THE PARTICULARITIES OF ROOT SYSTEM DEVELOPMENT IN WINTER WHEAT GROWN ON CARBONATE CHERNOZEM

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Abstract

Detailed information regarding the growth and development of crops root system, towards the soil agrophysical properties under various technological systems are necessary, as they allow to highlight the positive aspects of the applied system, expressed by agrophysics modeling, but allow to highlight the causes, risks that limit the development of root system. This will lead to optimal technological interventions in agroecosystem.
The paper exposes the particularities of the winter wheat root system development in a long-term crop rotation with 5 fields, grown on carbonate chernozem in conventional (plowing) and conservative (no-tillage) systems. The research took place at the Didactic Station "Chetrosu" of the State Agrarian University of Moldova, located in the South-East side of the Central Moldavian Plateau. There were established the regularities of roots' architectural spreading dependence of soil genetic characteristics, carbonate chernozem agrophisical parameters and of some technological elements applied to winter wheat cultivation. Data shows a double number of winter wheat agrocoenoses roots on No-tillage variant, compared with plowing variant, determined on 0.5 m^2 of the soil profile section. The research of soil moisture on 1.2 m profile confirm the ability of conservation soil tillage system to keep water in the soil. The soil compaction found in penetration resistance and bulk density data, restricted water consumption in flowering and ripening phases, which affected the winter wheat productivity, being similar on both researched variants (No-tillage and plowing). It's required detailed monitoring of the root system development, depending on the stage of crop and it's rate on yield formation.

Key words: agroecosystem, carbonate chernozem, winter wheat, root system.

The root system research in the compartive evaluation of crop production technologies represents a determinative ecological index of agroecosystems productivity.

Root systems serves as a bridge between the impacts of agricultural practices on soil and changes in shoot function and harvested yield. Some of the practices such as tillage affects root development and function, which by far the most important component in crop growth. As with impact of tillage on root distribution, no-tillage causes greater and deeper water accumulation in the soil profile and greater root growth (Guan D. *et al*, 2015). However, no-tillage practice can gradually increase mechanical impediment of the surface soil, limiting the distribution of roots in the upper soil profile and root downward progression (Mossadeghi *et al*, 2009).

The effects of tillage on root development and function are the most important role of tillage systems in crop development. The research of root mass distribution of winter wheat as influenced by different tillage systems in Semi Arid Region of Iran showed that tillage treatments changed the root distribution pattern of winter wheat. Conventional tillage treatment increased root length density in the top 10 cm depth at the tillering stage. However, No-tillage and Minimum tillage increased both root length density and the below ground biomass at the flowering stage (Barzegar A.R. *et al*, 2004).

It is known that root system will be directly influenced by the soil edafic volume, physical, physic-mechanical, physic-chemical, chemical, texture characteristics etc. Tillage system has the function to form optimal conditions for location and development of the root system.

The objective of this study was to investigate the influence of conventional (plowing) and conservative (No-tillage) tillage systems on winter wheat root density in addiction with soil bulk density, penetration rezistance and moisture.

MATERIALS AND METHODS

The research was conducted in the

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agricultural year 2014-2016 at the educational and experimental station of SAUM "SDE Chetrosu" in a crop rotation with 3 agrocoenoses including winter wheat - beans preceding. The reserched variants were conventional (plowing) and conservative (No-tillage) soil tillage systems.

The biometric measurements were performed parallel to the root system research, through cross-cutting roots method (at the end of the growing season, July). The method includes roots records in 0.5 m^2 soil profile section. It consists in placing on the vertical surface of soil profile a network of squares with a side of 10 cm, where the root presence, density and diameter (d> 3 mm, d = 1.3 mm, d <1mm) are highlighting. It was researched the root system architectural location and density on the depth of 0.5 m, the length on the soil surface - 1 m. The soil is represented by loamy carbonate chernozem, moderate humiferous. Agrophysical properties were determined according to agroecological monitoring methods (V. Cerbari, 1997; 2010): soil texture; physic-chemical indices; soil moisture; bulk density; resistance to penetration. The agrophysics characteristic of arable and subarable layers was evaluated in dynamics - May-July period. The net productivity (yield) of agroecosystems was assessed at the end of the growing season.

RESULTS AND DISCUSSIONS

The research regarding soil moisture, bulk density and resistance to penetration in May and July are presented in *table* 1 and 2. that found a higher soil moisture on No-tillage variant. The soil bulk density varies on 0-20 cm layer within the range 1.22-1.28 g/cm^3 limits on plowing variant (May), during the ripening stage of winter wheat this parameter increases more significant on plowing variant, comparative with No-tillage variant (*table 2*).

The penetration resistance parameters are according to soil moisture and the root system development, the values size do not correlate with bulk density indices, in May were recorded higher values of penetration resistance for both tillage systems, compared with July. Research has shown that, compacted layers retain water in the top layer of the soil profile, and conservative tillage system preserves water in May-July, being less used by plants, which is manifested by the root system development and winter wheat yield.

The comparative evaluation of soil moisture data (*figure* 1) shows soil compaction manifestation at 20-50 cm depth on plowing variant and at 10-50 cm depth on no-tillage variant. The bulk density configuration on soil profile (*figure* 2) illustrates the possibility to locate the winter wheat root system depending on tillage system, conservative system impose the plant to form a more developed root system, but it loss the capacity for yeild formation (*figure 4*). Soil compaction limites physiologically water and nutrients use, becoming the limiting factor of agroecosystems productivity under conservative tillage system.

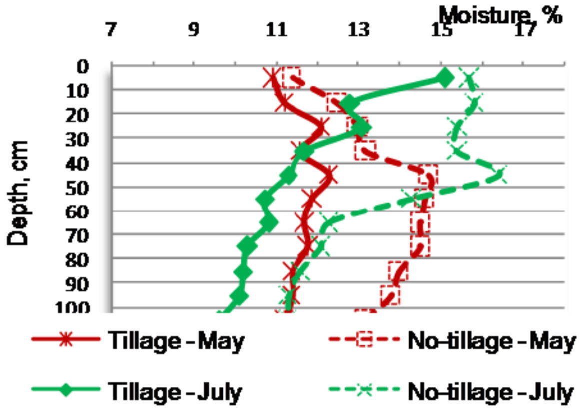

Figure 1 **Soil moisture in winter wheat agroecosystems, 2016**

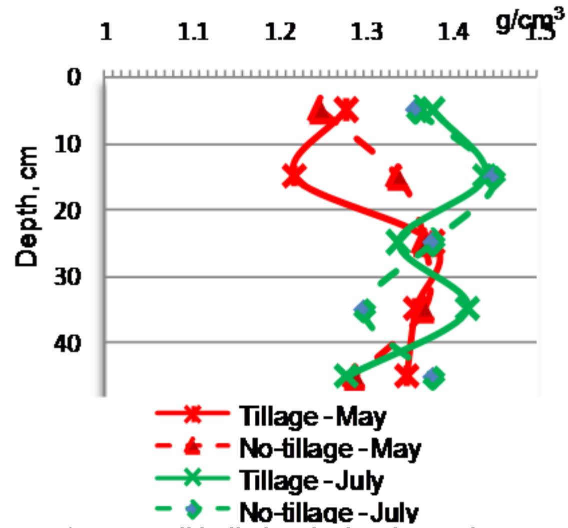

Figure 2 **Soil bulk density in winter wheat agroecosystems, 2016**

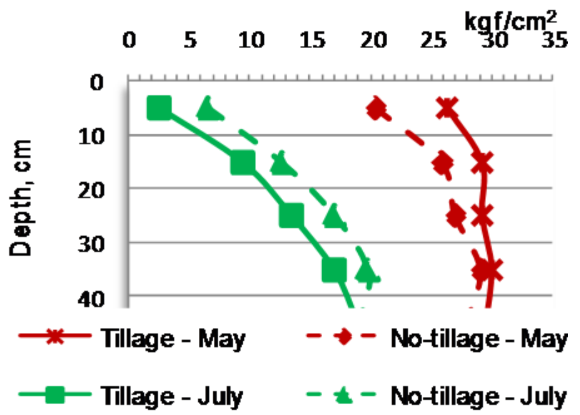

Figure 3 **Soil penetration resistance in winter wheat agroecosystems, 2016**

Table 1

The agrophysical indices and soil moisture in winter wheat agroecosystems, „SDE Chetrosu" - May 2016

Depth, cm	Moisture, %		Bulk density, g/cm^3		Penetration resistance, kgf/cm^2	
	Plowing	No-tillage	Plowing		Plowing	No-tillage
0-10	10.9	11.4	1.28	1.25	26.3	20.3
10-20	11.2	12.5	1.22	1.34	29.2	25.9
20-30	12.1	13.0	1.38	1.37	29.2	27.0
30-40	11.6	13.2	1.36	1.37	30.0	29.0
40-50	12.3	14.7	1.35	1.29	29.5	28.0
50-60	11.9	14.6	-	-	-	-
60-70	11.7	14.5	-	-	-	-
70-80	11.8	14.5	-	-	-	-
80-90	11.4	14.0	-	-	-	-
90-100	11.4	13.8	-	-	-	-
100-110	11.2	13.2	-	-	-	-
110-120	10.6	12.5	-	-	-	-

Table 2

The agrophysical indices and soil moisture in winter wheat agroecosystems "SDE Chetrosu" - July 2016

Depth, cm	Moisture, %		Bulk density, g/cm^3		Penetration resistance, kgf/cm^2	
	Plowing	No-tillage	Plowing	No-tillage	Plowing	No-tillage
0-10	15.1	15.7	1.38	1.36	2.5	6.5
10-20	12.8	15.8	1.44	1.45	9.4	12.6
20-30	13.1	15.4	1.34	1.38	13.4	17.0
30-40	11.7	15.4	1.42	1.30	17.0	19.8
40-50	11.3	16.4	1.28	1.38	19.0	19.1
50-60	10.7	14.3	-	-	-	-
60-70	10.8	12.3	-	-	-	-
70-80	10.3	12.1	-	-	-	-
80-90	10.2	11.6	-	-	-	-
90-100	10.1	11.3	-	-	-	-
100-110	9.6	11.3	-	-	-	-
110-120	15.1	15.7	-	-	-	-

Table 3

The distribution and density of roots in winter wheat agrocoenoses, July 2016

Depth, cm	Plowing			No-tillage		
	<1 mm	1-3 mm	>3 mm	<1 mm	1-3 mm	>3 mm
0-10	63.5	8	5.5	146.5	6	5.5
10-20	41	5.5	2	93.5	6	3
20-30	32	4	0.5	68	4	0
30-40	21	2	0	52.5	1.5	0
40-50	10	0	0	31	0.5	0
Sum	167.5	19.5	8	391.5	18	8.5
Total roots	195			418		
Yield, kg	4966			4955		

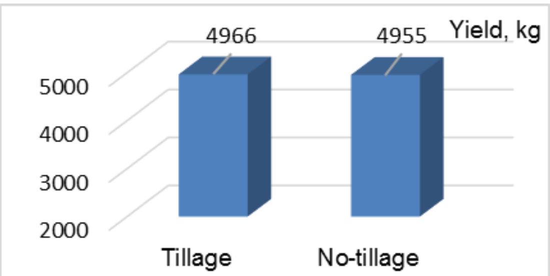

Figure 4 **Winter wheat yield in agricultural year 2015-2016**

Soil compaction under conservative tillage system in the drought agricultural year 2014-2015 was weaker manifested on the winter wheat productivity on some researched fields, compared with 2015-2016.

The distribution and density data of winter wheat roots are presented in *table* 3. The results showed that in both variants prevail the roots with <1mm diameter, on the No-tillage variant were in total recorded 392 roots, compared to 168 on the plowing variant. The fully number of roots with >3 and 1-3 mm diameter does not significantly vary on 0-50 cm layer of bouth variants. It was found that the root system on No-tillage variant is two times more developed according to the roots number, compared with plowing variant, and on the both researched systems the roots prevail in the 0-10 cm layer, (37-38%) distribution of the total roots.

The research of applied agricultural technologies in RM agroecosystems has little data regarding the root system architectonic. The root system studying in the country was carried out sporadically by a small number of researchers (Bacean I., 2000; Gîrla D., 2011). The comparative evaluation of architectonical distribution of the root system of winter wheat depending on the erosion soil degree, type of agroecosystem (degraded, improved, organic/mineral fertilized) showed that the main distribution of roots takes place in the top layer of soil (0-30 cm), with exception of fertilized variants, where the root mass in the 0-20 cm layer is 70-80%. Research has shown the predominance of thin roots (<1mm diameter) in fertilized agroecosystems.

Our research showed that winter wheat yield does not correlate with the root system density, it would be necessary nutrient presence through fertilization and accessible water.

CONCLUSIONS

The root system and it's architectural structure research has an important role in the comparative evaluation of agroecosystems with conventional (plowing) and conservative No-tillage systems.

Research has shown that a higher compaction of subarable layer on plowing variant (1.35-1.38 g/cm^3) occured during winter wheat active growing stages, and at the end of the growing season bulk density parameters grew up, reaching extreme values up to 1.42 g/cm^3.

Soil penetration resistance varies in addiction of soil moisture and less depends of bulk density. At the end of the growing season soil penetration resistance is within the range of optimal conditions (7-20 kgf/cm^2) compared to 20-30 kgf/cm^2 optained in the active growing stage of winter wheat.

The research showed that in bouth tillage systems predominate the roots of <1 mm diameter, which are located mainly in the 0-20 cm layer. The number of this roots on the No-tillage variant is 2.3 times higher, compared with plowing variant.

The total number of roots per researched section of 0.5 m^2 on No-tillage variant is 2.14 times greater than on plowing variant.

The number of roots of winter wheat root system and their distribution was not reflected on the level of 2015-2016 agricultural year yield.

The soil bulk density data correspond to architectural density of the root system on No-tillage variant.

It is necessary to identify the correlation between roots of different diameter and net productivity of the winter wheat.

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