veronica hederifolia* L.*, Ranunculus arvensis* L. *and Polygonum spp.,* which describe the main factors (Figure 3). Other weed species are found in the marginal density. The cluster analysis of weed infestation of barley displays that in the region dominated weeds can be separated also in three groups. The first group with the highest density includes weeds *Polygonum convolvulus* L., *Veronica hederifolia* L. and *Polygonum aviculare* L.. In the second group weed species are included in the moderate density, but also in all areas of study. The third group includes those which are with low density and slight degree of spreading.

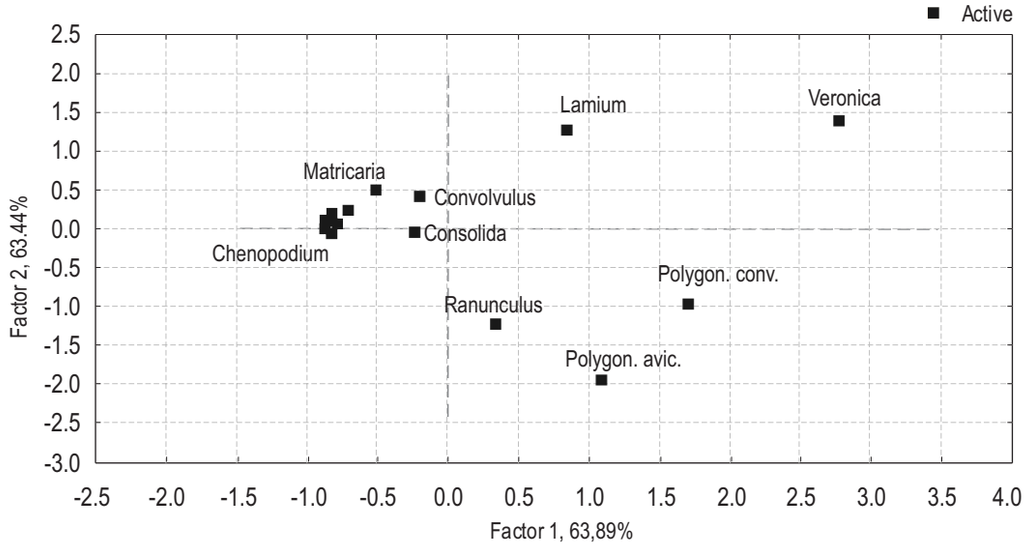

Figure 3. Distribution of weeds in Berley crops Cases with sum of cosine square >= 0,00

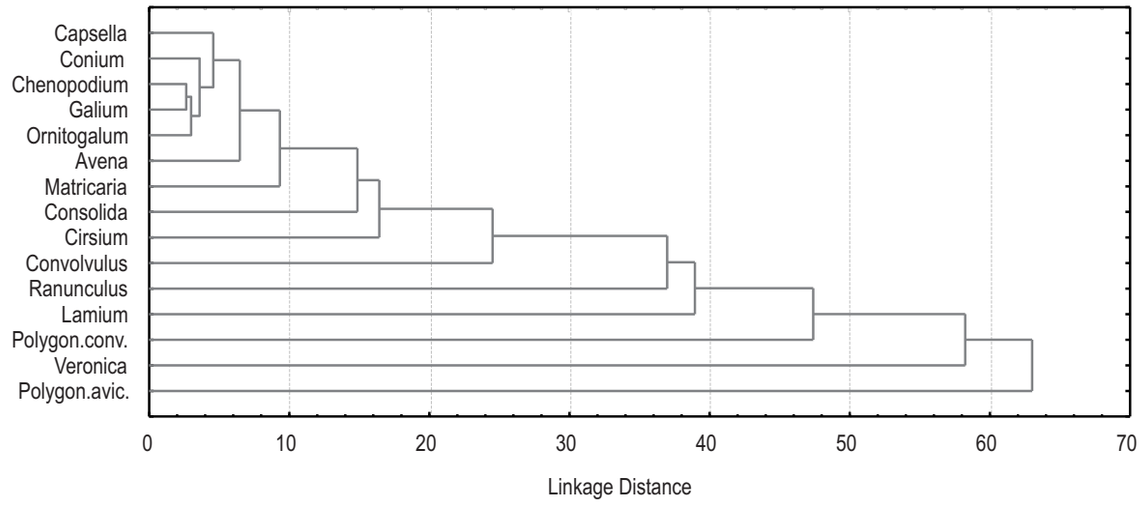

Figure 4. Grouping of weeds in Barley crop Single Linkage Euclidean distances

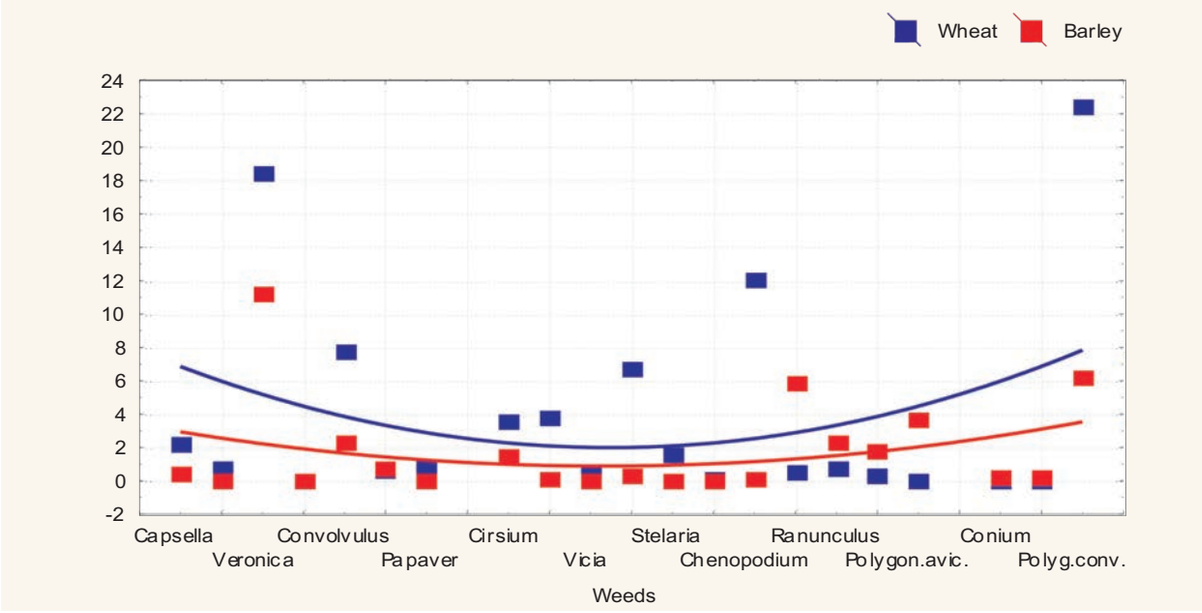

Figure 5. Weeds infestation by crops (average for the regions): Wheat = 550,9093-9,8464*x+0,0442*x^2 ; Barley = 240,568-4,307*x+0,0193*x^2

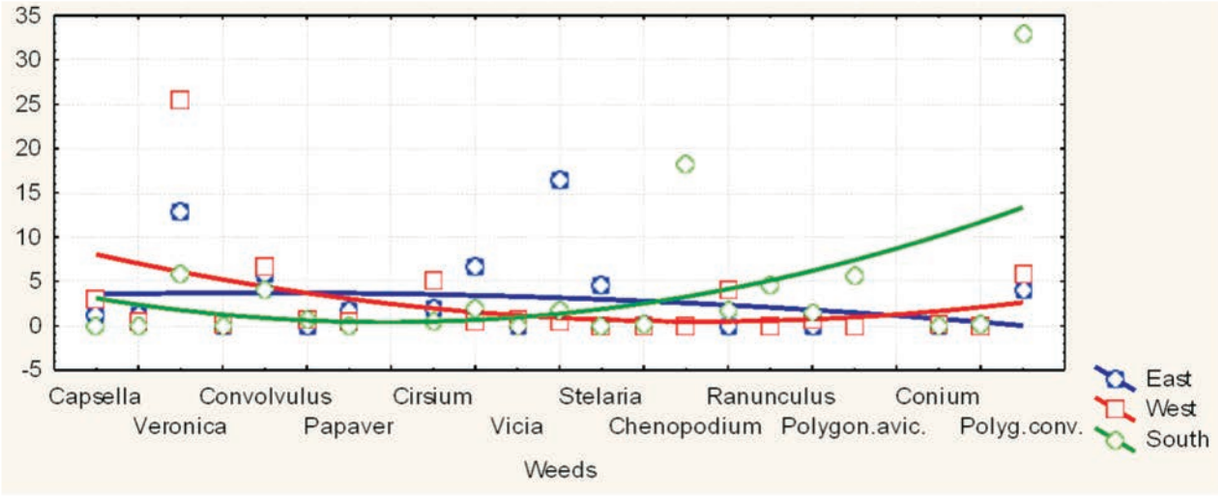

Figure 6. Weeds infestation by regions (average for wheat and barley): East = 121.1798+2.3805*x-0,0113*x^2 ; West=489,0984-8,4713*x+0,0367*x^2 ; South = 660,8372-12,2421*x+0,0567*x^2

Comparison among the degree of weeds infestation in wheat and barley crops shows that wheat crops have higher amount of weeds than those of barley (Figure 5). The main weed species distributed in the region and in the two crops are *Polygonum convolvulus* L., *Veronica hederifolia* L., and *Chenopodium album* L. Comparison of weed infestation in wheat and barley by regions demonstrated that the degree of weeds is higher in the South region (Figure 6). Weeds occurring therein differ from those reported in other areas of the municipality. In this region species such as *Chenopodium album* L., *Ranunculus arvensis* L. and some others are prevailing, which were not found in the Eastern and the Western region. As a whole, most naturally occurring wild type relatives weeds in high density and in the three districts of survey are: *Veronica hederifolia* L., *Polygonum convolvulus* L., *Convolvulus arvensis* L. and *Cirsium arvense* L. (Scop).

Conclusion

Wheat crops in the eastern region of Stara Zagora municipality are grown at high agricultural technology of cultivation but there are some economically important weeds such as *Polygonum*, *Cirsium*, etc. With the greatest density in the East region are *Veronica hederifolia* L. and *Convolvulus arvensis* L.; in the western area *Avena fatua* L. and *Veronica hederifolia* L.; in the southern part - *Chenopodium album* L. and *Ranunculus arvensis* L.

In Barley crops in the eastern area the most propagated weeds were *Veronica hederifolia* L. and *Lamium amplexicaule* L. In the southern region *Polygonum aviculare* L. and *Polygonum convolvulus* L. dominated. Weed infestation in barley crops was less compared to wheat crops. The degree of weed infestation of wheat and barley in the Southern area is higher than that in the East and West regions.

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