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Conservation Agriculture *versus* Conventional Agriculture: The Influence of Agriculture System, Fertilization and Plant Protection on Wheat Yield

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Abstract

The paper aimed at making a comparison between conservation agriculture and conventional agriculture on wheat yield, in a three crop rotation (wheat, maize and soybean) system. A three factorial experiment based on the split-plot model and variance analysis was set in the Transylvania area of Romania, as follows: A factor-agriculture system: A_1-tillage, A_2-no-tillage, B factor-fertilization: B_1-$N_{40}P_{40}$ kg/ha. B_2-$N_{40}P_{40}$ kg/ha+$N_{50}P_{30}$ kg/ha; C factor- treatments: C_1-4 treatments, C_2-3 treatments, C_3-2 treatments at heading, C_4-2 treatments at blooming. Fertilization applied in its B_2 variant in conservation agriculture brought 460 kg/ha production gain, significantly and statistically ensured. Under conservation agriculture, two treatments applied at blooming determined 318 kg/ha production gain, statistically and significantly covered. The interaction fertilization-treatments produced the highest wheat yield 5001 kg/ha in case of the B_2C_3 variant, in conventional agriculture, and 5272 kg for the same variant in conservation agriculture, the difference of 953 kg compared to the central variant B_1C_1 being statistically ensured. Under the conditions of Transylvania, farmers could adopt conservation agriculture as a solution for increasing wheat production, reducing the number of treatments and applying more fertilizer upon blooming. The advantage of the implementation of such a system resides in its beneficial effect on soil structure, water reserve and biodiversity, as well.

Keywords: fertilization, no-tillage, tillage, treatments, wheat, yield

Introduction

Conservation agriculture is an alternative to conventional agriculture exerting a beneficial impact on water retention and soil properties, production, environment and efficiency as it involves zero or minimum soil disturbance, a balanced use of fertilizers and herbicides, a permanent layer of plant residues. No tillage has arisen as a viable and sustainable alternative to traditional crop production systems, which led to soil degradation (Derpsch, 2008). As an application of modern technologies to improve production, conservation agriculture is destined to protect and enhance land resources at the same time (Dumanski *et al.*, 2006). Conservation agriculture has the purpose to prevent soil erosion and compaction, as well as to save labor and energy costs (Koepke, 2003). Different types of conservation tillage such as no tillage, reduced tillage, mulch tillage and strip tillage are practiced (Koller, 2003). For its benefits, conservation agriculture is considered a part of the agricultural practices and agri-environmental measures (Bilalis *et al.*, 2011; Garcia *et al.*, 2002).

In Romania, conservation agriculture is a solution for improving soil structure, water management, environment quality, crop yields and efficiency. Most research results refer to the effect of no-tillage or minimum tillage on crop yield, soil properties, water permeability. Important production gains in wheat and maize result using different doses of chemical fertilizers, sludges and vegetal residues (Ailincai *et al.*, 2010). The continuous application of intensive agriculture technologies determined low soil content in nutrients (Calciu *et al.*, 2010). A higher fertilization level combined with 2-3 treatments for crop protection has a positive impact on maize yield under conservation agriculture (Grigoras *et al.,* 2011). The use of no tillage and minimum tillage had a beneficial effect on soil compaction, moisture and temperature as well as on wheat, maize and soybean production (Moraru *et al.*, 2010). Reduced tillage and mainly zero tillage, retention of minimum 30% crop residues on the soil surface and viable crop rotation are the main features of conservation agriculture (Paraschivu *et al.*, 2009). Minimum soil tillage determines similar wheat, soybean and rape productions compared to those obtained under conventional tillage (Rusu *et al.*, 2005). In addition, minimum soil tillage systems in a three years rotation maize, soybean and wheat enabled soil hydro stability, its resistance to penetration and increased humus content due to the incorporation of vegetable remnants (Rusu *et al.*, 2006). An increased fertilizer amount determined important yield gains on the long term in maize crop under irrigation conditions (Zaharia *et al.*, 2009). Under three years rotation and optimum fertilization, important production gains in wheat production were obtained in wheat cropping (Sin *et al*, 2010). This type of research gives solutions to growers towards helping them to increase productivity and reduce production cost and aims to identify the most efficient and durable crop technologies that farmers need (Cociu, 2011).

The fertilization and the number of treatments are important factors deeply influencing winter wheat yield (Cojocaru *et al.*, 2010; Nagy 2004; Popa *et al.*, 2008).

The purpose of the paper is to evaluate the effect of no-tillage, fertilization and number of treatments on winter wheat yield in comparison with conventional tillage system. The research was destined to offer solutions to farmers in order to develop conservation agriculture and to benefit from its advantages by increasing the production and reducing the production cost.

Materials and methods

Plant material

In order to set up this paper, the biological material was represented by the local 'Arieşan' wheat cultivar, with high production performance: 50 grain mass, 99.9% protein, 96% gluten, 550 germinable grains/square meter, the seed dose: 287 kg/ha. Before sowing, seeds were treated with Yunta 2 ml/kg.

Study area

The experimental field was organized according to a three years crop rotation system: wheat-maize-soybean, based on a split-plot model in order to compare the effect of agriculture system, fertilization and plant protection on wheat yield in the Transylvania area, at Turda Research and Development Agriculture Station, Cluj County (Romania) in the 2010-2011 period.

Soil and climate conditions

The soil was a vertic luvisoil with a clay loam texture, with a neutral pH, a fertile soil well supplied with phosphorus and calcium and with an average humus content, favoring plant development.

The climate conditions were normal for this area in general. During the period of wheat vegetation, temperatures varied from one month to another, 6 months of a normal regime, 4 months were warm and 2 months colder than normal, but as a whole, the temperature provided good conditions for wheat development. During the winter season, a normal protecting snow straw covered wheat. The drought that set in April and May affected the wheat crop, but the rainfalls from the 3rd decade of June were beneficial for its recovery and assured good harvests. Therefore, water reserve was sufficient until the end of March, insufficient in April and May, but assured by the rainfalls of June.

Design of the experiments

The experiment was organized based on a split-plot model with three repetitions, the plot size being 4 m x 12 m. The three-factorial experiment consisted of: A factor-agriculture system in 2 variants: A_1-conventional agriculture (tillage) and A_2-conservation agriculture (no-tillage); B factor-fertilization in 2 variants: B_1-$N_{40}P_{40}$ kg/ha at sowing and B_2-$N_{40}P_{40}$ kg/ha at sowing + $N_{50}P_{50}$ kg/ha during growth in the spring season; C factor-number of treatments with 4 variants: C_1-4 treatments (during the growth period in the spring season, at the end of tilling, at heading off stage, at blooming), C_2-3 treatments (at the end of tilling, at heading off stage, at blooming), C_3-2 treatments (at the end of tilling, at heading off stage), and C_4-2 treatments at the end of tilling and at blooming (Tab. 1).

Tab.1. The application of treatments in various vegetation stages

Variant	At vegetation recovery in spring season	At the end of tilling	At heading off stage	At blooming
C_1	IF+IS	IF+E	IF+FG+IS+A	IF+FG+IS+A
C_2	-	IF+IS+E	IF+FG+IS+A	IF+FG+IS+A
C_3	-	IF+IS+E	IF+FG+IS+A	-
C_4	-	IF+IS+E	-	IF+FG+IS+A

C_1-4 treatments; C_2-3 treatments; C_3-2 treatments at heading off; C_4-2 treatments at blooming; IF-leaf fertilizer; IS-insecticide; FG-fungicide; E-herbicide

The applied treatments

The applied treatments consisted of: leaf fertilizer Polyfeed 19:9:19+microe. 5 kg/ha; insecticides: Calypso 100 ml/ha (at vegetation recovery, at the end of tilling), Proteus 0.4 l/ha (at heading off stage and at blooming), fungicides: Falcon 480 EC 0.6 l/ha (at the end of tilling and at heading off stage), Prosaro 1 l/ha (at blooming), herbicides: Sekator OD Progres 0.135 kg/ha +Esteron 0.5 l/ha at the end of tilling, adjuvant: Trend 0.3 l/ha (at heading off stage and at blooming). The treatments against weeding were established according to the weeding grade and weeds spectrum, using a "tank-mix".

Technological works

The technological works were the following ones: (1) after soybean harvesting in the fall, sowing was applied between October 26th, 2010 and November 2nd, 2010, at the same time with fertilization $N_{40}P_{40}$ kg a.s./ha, using a John Deere tractor 6620 SE + Gaspardo Directa 400 sowing machine for conservation agriculture. A number of 550 germinable grains was assured per surface unit. The wheat seed was directly sowed in the field of the precursory crop, which was harvested using CASE I H 1680 AF combine, chopping vegetal residues and then uniformly spreading them on the soil. Sowing was achieved in this vegetal layer of soybean residues and weeds from the spontaneous flora appeared meanwhile. The treatments were manually applied on the plots and harvesting was carried out using Wintersteiger Classic combine with 1.2 m operating width. In the case of conventional agriculture, sowing was achieved by using a John Deere tractor 6620 SE + HRB 400 D harrow + GC-2 sowing machine; (2) crop emergence was noticed on November 15th, 2010 for the seeds sowed on Oct. 26th, 2010 in the conservation agriculture system; (3) additional fertilization $N_{50}P_{30}$ was applied on March 30th, 2011 at vegetation recovery; (4) treatment C_1 was applied on April 20th, 2011 when wheat crop looked to have a good uniformity; (5) treatment C_2 + herbicide was applied on May 11th, 2011; (6) herbicides were applied with MET 1500 on May 12th, 2011 using a complex recipe; (7) treatment C_3 was applied at heading of stage on May 20th, 2011; (8) treatment C_4 was applied at the beginning of blooming on June 1st, 2011; (9) harvesting was carried out on July 11th, 2011.

Statistical analysis

The data collected from the field on wheat yield were processed using variance analysis.

These experiments are a part of the research work run within a partnership Project on Crop and Integrated System Management for obtaining high quantitative and qualitative productions.

Results and discussion

Conventional agriculture (tillage)

The influence of fertilization on wheat yield

In the conventional agriculture system, wheat yield was 4384 kg/ha for the control variant, B_1-$N_{40}P_{40}$ applied at sowing. On the plot the amount of fertilizer was higher, $N_{40}P_{40}$ at sowing + $N_{50}P_{30}$ applied at vegetation recovery in the spring season, wheat performance was 4563 kg/ha. The 179 kg/ha production gain was determined by the additional fertilization $N_{50}P_{30}$, but it was not statistically assured meaning that under the conventional agriculture system in the year 2011, the use of fertilizer in the spring season failed to have the expected effect (Tab. 2).

The application of an additional dose of nitrogen at the vegetation recovery in the spring season determined an increased wheat production (Mustatea *et al.*, 2009)

Tab. 2. The influence of fertilization on wheat yield, in the conventional agriculture system

B Factor Fertilization	Wheat yield		Difference Kg/ha	Significance
	Kg/ha	Kg/ha		
B_1-$N_{40}P_{40}$ at sowing	4384	100.00	mt	-
B_2-$N_{40}P_{40}$ at sowing+$N_{50}P_{30}$ at vegetation recover in spring	4563	104.10	179	-
DL 5%			901	
DL 1%			1080	
DL 0.1%			6619	

B-fertilization; DL-degrees of liberty; mt-average difference

The reduced production gain resulted due to the weak mineralization under the local climate conditions, characterized by low rainfalls during the vegetation period and drought, because at the beginning of the month of may the water requirement was lower than the accessible reserve.

The influence of treatments on wheat yield

On the plots where control variant C_1-4 treatments was applied wheat production registered 4367 kg/ha. On the plots where C_2-3 treatments were practiced, wheat performance was 4548 kg/ha, namely 3.9% higher compared to C_1. The additional yield gain counted for 172 kg/ha, but it was not statistically assured.

The applied treatments during the vegetation period determined production gains both due to the additional leaf fertilizer amount and mainly due to crop protection (Barraclough *et al*, 1995).

In case of the C_3 variant-2 treatments (at the end of tilling and at the heading off stage), the highest wheat yield was recorded, 4704 kg/ha, namely 7.5% higher than the yield performance of C_1. The 328 kg production gain is important, but it was not statistically assured. In case of C_4 variant-2 treatments (at the end of tilling and at blooming), the wheat yield registered the lowest performance, 4268 kg/ha, being by 2.5% lower than the yield recorded by the control variant, C_1. The production of less than 108 kg/grains/ha was not assured from a statistical point of view. Therefore, the most efficient technological variant under conventional agriculture system in the year 2011 was C_3. In case of the 4 treatments a slower crop development was noticed. (Tab. 3).

Tab. 3. Influence of treatments on wheat yield, conventional agriculture system

C Factor Treatments	Wheat yield		Difference	Significance
	Kg/ha	%	Kg/ha	
C_1-4 treatments (at vegetation recovery in spring at the end of tilling, at the heading off stage, at blooming	4367	100.00	mt	-
C_2-3 treatments (at the end of tilling, at the heading off stage, at blooming	4548	103.9	172	-
C_3-2 treatments (at the end of tilling, at the heading off stage)	4704	107.5	328	-
C_4-2 treatments (at the end of tillering, at blooming	4268	97.5	-108	-
DL 5%			413	
DL 1%			580	
DL 0.1%			819	

C-treatments; DL-degrees of liberty; mt-average difference

Influence of fertilization-treatments interaction on wheat yield

This interaction had the deepest impact in case of B_2C_3 combined variant where wheat yield registered the highest performance, 5001 kg/ha, meaning 13.5% more than in case of control variant B_1C_1. Instead, the additional production gain, 594 kg/ha, was not statistically assured. Despite that in all cases, an additional gain was noticed, no significance was observed. Therefore, the combined effect of fertilization-treatments, the interaction under conventional agriculture system was not statistically assured, because by burning the field and tilling it, the incidence of weeds and pests was less. However, the treatments applied during the period of crop vegetation had a beneficial effect allowing the plant to register a normal development (Tab. 4).

Tab. 4. Influence of fertilization-treatments interaction in wheat yield

Combined variants	Wheat yield		Difference	Significance
	Kg/ha	%	Kg/ha	
B_1C_1	4245	100.00	mt	-
B_2C_1	4507	106.2	262	-
B_1C_2	4647	100.00	mt	-
B_2C_2	4448	95.70	-198	-
B_1C_3	4406	100.00	mt	-
B_2C_3	5001	113.50	594	-
B_1C_4	4239	100.00	mt	-
B_2C_4	4297	101.40	58	-
DL 5%			979	
DL 1%			1260	
DL 0.1%			1604	

B_1C_1-fertilization N40P40, 4 treatments; B_2C_1-fertilization N40P40+N50P30, 4 treatments; B_1C_2-fertilization N40P40, 3 treatments; B_2C_2-fertilization N40P40 +N50P30, 3 treatments; B_1C_3-fertilization N40P40, 2 treatments at heading off; B_2C_3-fertilization N40P40+N50P30, 2 treatments at heading off; B_1C_4-fertilization N40P40, 2 treatments at blooming; B_2C_4-fertilization N40P40+N50P30, 2 treatments at blooming; DL-degrees of liberty; mt-average difference

Tab. 5. Influence of treatments-fertilization interaction on wheat yield

Combined variants	Wheat yield		Differences	Significance
	Kg/ha	%	Kg/ha	
C_1B_1	4245	100.00	mt	-
C_2B_1	4647	109.50	402	-
C_3B_1	4408	103.80	162	-
C_4B_1	4239	99.90	-6	-
C_1B_2	4507	100.00	mt	-
C_2B_2	4448	98.70	-59	-
C_3B_2	5001	111.00	494	-
C_4B_2	4297	95.30	-210	-
DL 5%			584	
DL 1%			820	
DL 0.1%			1158	

C_1B_1-4 treatments, N40P40; C_2B_1-3 treatments, N40P40; C_3B_1-2 treatments at heading off, N40P40; C_4B_1-2 treatments at blooming, N40P40; C_1B_2-4 treatments, N40P40+N50P30; C_2B_2-3 treatments, N40P40+N50P30; C_3B_2-2 treatments at heading off; N40P40+N50P30, C_4B_2-2 treatments at blooming, N40P40+ N50P30; DL-degrees of liberty; mt-average difference

Analyzing the influence of fertilization (B) for the same treatment required for crop maintenance (C) led to the observation that the application of an additional amount of fertilizer at vegetation recovery led to increased productions but the production gains have not yet been significant because of the specific climate and local conditions. The low rainfall level did not allow for a superior effect of the fertilization.

Influence of treatments-fertilization interaction on wheat yield

This interaction had the most beneficial effect in case of C_3B_2 variant, where wheat yield registered 5001 kg/ha, by 494 kg/ha more than control variant C_1B_1. In case of other variants such as: C_4B_1, C_2B_2 and C_4B_2, the combined effect had a negative impact on wheat yield resulting losses (Tab. 5).

The analysis on the influence of treatments for crop maintenance (C) for the same fertilization level (B) showed that for the experimental variants which did not benefit from fertilization upon vegetation recovery, the cancellation of the treatment with insecticide and leaf fertilizer applied after the vegetation recovery (C_2) determined 402 kg production gain per surface unit due to the diminished stress during this growth stage (Gajjar *et al.*, 2005).

The lower production registered by C_3 and C_4 variants is explained by the reduced number of treatments applied for crop maintenance in the vegetation period. The production difference between C_3 and C_4 variant has shown that the treatments applied at the heading off stage had a deep effect on production and their application at blooming stage could not cover the deficits.

With regard to B_2, the variants with an additional fertilization during vegetation recovery (agrifund B_2) it was noticed that B_2C_2 variant where the treatment with insecticide was missing, a slight production decrease was recorded explained by the crop sensitivity to pest attack (Chowdhury *et al.,* 1980).

The application of a treatment at bloomingled to a diminished production, an effect due to the sterility induction in this vegetation stage (Jan *et al.*, 1976).

Conservation agriculture system

Conservation agriculture system in its variant of minimum tillage in comparison with conventional agriculture system (tilt furrow ploughing) assured similar wheat production in the Transylvania area in the period 2000-2004 (Rusu *et al.*, 2006)

Influence of fertilization on wheat yield

This influence was obviously a positive one, the higher the amount of fertilizer, the higher the wheat yield. In case of the B_2-fertilization variant ($N_{40}P_{40}$ kg/ha+$N_{50}P_{30}$

kg/ha), wheat production was 5023 kg/ha, 19.4% higher than in the case of the control variant. More than that, the additional yield gain, 817 kg/surface unit, was statistically assured. Therefore, the additional application in spring led to a significant yield gain.

This was due to the conservation agriculture system where vegetation stages are developing under bad conditions and the sowing machine is able to lay the fertilizer in the open drain for seed, so that the young crop can benefit from the needed nutrients for a fast development. On the other side, because of the no-tilled land, in the spring season, wheat crop is less developed than the one sowed under tillage system, but these differences are immediately covered by additional fertilization. Therefore, additional fertilization is very important under conservation agriculture as wheat crop to perform the best production (Tab. 6).

The highest grain yields were obtained under conservation tillage in its variants no tillage and minimum tillage for various wheat varieties in organic agriculture (Bilalis *et al.*, 2011). Other research results showed that in minimum tillage systems, winter wheat could perform 93-99% yield compared to conventional tillage in close relationship to soil properties, determined by the use of paraplow, followed by rotary harrow and chisel (Rusu *et al.*, 2011)

A significantly increased production was noticed due to the application of an additional dose of fertilizer at vegetation recovery. The production gain in conservation agriculture system is explained by the ability of this system to preserve water (Steduto *et al.*, 2007).

Influence of treatments on wheat yield

This influence was also important under the conservation agriculture system. Compared to the control variant, C_1-4 treatments, production gains registered by the other three variants are significant. The most efficient variant was C_3-2 treatments, where thewheat yield was the highest, 4795 kg/ha, and yield gain was 318 kg/ha statistically and significantly assured. Also, the C_2 variant-3 treatments (at vegetation recovery in spring, at the end of tilling, at blooming) registered 204 kg/ha production gain (Tab. 7).

Influence of fertilization-treatments interaction on wheat yield

Influence of fertilization-treatments interaction on wheat yield was pointed out in the case of all variants, but mainly on the plots where a corresponding fertilization level combined with 3-2 treatments was practiced.

Therefore, the most efficient variant was B_2C_3, whose wheat yield was 5272, 22.1% higher that the one recorded by the B_1C_1 control variant. The production gain of 958 kg/ha was statistically assured.

In addition, the variants B_2C_1 and B_2C_2 achieved high yield gains statistically assured proving that under conservation agriculture systems, fertilization and a reduced number of treatments could bring additional performance (Tab. 8).

Tab. 6. Influence of fertilization on wheat yield, in the conservation agriculture system

B factor -fertilization	Wheat yield		Difference	Significance
	Kg/ha	%	Kg/ha	
B_1-$N_{40}P_{40}$ at the same time with sowing	4206	100.00	Mt	-
B_2-$N_{40}P_{40}$ at sowing+$N_{50}P_{30}$ at vegetation recover in Spring	5023	119.40	817	-
DL 5%			605	
DL 1%			903	
DL 0.1%			1104	

B-fertilization; DL-degrees of liberty; mt-average difference

Tab. 7. Influence of treatments on wheat yield, conservation agriculture system

C factor-treatments	Wheat yield		Difference	Significance
	Kg/ha	%	Kg/ha	
C_1-4 treatments (at vegetation recovery, at the end of tilling, at the heading off, at blooming	4477	100.00	Mt	-
C_2-3 treatments (at the end of tilling, at the heading off, at blooming	4681	104.50	204	-
C_3-2 treatments (at the end of tilling, at the heading off	4795	107.10	318	-
C_4-2 treatments (at the end of tilling, at blooming	4506	100.60	28	-
DL 5%			192	
DL 1%			270	
DL 0.1%			381	

C-treatments; DL-degrees of liberty; mt-average difference

Tab. 8. Influence of fertilization-treatments interaction on wheat yield, conservation agriculture

Combined variants	Wheat yield		Difference	Significance
	Kg/ha	%		
B_1C_1	3914	100.00	Mt	-
B_2C_1	5041	128.80	1,127	*
B_1C_2	4295	100.00	Mt	-
B_2C_2	5067	118.00	772	*
B_1C_3	4319	100.00	Mt	-
B_2C_3	5272	122.10	953	*
B_1C_4	4297	100.00	Mt	-
B_2C_4	4714	109.70	417	-
DL 5%			623	
DL 1%			915	
DL 0.1%			1,170	

B_1C_1-N40P40, 4 treatments; B_2C_1-N40P40+N50P30, 4 treatments; B_1C_2-N40P40, 3 treatments; B_2C_2-N40P40+N50P30, 3 treatments; B_1C_3-N40P40, 2 treatments at heading off; B_2C_3-N40P40+N50P30, 2 treatments at heading off; B_1C_4-N40P40, 2 treatments at blooming; B_2C_4-N40P40+N50P30, 2 treatments at blooming; DL-degrees of liberty; mt-average difference; *-significant difference

Influence of treatments-fertilization interaction

This influence had a significant impact on wheat yield. Maintaining the fertilization at the same level, the variation of the number of treatments could lead to important production gains. The variant C_3B_2 assured the highest yield, 5272 kg/ha, 4.6% higher than when compared to the control variant C_1B_1.

The analysis of the influence of treatments applied for crop maintenance revealed that the highest wheat production was carried out in case of the C_3 variant where the treatments were applied only at the end of tilling and at the heading off stage. The treatment application at blooming determined a lower production (C_1 and C_2) and the lack of treatment at the heading off stage also resulted in a reduced yield (C_4).

Analyzing the influence of fertilization upon wheat yield (B) for the same treatment applied for crop maintenance in vegetation (C), it was noticed that the application of an additional fertilizer amount determined important production gains in case of all the variants including treatments for crop maintaining. These production gains are statistically assured except the C_4 variant.

The highest production gain accounting for 405 kg/ha was registered by the C_3B_1 variant, significantly and statistically assured. Also, important gains of 383 kg/ha and 381 kg/ha were registered by C_4B_1 and respectively, C_2B_1 variants.

Therefore, in the case of the second fertilization, different treatments had no statistical significance and thu, it should be accepted that only one basic fertilization level is needed and also, apply 3 or 2 treatments in order to produce more wheat gains/ha (Tab. 9).

Analyzing the influence of the treatments applied for crop maintenance (C), for the same agrifund (B) showed that in the case of variants where fertilizers were applied only at sowing (B_1), the treatment application destined for crop maintaining determined significant production gains that were statistically assured. The application of the treatments at blooming caused the reduction of production (C_1, C_2 and C_4) and the lack of treatments at the heading off stage as led to a diminished yield (C_3).

Tab. 9. Influence of treatments-fertilization interaction on wheat yield, conservation agriculture

Combined variants	Wheat yield		Difference	Significance
	Kg/ha	%	Kg/ha	
C_1B_1	3914	100.00	Mt	-
C_2B_1	4295	109.70	381	*
C_3B_1	4319	110.30	405	**
C_4B_1	4297	109.80	383	**
C_1B_2	5041	100.00	Mt	-
C_2B_2	5067	100.50	26	-
C_3B_2	5272	104.60	231	-
C_4B_2	4714	93.50	-327	-
DL 5%			272	
DL 1%			382	
DL 0.1%			539	

C_1B_1-4 treatments, N40P40; C_2B_1-3 treatments, N40P40; C_3B_1-2 treatments at heading off; N40P40; C_4B_1-2 treatments at blooming, N40P40; C_1B_2-4 treatments, N40P40+N50P30; C_2B_2-3 treatments, N40P40+N50P30; C_3B_2-2 treatments at heading off, N40P40+N50P30; C_4B_2-2 treatments at blooming, N40P40+N50P30; DL-degrees of liberty; mt-average difference; *significant difference; ** very significant difference

Conclusions

The conservation system determined the obtaining of higher productions compared to the classical agriculture system because this system has the advantage to preserve water and under the condition of a water deficit during the vegetation period, it contributes to a more efficient use of fertilizers.

The application of an additional dose of fertilizer at vegetation recovery determined important production gains that were statistically assured only in the case of conservation agriculture, even though a lack of rainfall was recorded locally.

The treatments applied for crop maintenance at vegetation had a different effect. As such, in all the cases where the treatments were applied at the heading off stage important production gains were achieved. On the contrary, where the treatments were applied at blooming, they led to a diminished production.

Conservation agriculture could be an alternative for obtaining higher wheat yield under the conditions of the Transylvania area (where rainfall is not uniformly distributed), and it is recommended to be applied in wheat cropping with a beneficial impact on wheat production, water resource, soil structure and biodiversity. No tillage practice assures a better water management into the soil. Additional fertilization applied during the spring season could lead to important production gains. For the same fertilization level, 3 or 2 treatments could also positively influence wheat production.

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