RELATIVELY AGROTECHNICS EVALUATION OF THE SYSTEMS OF CONVENTIONAL AND CONSERVATIVE TILLAGE WITHIN CROP ROTATION

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Abstract

The scientific researches were carried out by long-time standing experiences within the crops rotation with nine camps within the Didactical-Experiential Station "Chetrosu". They have been directed to a comparative agrotechnics evaluation of different tillage systems and its' influence on the weed control level, the soil capacity of water conservation in soil, the degree of the field crops' water assurance, some soil's agro-physics peculiarities, the productivity level of the researched plants. All researches results admit to establish the following: the plant health was been also determined by concurrency capacity with field's weeds. A better weeds control was assured by the winter wheat and it proved a low numeric and gravimetric level of weeds. The lowest competitiveness with weeds has been shown by peas bean, attesting a low numeric and gravimetric level of the weeds; the capacity of tillage systems has differently influenced the weed control pointing out that, only conventional tillage systems have assured a positive degree of the weed control. The studied tillage systems have not essentially influenced water storage capacity, the degree of plants water assurance, except the observation of its growing unessential drift at the unconventional tillage systems. The highest crops productivity level was assured by the conventional tillage system with a deep ploughing with a furrows overthrow dominance.

Key words: crop rotation, field crops, productivity, conventional system, conservative system.

In Besarabia, at the end of the XIX century and the beginning of the XXI century there were initiated warm disputes concerning the tillage. They argued on the idea - to plough or not to plough.

In scientific literature, terms and concepts relating to soil conservation tillage are often treated differently. In the 1980s, the concept of conservative tillage came to term of tillage, which meant to keep at least 30% of crop residues in the soil surface in order to protect it from erosion. In the 1990s, the definition of conservative tillage bear some changes where it is not specified the amount of crop residues rendered into soil. Later, this system has progressed into "Plant Resource Management System". The conservative tillage is represented by wide spectrum of agro processes of a basic tillage without furrows overthrow (chisel, paraplow, disc harrow, etc.) (Boincean B., 2011).

Participants of the 5th International Symposium, "Minimal tillage systems "(Cluj-Napoca, 2008) have presented their points of views on the positive and negative aspects of conventional and conservative tillage systems. Most participants determine the following:

- minimal tillage systems should be regarded as conventional tillage system alternative;
- minimal systems application establishes the humus content increase, hydro stabile macro aggregates, apparent density values;
- the convenient role of unconventional tillages increases when they are applied within optimal rotation for crops (Guş P. and Rusu T., 2005; Rusu T., et al, 2005; Marin D., et al, 2005; Moraru Paula, et al, 2005).

MATERIAL AND METHOD

Experiments focused on studying various tillage systems were founded in 1975 (*table 1*). Scientific studies were and are still carried on experimental fields of SDE" Chetrosu" Anenii-Noi district, within the crop rotation of 9 camps with the following crops' structure:

1. Wheat/winter - 25%; 2. Corn/grains - 25%; 3. Peas/beans - 12.5%; 4. Soya/beans - 12.5%; 5. Sunflower - 12.5%; 6. Corn/silo- 12.5% with the following sequence of crops in space and time within crop rotation:

1. Peas/beans; 2. Wheat/winter (1); 3.sunflower; 4. Spring vetch; 5. Wheat/winter (2); 6. Soya/beans; 7.corn/grains (1); 8. Corn/grains (2); 9. lucerne (field jumping).

Parcels area - 1000m^2. The number of repetitions - 4. Variants distribution - systematic. There were studied field crops within the rotation link

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"pea beans - winter wheat - sunflower – corn beans."

The researches aim: to study the conventional and nonconventional (conservational) tillage systems influence within crop rotation on some elements and soil's fertilization conditions.

Researches objectives provide the studding of:

1. the weed spices spectrum modification dependent on tillage systems, specifying:
   - weeds type;
   - numerical and gravimetrical level of weeds;
   - weed pest threshold.
2. the tillage systems influence on the soil water storage, the provision level of the available water.
3. the tillage systems influence on agro physics amount coefficients of the soil.
4. the tillage systems influence on the productivity level of field crops within the rotation.

Table 1

Experience's variances

No.	Tillage systems	Tillage variants	Tillage variants of peas beans	Tillage variants of winter wheat	Tillage variants of the sunflower
1.	Conventional system	Deep ploughing (with overthrow furrow	Deep ploughing, 20-22cm	Disking, 10 -12cm	Deep ploughing, 25 – 27cm.
2.	Nonconventional system (alternative, conservation, minimum)	Deep loosening (without overthrow furrows)	Deep loosening, 20-22cm	Disking, 10 -12cm	Deep loosening, 25 – 27cm.
3.	Conventional system	Shallow ploughing	Shallow ploughing, 14-16cm	Disking, 10 - 12cm	Shallow ploughing, 14-16cm
4.	Nonconventional system (alternative, conservation, minimum)	Shallow loosening	Shallow loosening, 14-16cm	Disking, 10 - 12cm	Shallow loosening, 14-16cm
5.	Nonconventional system (alternative, conservation, minimum)	Shallow tillage with disc harrow	Disking, 10-12cm	Disking, 10 -12cm	Disking, 10-12cm

Research methods and calculation:

< soil humidity determination method, total and available water reserves, the available water provision level (B. Dospehov, 1977);

< determination method of the weed type, numerical and gravimetric level, of the weed pest thresholds (B. Dospehov, 1977; N. Nicolaev, 2000);

< field crops productivity potential determination method (Neonila Nicolaev, 2003);

< some soil agro physics coefficients determination method (B. Dospehov, 1977);

Crops harvest of: peas beans – divided, at the ripening of 75% of fruits; winter wheat – at the total ripening of grains, directly; sunflower – at scald phase of 75% of calatidiu total amount, with of each crop production accounting, each variance, within each repetition, on the all parcel. The harvest was transferred to crops standard humidity.

There were applied varieties and hybrids in the experience, which are included into Register of plants varieties homologated in the Republic of Moldova.

RESULTS AND DISCUSSION

The first research objective provided the soil health evaluation of studied field crops, stated by weed numerical and gravimetric level, weed pest threshold according to conventional and conservative tillage systems.

Researches results allowed establishing the following:

- at peas beans there were detected the existence of 9 weed varieties from 6 botanical families and 4 biological groups;
- at winter wheat there are detected the existence of 9 weed varieties, representatives of 6 botanical families and 5 biological groups;
- at sunflower there were detected the existence of 10 weed varieties, representatives of 6 botanical families and 5 biological groups.

Percentage ration between terofite and criptofite weeds groups is:

- 67:33 – at peas beans;
- 67:33 – at winter wheat;
- 60:40 – at sunflowers.

Weed pest thresholds, the weed level are influenced as by the studied tillage system as by the field crops biological properties to compete with weeds. It was establish that compact seeded crops have a higher capacity of competing with weeds. In our experiences, this particularity was detected at the winter wheat. Weeding plants have a lower competiveness with weeds (in our case corn grains and sunflower).

According to presented information from the table 1 and 2, we could emphasize the following:

- **at peas beans:**
  - the soil health has been influenced by the studied tillage systems particularities;
  - tillage systems has assured economic pest thresholds the a numerical and gravimetric LOW weed level;
  - studied tillage systems has assured a LOW gravimetric level of weeds after green and aero-dried weeds mass;
  - it is detected the weed amount and mass growing trend within conservative tillage systems

(shallow tillage with plough, paraplow and disk harrow) (*table 1,2)*.

➢ **at winter wheat:**

- the soil health was less dependent of studied tillage systems particularities;
- tillage systems assured a PHYTOCENOTIC pest threshold and a numerical VERY LOW weed level;
- studied tillage systems has assured a gravimetric VERY LOW level of weeds both after green and aero-dried weeds mass;
- it is also detected the weed amount and mass growing trend within conservative tillage systems (shallow tillage with paraplow and the dick harrow) (*table 3, 4*).

➢ **at sunflower**

- tillage systems assured an ECONOMIC pest threshold and a numerical LOW weed level;
- studied tillage systems assured a gravimetric LOW weed level - after green and aero-dried weeds mass;
- it is detected the weed amount and mass growing trend within conservative tillage systems (shallow tillage with the paraplow and dick harrow) (*table 5, 6*).

Table 1

Soil health for peas beans, according to 2012-2013 tillage systems. Previous cropping – corn/grains. Critical phase to weeds

Experience variances	Experience variances during the researching year	Weeds amount/m^2	Pest threshold	Weeds numerical level
Deep ploughing	Ploughing– 20-22cm.	74	Economic	Low
Deep loosening	Loosening – 20-22cm.	86	Economic	Low
Shallow ploughing	Shallow ploughing (14 – 16cm.)	90	Economic	Low
Shallow loosening	Shallow loosening (paraplow- 14 – 16cm.);	94	Economic	Low
Shallow tillage with disk harrow	Shallow tillage (dicking) - 8-10cm.	92	Economic	Low

Table 2

Soil health for peas beans, according to 2012-2013 tillage systems. Previous cropping – corn/grains. Critical phase to weeds.

Experience variances	Experience variances during the researching year	Green and aero-dried weeds mass, g/m^2	Weed gravimetric level after weeds mass	
			green	aero-dried
Deep ploughing	Ploughing –20-22cm.	114,5/28,5	Low	Low
Deep loosening	Loosening – 20-22cm.	164,0/43,0	Low	Low
Shallow ploughing	Shalloe ploughing (14 – 16cm.)	206,0/54,0	Low	Low
Shallow loosening	Shallow loosening (paraplow- 14 -16cm.);	248,0/64,0	Low	Low
Shallow tillage with dick harrow	Shallow tillage (disking) - 8-10cm.	227,0/62,0	Low	Low

Table 3

Soil health for winter wheat, according to 2012-2013 tillage systems. Previous cropping – peas beans. Critical phase to weeds

Experience variances	Experience variances during the researching year	Weeds amount/m^2	Pest threshold	Weeds numerical level
Deep ploughing	Shallow tillage disking – 10-12cm.	6	Phytocenotic	Very low
Deep loosening	Shallow tillage disking – 10-12 cm.	8	Phytocenotic	Very low
Shallow ploughing	Shallow tillage disking- 10-12 cm.	6	Phytocenotic	Very low
Shallow loosening	Shallow tillage disking- 10-12cm.	8	Phytocenotic	Very low
Shallow tillage with disk harrow	Shallow tillage dicking -10-12cm.	8	Phytocenotic	Very low

Table 4

Soil health for winter wheat, according to 2012-2013 tillage systems. Previous cropping – peas beans. Critical phase to weeds

Experience variances	Experience variances during the researching year	Green and aero-dreid avarege weeds mass g/m^2	Gravimetric weed level after green weeds mass	Gravimetric weed level after aero-dried weeds mass
Deep ploughing	Shallow tillage disking – 10-12cm.	16,5/2.0	Very low	Very low
Deep loosening	Shallow tillage disking – 10-12 cm.	32,0/7,5	Very low	Very low
Shallow ploughing	Shallow tillage disking- 10-12 cm.	31,5/6,5	Very low	Very low
Shallow loosening	Shallow tillage disking- 10-12cm.	39,0/9,0	Very low	Very low
Shallow tillage with disk harrow	Shallow tillage dicking -10-12cm.	55,0/11,5	Very low	Very low

Table 5

Soil health for sunflower, according to 2012-2013 tillage systems. Previous cropping – winter wheat. Critical phase to weeds

Experience variances	Experience variances during the researching year	Weeds amount/m^2	Pest threshold	Weeds numerical level
Deep ploughing	Ploughing– 25-27cm.	54	Economic	Low
Deep loosening	Loosening – 25-27cm.	56	Economic	Low
Shallow ploughing	Shallow ploughing (14 -16cm.)	55	Economic	Low
Shallow lossening	Shallow loosening (paraplow- 14 -16cm.);	66	Economic	Low
Shallow tillage with disk harrow	Shallow tillage (dicking) - 8-10cm.	59	Economic	Low

Table 6

Soil health for sunflower, according to 2012-2013 tillage systems. Previous cropping – winter wheat. Critical phase to weeds

Experience variances	Experience variances during the researching year	Green and aero-dreid avarege weeds mass g/m^2	Gravimetric weed level after green weeds mass	Gravimetric weed level after aero-dried weeds mass
Deep ploughing	Ploughing - 25-27 cm	123,0/29,0	Low	Low
Deep loosening	Loosening – 25-27 cm	174,0/43,0	Low	Low
Shallow ploughing	Shallow ploughing – (14-16cm.)	166,0/35,0	Low	Low
Shallow loosening	Shallow loosening (ploscorez- 14-16 cm.)	250,0/62,0	Low	Low
Shallow tillage with disk harrow	Shallow tillage (dicking) -8-10cm.	199,0/50,0	Low	Low

Another research objective has provided comparative evaluation of storing water capacities in soil according to conventional and conservative tillage systems. It was detected the following:

➢**at peas beans:**

- total water reserves have varied according to tillage systems in the 183,9-234,0mm limits;
- water reserves available for plants have varied according to tillage systems in the 118,6-124mm limits that correspond to SATISFYING water providing level;
- within studied tillage systems it can be determined a higher capacity of water storage available for plants at the tillage systems with deep ploughing and loosening predominance (*figure 1*).

➢**at winter wheat:**

- total water reserves have varied according to tillage systems in the 160,9-201,4mm limits;
- water reserves available for plants have varied according to tillage systems in the 72,7-88,7mm limits that correspond to UNSATISFYING water providing level;
- within studied tillage systems it can be determined the same higher capacity of water storage available for plants at the tillage systems with deep ploughing and loosening predominance. (*figure 2*).

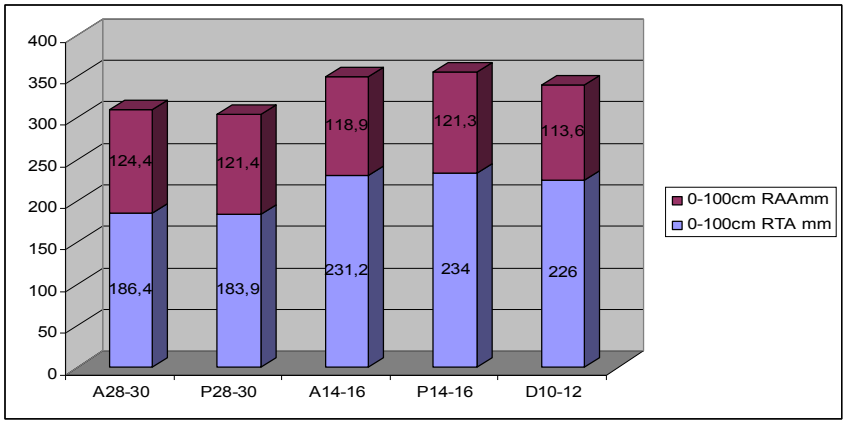

Figure 1 **Total and available water reserves at peas beans according to tillage systems, mm. The horizon 0-100cm. Evidence I, 2013**

➢ **at sunflower:**

• total water reserves have varied according to tillage systems in the 245,0-249,0mm limits;

• water reserves available for plants have varied according to tillage systems in the 132,0-136,0mm limits that correspond to GOOD water providing level;

• within studied tillage systems it can be determined a light bearing increasing capacity of water storage available for plants at the tillage systems with deep ploughing and loosening predominance (*figure 3, 4*).

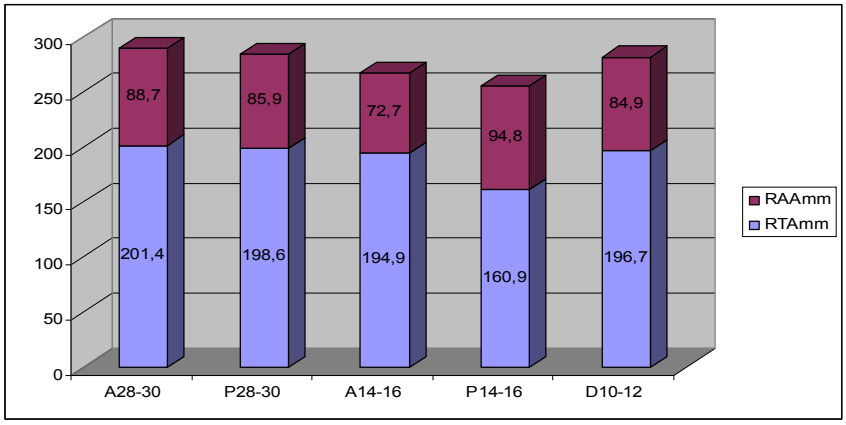

Figure 2 **Total and available water reserves at winter wheat according to tillage systems, mm. The horizon 0-100cm. Evidence I, 2013**

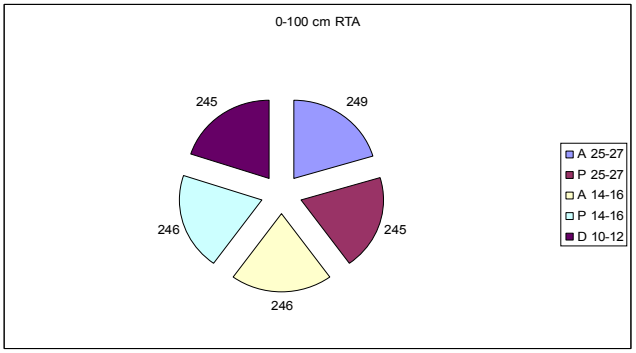

Figure 3 **Total and available water reserves at sunflower according to tillage systems,0-100cm. Evidence I, 2013**

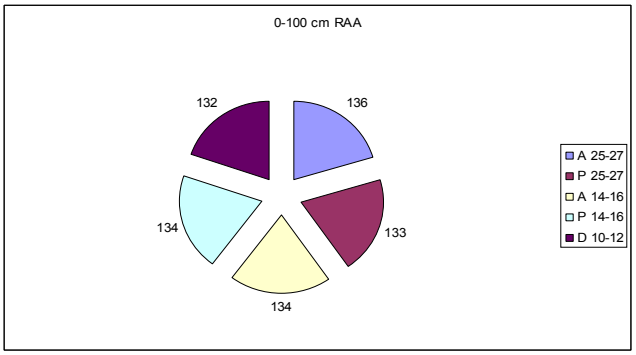

Figure 4 **Available water reserves at sunflower at the begging of vegetation period according to tillage systems, 0-100cm. Evidence I, 2013**

The third research objective is focused on tillage systems influences evaluation on soil's aggregate composition, on its hydro stability.

Soil samples were collected from three layers: 0-10; 10-20; 20-30cm.

There are presented obtained results of sieve in water and fraction values of macro structural hydro stabile aggregates of 1-3mm, considering to be the most profitable from an agro technic point of view (*figure 5, 6, 7*).

Based on obtained results evaluation it were detected the following:

studied tillage systems differently influence aggregative composition values of the soil both at sieve on land and sieve in water;

• at studied field crops and within tillage systems it was determined a lower content of macro structural hydro stabile aggregates, in arable layer, at 25% level and a micro structural aggregates predominance - at 63% level (*table 7*).

Table 7

Percentage quota and proportion percentage of macro and micro structural aggregates within tillage systems

Soil layer,cm	Macrostructural aggregate , 0,25-7,0mm,%	Microstructural aggregate, <0,25mm,%	The proportion between aacro and microstuctural aggregates
0-10	27	60	1:2,2
10-20	24	61	1:2,5
20-30	24	67	1:2,8

*at the percentage content evaluation of a macro structural hydro stabile aggregates with a 1-3mm diameter, it was detected its' decreasing bearing from 0-10 layers to the 20-30cm one (4,1-2,7%), without any essential difference of its content within tillage systems (*figure 5, 6, 7*).

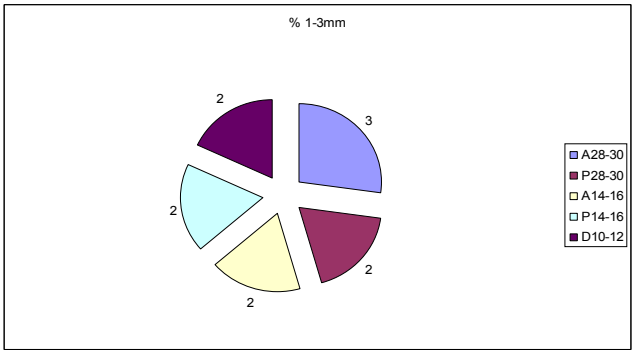

Figure 5 **1-3 mm aggregates quota at peas beans, according tillage systems, the horizon 20-30cm, sieve in water, 2012**

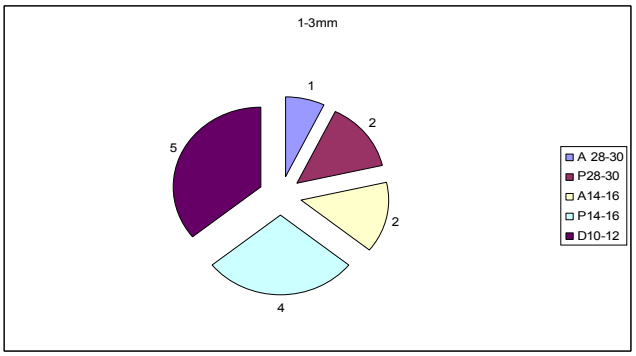

Figure 6 **1-3 mm aggregates quota at corn grains, according tillage systems, the horizon 20-30cm, sieve in water, 2012**

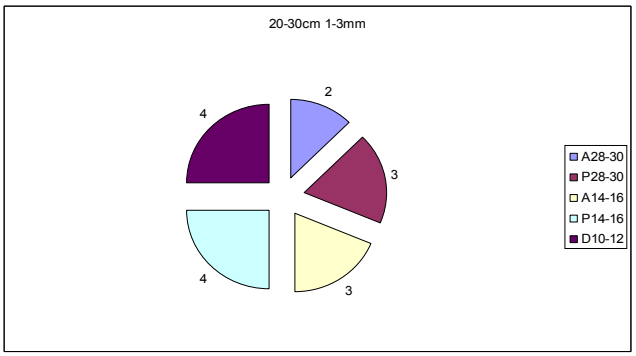

Figure 7 **1-3 mm aggregates quota at winter wheat, according tillage systems, the horizon 20-30cm, sieve in water, 2012**

Table 8

Corn grains productivity according to tillage systems, 2011- 2012

Corn grains	Crop, t/ha	+ /-unto deep ploughing	% unto deep ploughing
Ploughing- 28-30cm	1,54	-	100,0
Paraplow – 28-30cm	0,21	-1,33	13,6
Shallow ploughing -14-16cm	0,87	-0,67	56,5
Shallow loosening, 14-16cm	0,92	-0,62	59,7
Shallow tillage with the harrow-10-12cm	0,63	-0,91	40,9
DL 05, t/ha	**0,99**		

Table 9

Peas beans productivity according to tillage systems, 2011- 2012

Peas beans	Crop, t/ha	+ /-unto deep ploughing	% unto deep ploughing
Ploughing- 20-22cm	0,60	-	100,0
Paraplow –20-22cm	0,40	-0,20	66,7
Shallow ploughing-14-16cm	0,31	-0,29	51,7
Shallow loosening- 14-16cm	0,29	-0,31	48,3
Shallow tillage with the harrow-10-12cm	0,33	-0,27	55,0
DL 05, t/ha	**0,22**		

Table 10

Winter wheat productivity according to tillage systems, 2011- 2012

Winter wheat	Crop, t/ha	+/--unto deep ploughing	% unto deep ploughing
Disking-10-12cm	1,99	-	100,0
Disking-10-12cm	1,85	-0,14	92,0
Disking-10-12cm	1,43	-0,56	71,9
Disking-10-12cm	1,5 3	-0,46	76,9
Disking-10-12cm	1,83	-0,16	92,0
DL 05, t/ha	**0,33**		

Table 11

Peas beans productivity according to tillage systems, 2012- 2013

Peas beans	Crop, t/ha	+ /-unto deep ploughing	% unto deep ploughing
Ploughing- 20-22cm	1,67	-	100,0
Paraplow – 20-22cm	1,11	-0,56	66,5
Shallow ploughing -14-16cm	1,35	-0,32	80,8
Shallow loosening, 14-16cm	0,93	-0,74	-55,7
Shallow tillage with the harrow-10-12cm	0,77	-0,90	-46,1
DL 05, t/ha	**0,59**		

Table 12

Winter wheat productivity according to tillage systems, 2012- 2013

Winter wheat	Crop, t/ha	+ /-unto deep ploughing	% unto deep ploughing
Disking-10-12cm	5,70	-	100,0
Disking-10-12cm	5,20	-0,5	91,2
Disking-10-12cm	5,20	-0,5	91,2
Disking-10-12cm	5,30	-0,4	92,9
Disking-10-12cm	5,00	-0,7	87,7
DL 05, t/ha	**1,16**		

Table 13

Sunflower productivity according to tillage systems, 2012- 2013

Sunflower	Crop, t/ha	+/--unto deep ploughing	% unto deep ploughing
Ploughing - 25-27cm	2,33	-	100,0
Paraplow - 25-27cm	2,20	-0,13	94,4
Shallow ploughing - 14-16cm	2,30	-0,03	98,7
Shallow loosening - 14-16cm	1,93	-0,43	82,8
Shallow tillage with the harrow – 10-12cm	2,13	-0,17	91,4
DL 05, t/ha	**1,11**		

CONCLUSIONS

Evaluation results regarding the field crops productivity level according to tillage systems it was determined the following:

- field crops productivity was strongly influenced by the climatic conditions of the agricultural year and less by tillage systems particularities;
- at extreme climatic conditions of the agricultural year 2011-2012, the highest productivity was provided by the tillage system with deep ploughing predominance (0.60 t / ha- at peas beans; 1.99 t/ha- at winter wheat; 1.54 t/ha - at corn grains). Production decreases in contrast to other tillage systems are considered as significant, respectively representing: -0.20 - 0.31; -0.14 - 0.56; - 0.62 - 1.33 t/ha;
- at climatic conditions of the agricultural year 2012-2013, the highest level of productivity was also provided by tillage system with deep ploughing predominance (1.67 t/ha at peas beans, 5.70 t/ha – at winter wheat, 2.33 t/ha - at sunflower). Production decreases in contrast to other tillage systems are considered as significant, respectively representing: -0.32 - 0.90; -0.40 - 0.70; - 0.03 - 0.43 t/ha.
- tillage systems within experiences framework have not substantial influenced the soil capacity of water accumulation and storage. Even during deficit humidity years, it can be established a light capacity increasing bearing of water storage within nonconventional (conservative) systems with an overthrow furrows tillage predominance. According to assessment scale of assurance of plant available water conservation and proving level, all tillage systems have attested similar values.
- at all tillage systems was detected an increasing bearing of percentage quota at microstructural hydro stabile aggregates. Percentage proportion between macro and micro stable aggregates fractions into soil's arable layers have varied under 1:2, 2 -1:2, 8 limits. Along with arable layer deepness from 0-10 to 20-30cm, it is detected its' decreasing from 4, 1 till 2, 7%.
- the highest productivity level at studied crops has been detected by the conventional tillage system with deep ploughing predominance. The productivity level decreasing at the other tillage systems was stated as significant and was confirmed by statistic processing of researches' results.

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