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EFFECTS OF TILLAGE SYSTEMS AND FERTILIZATION LEVEL ON THE WEEDINESS OF WINTER WHEAT

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ABSTRACT

This paper deals with results of the effects of three tillage systems and different nitrogen fertilizer level on floristic composition of weed community in winter wheat in investigated period on the chernozem-luvic soil type. The trial was carried out on the estate experimental field of the Faculty of Agriculture - Zemun "Radmilovac" near Belgrade in Serbia. Tillage systems and fertilization with nitrogen fertilizers have a big influence on weed control and floristic composition, number of species and individuals and biomass of weeds in winter wheat. The weed community in winter wheat crops was composed of 14 weed species in both year of investigation, respectively, with dominancy of terophytes. The obtained results showed that the dominant weed species were *Avena fatua* L., *Papaver rhoeas* L., *Sinapis arvensis* L. and *Stellaria media* (L.) Vill. from annuels and. *Convolvulus arvensis* L. from perennials prevailed in the weed community in winter wheat crops.Conventional tillage system with nitrogen level in top dressing 120 kg ha^{-1} had better effect in weed control than both of both investigated conservation tillage systems (MTS and NTS) had. However, mulch tillage has not lagged behind the conventional tillage increased total weed number of individuals annual and perennial species especially fresh biomass. No-tillage system makes weed control difficult.

Keywords: *tillage systems, nitrogen, weed community, winter wheat.*

INTRODUCTION

Conventional small grain seeding equipment has been designed to operate most efficiently in a tilled, firm, residue-free seedbed. Unfortunately, the tillage operations required to prepare the soil for conventional seeding are expensive, leave land susceptible to erosion and enhance seedbed moisture loss through evaporation. Recent farming technology has provided various combinations of reduced tillage systems capable of cutting costs, conserving moisture and reducing erosion. Tillage systems are generally categorized in conventional tillage using a mouldboard plough, conservation tillage using chisel plow, disk plow, harrow disk or cultivators, and no-till systems using direct drilling in untilled soil. There is increasing worldwide interest in soil conservation systems due to their economic and environmental benefits. Economic benefits of no-till systems may arise from lower drought susceptibility due to higher plant-available soil water content, resulting in more stable yields and savings of labor and fuel. Ecological benefits include an increase of soil organic carbon, biotic activity, soil porosity, agro-ecological diversity, less soil erosion and lower carbon emissions (due to less fuel consumption) (Derpsch et al. 2010). However, because these systems retain large amounts of residue on the soil surface, they require different seeding equipment. The transition from conventional farming systems that use large quantities of mineral fertilizers and pesticides to sustainable systems like organic production for example leads through "low-input" technology (Barberi et al., 1997; Koocheki et al., 2009; Kovačević et al., 2010a; Dolijanovic et al., 2014). The floristic composition and structure of the weed community in winter wheat crops depends to a large extent on the way cultivation is done, where the tillage system and fertilization have a frequent influence. Such systems can only be achieved by a more flexible cultural practices in harmony with agroecological conditions and soil types in a particular region. Adaptation, means first of all adaptation to natural and also economic conditions. Reduction of production costs is one strategy for increasing farm profitability (Leibman et al., 2001; Kovacevic et al., 2010b).

The aim of the present study was to assess the influence of three soil tillage systems, and two level of nitrogen dressing on weed infestans in winter wheat under Pannonian climate conditions on a chernozem luvic soil type in central part of Serbia.

MATERIAL AND METHODS

Field experiments were conducted during 2012/13 and 2013/14 winter wheat growing seasons to examine the effect of three tillage systems and two level of nitrogen in top dressing (60 and 120 kg ha $^{-1}$) on weed floristic composition in winter wheat. The experiment was carried out at the Radmilovac experimental farm of the Faculty of Agriculture University of Belgrade, near Belgrade, R. Serbia (44°45′N, 20°35′E; 152 m a.s.l.).The field is located east of Belgrade, Serbia.

The following tillage systems (A) were included:

Conventional tillage system - (CTS) - moldboard ploughing to the depth of 25 cm + presowing preparation by disking and harrowing;

Mulch tillage (MTS)-chisel ploughing to the depth of 25 cm + presowing preparation by disking and harrowing and

No-tillage system - (NTS). The whole amounts of chopped residues where lefted on the ground after harvesting of maize on the MTS and NTS plots. Since more than 30 percent of land surface were covered with organic residues those tillage systems could be marked as conservation tillage practice.

The main plot treatment was split into two subplot treatments (B): control-without N fertiliser (N_0) and two level of nitrogen in top dressing (N1-60 kg ha^{-1} and N_2 - 120 kg ha^{-1} nitrogen). The nitrogen fertilizer (Urea, 46% N) was applied. Plots for each tillage system were arranged in a split plot design. Plots were divided into subplots and were subjected to tillage treatments with four replications.
The experiment was conducted in a 4-year rotation (maize-winter wheat-spring barley+red clover-red clover) where red clover acted as nitrogen source.
Wheat was sown in mid-October (between 12th and 24th) with 600 germinable seeds/m^2. Six Serbian winter wheat cultivar Pobeda were used. Weed control was generally performed with 2, 4 D herbicides (Monosan 1, 5 l ha^{-1}) in mid-April on all plots. Combine harvest was performed in July (between 5th and 10th).
Weediness in winter wheat was evaluated in both investigated years 2013 and 2014 at the end of second decade of May in cvs Pobeda one month from the application. The evaluation, which consisted of weed counting, was using the weight–counting method on the quadrats (l m^2 area) in each replication. At the end of second decade of May a destructive sample was taken in the quadrants and the weeds were identified, grouped into perennials and annual and counted. These groups were counted separately. Weeds were identified to species level and counted were taken and fresh biomass weights were recorded. After drying in the air, the dry biomass of weeds weights were recorded.
The data for number of weeds species, individuals and weed biomass in investigated tillage systems and top dressing treatments, as well as their interactions, were subjected to an analysis of variance test using the statistical software (STATISTICA 5.0 for Windows), while the least significant difference (LSD) test was used for individual comparison of differences between means.

Meteorological data (temperatures and precipitation) in Belgrade during the period of investigation

Figure 1 presents weather conditions in the experimental field during studies on weed infestation in winter wheat. Both investigation years were favourable for weed winter wheat. On the territory of Serbia, 2013, with a mean air temperature of 11.6ºC, it is the seventh hottest year in the period from 1951. According to the distribution of percentile, the amount of precipitation in 2013 was in the category of normal average for this continental climate. The dominant climatic feature of 2014 in the area of Belgrade is the phenomenon of extremely high precipitation. It was the worst year since 1888, and at the same time the second hottest (after 2000) the hottest year since systematic meteorological measurements. This meteorological conditions were with a more favorable for the growth and development of weeds in winter wheat are performed. The second year were extremely wet in a long period (from mid May to August) and affected to dominant weeds on the observed area.

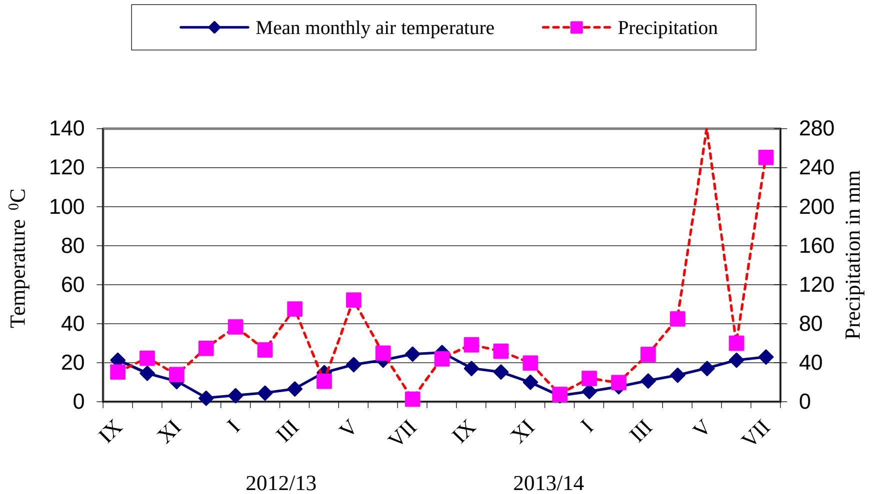

Figure 1. Climate diagram for meteorological conditions in Belgrade according Walter

RESULTS AND DISCUSSION

Tables 1 and 2 present effects of different tillage systems and top dressing on weed weediness in the winter wheat crop. The differences between the two years of investigation were, mainly a result of different weather conditions, especially precipitation sums, and distribution during the growing season of winter wheat. According to data presented in Tables 1 and 2, the weed community of winter wheat was composed of 14 weed species in both year of investigation. *Avena fatua* L., *Sinapis arvensis* L. and *Stellaria media* (L.) Vill. prevailed among annual weed species, while *Convolvulus arvensis* L. were dominant perennial weed species in first investigated year. In the second investigated year hot and wet conditions in second part of May were favourable, especially for *Papaver rhoeas* L., *Avena fatua* L., and *Stellaria media* (L.) Vill. from annuals and *Convolvulus arvensis* L.

Table 1. The effects of tillage systems on floristic composition weed sinuzia in winter wheat (2013)

No.	Weed species	(A) Tillage systems								
		CTS			MTS			NTS		
		(B) N level in dressing (N_0- control, without N; N_1 60 kg ha $^{-1}$; N_2 120 kg ha $^{-1}$)								
		N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
1.	*Avena fatua* L.	15	7	10	11	6	10	4	-	-
2.	*Bilderdykia convolvulus* (L.) Dum.	-	-	-	1	2	-	1	-	-
3.	*Capsella bursa pasteris* L. Med.	-	-	-	-	-	-	-	-	3
4.	*Convolvulus arvensis* L.	-	1	-	2	5	-	3	2	-
5.	*Consolida regalis* Gray	-	-	-	1	2	1	-	2	1
6.	*Daucus carota* L.	-	-	-	-	-	-	-	1	-
7.	*Matricaria chamomilla* L.	-	-	-	-	2	-	-	-	-
8.	*Papaver rhoeas* L.	-	-	-	-	-	-	1	-	2
9.	*Polygonum aviculare* L.	-	-	-	2	1	-	1	-	1
10.	*Sinapis arvensis* L.	6	7			2	5	2		1
11.	*Stellaria media* (L.) Vill.	2	2	3	2			3	5	3
12.	*Sonchus oleraceus* L.	-	-	-	-	1	-	5	5	5
13.	*Stenactis annua* (L.) Ness.	-	1	-	-	1	2	5	1	2
14.	*Veronica persica* Poir.	1	1	-	1	1	2	-	1	-
Total number of weed species		4	6	2	7	10	5	9	7	8
Total number of individuals m^2		24	19	13	20	23	20	25	17	18
No. of individuals annual weeds		24	18	13	18	18	20	22	14	18
No. of individuals perennial weeds		-	1	-	2	5	-	3	3	-
Fresh Biomass g m $^{-2}$		72.2	129.8	61.2	140.4	47.4	31.6	149.0	53.2	80.1
Air-dry Biomass g m $^{-2}$		27.4	51.3	41.0	43.3	24.4	12.1	34.1	16.6	22.9

Table 2. The effects of tillage systems on floristic composition weed sinuzia in winter wheat (2014)

No.	Weed species	(A) Tillage systems								
		CTS			MTS			NTS		
		(B) N level in dressing (N_0 - control, without N; N_1 60 kg ha $^{-1}$; N_2 120 kg ha $^{-1}$)								
		N_0	N_1	N_2	N_0	N_1	N_2	N_0	N_1	N_2
1.	*Avena fatua* L.	1	4	2	-	-	-	4	6	7
2.	*Ambrosia artemisiifolia* L.	-	-	1	-	-	-	-	-	-
3.	*Bilderdykia convolvulus* (L.) Dum.	4	-	1	-	2	1	-	-	1
4.	*Chenopodium album* L.	-	-	-	-	-	-	-	1	-
5.	*Convolvulus arvensis* L.	1	-	1	-	1	-	7	6	2

6.	*Consolida regalis* Gray	-	-	-	-	-	-	4	2	2
7.	*Daucus carota* L.	-	1	-	-	-	-	-	-	-
8.	*Papaver rhoeas* L.	11	8	4	7	3	8	13	10	10
9.	*Polygonum aviculare* L.	-	-	1	-	-	-	-	-	-
10.	*Sinapis arvensis* L.	1	2	1	2	1	3	1	1	5
11.	*Stellaria media* (L.) Vill.	4	-	3	4	1	4	1	3	-
12.	*Sonchus oleraceus* L.	-	1	-	-	-	-	-	1	-
13.	*Stenactis annua* (L.) Ness.	-	-	-	3	1	-	-	-	-
14.	*Veronica persica* Poir.	1	1	-	-	1	1	-	-	2
Total number of weed species		7	6	8	4	7	5	6	8	7
Total number of individuals m^2		23	17	14	16	10	17	30	30	29
No. of individuals annual weeds		22	17	13	16	9	17	23	24	27
No. of individuals perennial weeds		1	-	1	-	1	-	7	6	2
Fresh Biomass $g\ m^{-2}$		31.2	67.0	70.1	52.5	119.0	146.0	157.2	86.2	162.8
Air-dry Biomass $g\ m^{-2}$		16.5	18.3	12.5	17.3	57.8	23,7	34.3	20.4	44.4

Agricultural practices change the population and composition of weeds and the soil seed bank in agro-ecosystems; although most weed management systems do not consider the impact on weed population dynamics (Davis et al., 2004). If we compared tillage systems annuel weeds dominated in total weed population accounted for 89,29% in 2013 and 91,52% of the total weed population in second year of investigation, respectively.

This could be associated with a lower tillage level applied for seed-bed preparation in these cropping systems. Greater prevalence of perennial weeds in minimum tillage has been reported in the literature (Dawit and David, 1997; Kovacevic et a., 2010b). (Barberi et al. (1998) reported that frequent seed-bed preparation and high level of tillage practices decreased perennial weeds.

The highest number of weed plants and weed plants per species, with a significant number of individuals annual and individuals perennial weed plants, was registered in no-tillage system in both years of investigation (Table 1, 2 and 3).

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Table 3. Statistical significance for investigated parameters – LSD 0.05 and 0.01 values

	2013			2014		
	A	B	AB	A	B	AB
Total number of weed species						
LSD 0.05	0.982	0.982	1.701	2.174	2.174	3.765
0.01	1.445	1.445	2.504	3.197	3.197	5.542
Total number of individuals m^2						
LSD 0.05	0.899	0.899	1.541	1.134	1.134	1.964
0.01	1.309	1.309	2.218	1.669	1.669	2.891
No. of annual weeds						
LSD 0.05	0.956	0.956	1.657	0.982	0.982	1.701
0.01	1.408	1.408	2.439	1.445	1.445	2.504
No. of perennial weeds						
LSD 0.05	0.471	0.471	0.817	0.444	0.444	0.770
0.01	0.694	0.694	1.203	0.654	0.654	1.134
Fresh Biomass g m^{-2}						
LSD 0.05	4.479	4.479	7.758	25.713	25.713	44.537
0.01	6.504	6.504	11.266	37.364	37.364	64.717
Air-dry Biomass g m^{-2}						
LSD 0.05	32.184	32.184	55.744	19.374	19.374	33.557
0.01	46.766	46.766	81.002	28.153	28.153	48.762

The increased number of weed plants per species per area units means enhanced competition for principal factors of the growth and development, hence the crop density is lower, and without the optimum density, there are no optimum yields.

The differences in weed fresh biomass among NT compared with CT and MT were statistically significant. In both years of investigation, the lowest values of weed fresh biomass per area unit were obtained in conventional tillage systems and top dressing with 120 kg ha^{-1}. Our study show that the greatest number of weed plants per species was detected in two conservation systems (MT and NT). Not only was a great number weed species, total weed individuals, detected in all investigated tillage systems especially in second year of investigated period, but also the significantly greatest fresh and air-dry weed biomass was recorded in control variant and dressing with 60 kg ha^{-1} nitrogen level conservation tillage systems in first investigated year MTS 282.3 g m^{-2} and NTS 406.2 g m^{-2} in second year of investigated period).

CONCLUSION

According to studies on the effect of three different tillage systems and top dressing with different level of nitrogen on the weed community in winter wheat conducted on leached chernozem in the experimental agricultural farm of Radmilovac (R. Serbia) during the two-year period, the following can be concluded:

The weed community in winter wheat crops was composed of 14 weed species in both year of investigation, respectively, with dominancy of terophytes.
The annual species *Avena fatua* L., *Papaver rhoeas* L., *Sinapis arvensis* L. and *Stellaria media* (L.) Vill. and. *Convolvulus arvensis* L. from perennials prevailed in the weed community in winter wheat crops.The conventional tillage soil treatment showed greater efficiency in suppression (number of species, individuals and weed fresh and air-dry masses) than two conservation systems (MT and NT).The conventional tillage system showed on chernozem luvic soil type all the advantages compared to both conservation tillage systems (MT and NT). No tillage system makes weed control difficult. However, this results shows that there are interesting interactions between soil tillage systems and top dressing. The statistically lowest values of the number of weed individuals and fresh biomass were recorded in conventional tillage systems with 120 kg ha^{-1} nitrogen in top dressing.

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