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The Effects of Wheat Plant Residues Management and Conservation and Conventional Tillage Systems on Sugar Beet Yield Components and Soil Nutrients Amounts

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ABSTRACT

In order to investigate the effects of tillage kinds and wheat residues and their interactions effect on qualitative and quantitative yield of sugar beet, an experiment as a split plot form in a randomized complete block design in the farming year at the 2012-2013 was conducted. The main factor includes tillage in two levels of conventional and conservation and wheat sub factor residues at four levels includes zero (control), 1, 3 and 5 tons per hectare. According to the variance analysis results of tillage at one percent probable on the leaf dry weight and soil phosphorus and at the five percent probable on the leaf fresh weight, roots dry weight have a significant effect, but on the root fresh weight, potassium and nitrogen have not a significant effect. Also wheat residues at one percent probable on the soil potassium and the interaction effect of tillage with wheat residues have a significant effect on the soil potassium and phosphorus at one percent probable. The obtained results of mean comparison showed that the conventional tillage causes more leaf fresh weight, leaf dry weight and root dry weight and phosphorus in comparing with conservation tillage. Also the using of wheat residues reduces soil potassium.

KEYWORDS: nitrogen, phosphorus, potassium, tillage, wheat residues.

INTRODUCTION:

Sugar production in many countries is one on the essential aspects of its agricultural economics and among this situation; sugar beet plant plays an important role and exclusively as a source of sucrose is cultivated (koocheki, 1996). Researchers are trying to develop sustainable growth of sugar beet production and to minimize any threat that depends on the environment (Draycott, 2006). According to aspects of soil quality and crop production that has increased in recent years, has led to new interest in plant residues, green manures and other organic fertilizers as a source of organic fertilizer for the soil organic matter and plant nutrient elements (Kumar, 1998). Plant residues, the basic important resources, generally are parts of plants that remain in the field after harvesting crops (Singh et al., 2003). Plant residues can replace with the nutrients in the soil, maintain the power of the agriculture production, increase organic matter, water maintenance, stimulate microbial activities, soil aggregation and reduce fluctuations in soil temperature, and improve the plowing power and reduce evaporation of the soil. Plant residues can improve the weather quality, reduce the runoff and modify the effects of air pollution. Also the plant residues can balance in the global climate by taking of organic carbon and reducing withdrawal of carbon dioxide and other greenhouse gases (Blanco-Canqui and Lal, 2009). Most farmers in the management of the plant residues have this concern that has the least negative effects on function and cultivation and other plants process. According to the this reason in a long times ways such as the plant residues burning, leaving crop residue on the soil surface, residues accumulation of farm surface and residues plowing in the soil has been discussed. Unfortunately, due to lack of knowledge or lack of the life necessities, except limited use of these substances, farmers and land owners and ranchers behaviors with plant residues are not rational and principle. Sometimes to ease works, the obtained nature work which should place in the production cycle and soil development and networks and food chains and levels of crop ecosystem, is wrongly plowing and is affected by overgrazing or burning. Despite the increasing of soil nutrients that affected by plant residue burning, most done studies show the adverse effects of this method is based on the characteristics such as organic matter and soil permeability that in the long times would endanger the production stability in the crop ecosystems (Due Preez et al., 2001). The plant residue burning causes the 80 percent nitrogen, 25 percent phosphorus, 21% potassium and 40% to 60% sulfur losses and destroy the soil microorganisms (Gangwar et al., 2006). The plant residues decaying in the residue keeping treatment reduces the soil bulk density (Izaurrald et al.,

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1986). But researchers (Haynes and Bears, 1996) stated that the using of conservation tillage in the farms increases the organic matter and therefore causes the soil fertilities. Burning or removing plant residues can be facilitated tillage operation but straw burning is damaged to the beneficial microorganisms and causes soil erosion as well. In contrast, plant residues remaining on the soil surface, reduces the soil erosion and physical, chemical and biological characteristics of the soil improves (Logsdon and Karlen, 2004).

In response to the increasing costs of fossil fuels, massive soil erosion, intensive using of chemical fertilizers and pesticides and environmental concerns associated with water pollution and the public costs of doing business, that the need of the new agricultural technologies is be felt. Studies show that each year a large area of crops lands in the world due to soil compaction and erosion destroy. Therefore the using of appropriate strategies to reduce nutrient losses and soil erosion is essential. Conservation tillage system includes low tillage and no-tillage that is the one of the useful methods to prevent this problem (Limousin and Tessier, 2007). The obtained results of an experiment in the Southern States, Ontario, Canada, showed that no-tillage system in comparing with the conventional tillage system reduces the 61 percent of the crop costs during a year (Weersink et al., 1992). Researchers say that in the no-tillage system in comparing with conventional tillage systems, more moisture stored in the soil. This moisture increasing in the conservation tillage is mainly the result of better penetration of water in the soil, evaporation and runoff decreasing (Opoku and Vun, 1997). The researchers stated that in the no-tillage system in comparing with the conventional tillage of soil crust, specific bulk density and soil compaction decreases (Hermowan and Cameron, 1993). Also the conservation tillage systems in comparing with conventional tillage increase the nutrients in the soil (Alvarez et al., 1995). Research results show that the tillage systems also effect on the plants yield. In the 5 year experiment, cotton yield in the first two years of the no-tillage system in comparing with the conventional tillage and disc and chisel were lower, but three years later, no-tillage system increases the yield and also more precocious of production in amount of 6 to 10 days in comparing with the conventional tillage systems (Triplett et al., 1996). Researchers the implementation of minimum tillage farming methods as a beneficial effect factor on the soil characteristics such as structure and increasing of the organic matter and production have been reported (Ismal et al., 1994). In general observed that crop cultivation can reduces soil organic matter especially if it is combined with conventional tillage and moldboard plow (Lampurlans et al., 2001). Conservation tillage can increase soil porosity and soil weakness and allow moving and appropriate exchange of air in the soil and increases root growth (Lapen et al., 2004).

Due to the plant residues as an input within the field in the nutrients supplying of plant need such as potassium and the importance of tillage as an appropriate strategy to reduce soil erosion and nutrient losses of this study to determine the effect of plant residues and conservation tillage difference with conventional tillage and provide the required elements on sugar beet plants were conducted.

MATERIALS AND METHODS

This experiment in the farming year at 2012-2013 in the research field at the phytopathology Research Institute Located on the Meshkindasht road of Karaj was conducted. Average annual rainfall of that area 250 mm and the average annual temperature, 16.2 ° C was observed. This experiment also as a split plot form in a randomized complete block design with three replications was conducted. Investigated treatments in this research were included the tillage operation at two levels of conservation and conventional tillage as the main factor and the use of different amounts of wheat plant residues at four levels of zero (control), 1, 3 and 5 tons per hectare as a subplot on the sugar.

To determine the physical, chemical characteristics, and to measure the situation and the amount of nutrients elements of it, the soil sampling was sent to the laboratory and mentioned characteristics were measured. The soil specifications in Table 1 are presented.

Table 1. Characteristics of the examined soil

Depth (cm)	Tissue	EC (ds/m)	pH	O.C (%)	N (%)	P (ppm)	K (ppm)
0-30	Loam	0.79	8.05	0.56	0.06	7.12	222

In order to apply the experimental treatments, the experiment map and privacy experimental plots were identified in autumn 2013. Wheat plant residues according to the desired values in the experimental plots were distributed manually. In December 2013, related plots to the conventional tillage by moldboard plow ploughed and then creation of plots was done. Plots in length of 10 meters and in width of 6 meters were observed and has 11 planting rows and between each plot was not planted a row. The distance between the blocks was 3 m and plant distance on each row of each other 20 × 50 cm with density 10 plants per m2. In this study, the modified sugar beet

seeds called Torbat figure was used, which was prepared by the Institute of plant and seed in Karaj. Cultivation of sugar beet seed at the first week of May of 2013 was conducted. After full emergence, 4-leaf stage of sugar beet thinning operation and gap filling to achieve the desired density was conducted and control plots of urea fertilizer was applied in three stages. Watering operation according to plant need was done.

The final of harvesting time to remove marginal effect of one meter from the beginning and end of each plot, were eliminated and the rest of the harvest was performed. The leaves and roots were separated and weighed separately and were placed in paper bags and in the oven at 75 ° C for 48 hours was dried. After that the samples were removed from the oven and weighed with a sensitive scale. The measured characteristics in the soil was included the food elements nitrogen (kejeldahl method), phosphorus (olsen method), and potassium (flame photometer method) (Abbasdokht and Chaichi, 2001).

In order to data analysis from the SPSS statistical software and for the data mean comparison from Duncan's multiple range test at the five percent probable level were used.

RESULTS

Leaf fresh weight: Variance analysis results (Table 2) showed that tillage type has significant effect at five percent probable on the leaf fresh weight but has not significant effect on the wheat residues and the interaction effect of tillage with wheat residues. The mean comparison results are influenced by tillage showed that leaf fresh weight in the conventional tillage in amount of (3167.01 kg per hectare) is more than conservation tillage in amount of (1495.72 kg per hectare) and caused a significant increase in leaf fresh weight that represents an increase in amount of 111.54 percent of leaf fresh weight in the conventional tillage in comparing with conservation tillage (Table 3). According to the mean comparison results of the interaction effect of tillage types with different levels of wheat residues, the most leaf fresh weight in amount of 4345.53 kg per hectare in the treatment without using of wheat residues in the conservation tillage and the lowest leaf fresh weight in amount of 1354.6 kg per hectare in the treatment in amount of 1 ton per hectare of wheat residues in the conservation tillage were obtained (Table 5).

Leaf dry weight: Variance analysis results (Table 2) showed that tillage type has significant effect at one percent probable on the leaf dry weight but has not significant effect on the wheat residues and the interaction effect of tillage with wheat residues. The mean comparison results of leaf dry weight are influenced by tillage factor showed that leaf dry weight in the conventional tillage in amount of (611.73 kg per hectare) and conservation tillage in amount of (322.32 kg per hectare) were obtained, on the other words leaf dry weight in the conventional tillage in amount of 89.79 percent was more than conservation tillage (Table 3). The mean comparison results of the leaf dry weight are influenced by tillage type and different levels of wheat residues showed that the most leaf dry weight in amount of (786.8 kg per hectare) in the treatment without using of wheat residues in the conservation tillage and the lowest leaf dry weight in different levels of wheat residues in the conservation tillage was obtained (table 5).

Root fresh weight: According to the variance analysis results between different types of tillage, wheat residues and the interaction effect of tillage with wheat residues were not obtained significant difference on the root fresh weight in the conducted experiments (Table 2).

Root dry weight: Variance analysis results showed that applied tillage on the root dry weight at the five percent probable has significant effect but wheat residues and the interaction effect of tillage with wheat residues have not significant effect on the root dry weight (Table 2). According to the obtained results from tillage mean comparison was found that the most root dry weight in amount of 3190.53 kg per hectare is related to the conventional tillage and the lowest root dry weight in amount of 1887.37 kg per hectare is related to the conservation tillage which represents the difference in amount of 69.05 percent conventional and conservation tillage in the root dry weight (Table 3). Also the mean comparison results of the interaction effect of tillage with wheat residues showed that the most root dry weight in amount of 3794.33 kg per hectare is related to the lack of wheat residues by using in the conventional tillage and the lowest root dry weight in amount of 1239.53 kg per hectare is related to the 3 ton per hectare of wheat residues using in the conservation tillage (Table 5).

Soil potassium: The obtained information of variance analysis results showed that wheat residues and the interaction effect of tillage with wheat residues at one percent probable have significant effect on the potassium but there was no significant effect in the tillage treatment (Table 2). The mean comparison results of influenced by wheat residues showed that the amount of potassium by increasing of wheat residues was decreased, so that the most amount of potassium (234.33 ppm) in the control treatment and the lowest amount of potassium (191.83 ppm) in the treatment of 1 ton per hectare of wheat residues was observed (Table 4). According to the potassium mean comparison that influenced by tillage kind and different level of wheat residues, the most potassium in amount of 254 and 254.67 ppm is related to the 5 ton per hectare of wheat residues in the conservation tillage and the absence of wheat residues in the conventional tillage was obtained (Table 5).

Soil phosphorus: The obtained information of variance analysis results showed that wheat residues and the interaction effect of tillage with wheat residues at one percent probable have significant effect on the phosphorus but there was no significant effect in the tillage treatment (Table 2). The mean comparison results of phosphorus that influenced by wheat residues showed that the phosphorus in amounts of 6.62 ppm and in the conservation tillage 6.26 ppm were observed that was indicted to the increasing of 10.54 percent in the conventional tillage (Table 3). According to the phosphorus mean comparison that influenced by tillage kind and different level of wheat residues, the most phosphorus in amount of (7.61 ppm) in lack of wheat residues treatment in conventional tillage was obtained (Table 5).

Soil nitrogen: The obtained information of variance analysis results showed that the main effects of tillage and wheat residues as well as the interaction effect of tillage with the main effects of tillage and wheat residues as well as the interaction of tillage with wheat residues had no significant effect on the nitrogen (Table 2).

Table2. Variance analyze results of tillage and wheat residues effects on the sugar beet yield and soil food elements

S.O.V	df	Leaf fresh weight	Leaf dry weight	Root fresh weight	Root dry weight	Soil potassium	Soil phosphorus	Soil nitrogen
Block	2	316.28^{ns}	40229.71^{ns}	2021.9^{ns}	238.73^{ns}	23.29^{ns}	0.13^{ns}	0.00004^{ns}
Tillage (a)	1	1674.36^{*}	18941.68^{**}	3574.1^{ns}	1006.22^{*}	54^{ns}	2.59^{**}	0.0000006^{ns}
Error	2	45.04	18941.68	2.97	35.18	332.38	0.05	0.00003
Wheat residues (b)	3	107.53^{ns}	29157.67^{ns}	195.91^{ns}	127.22^{ns}	2004.11^{**}	0.25^{ns}	0.000005^{ns}
a*b	3	42.81^{ns}	15805.34^{ns}	425.56^{ns}	55.52^{ns}	3104.78^{**}	2.98^{**}	0.00005^{ns}
Error	12	192.79	47420.45	775.46	179.37	60.28	0.13	0.00003
CV%		30.19	46.63	29.35	27.56	3.56	5.47	9.13

**, * and ns are significantly at 1%, 5% and not significant, respectively

Table3. The mean comparison of tillage effect on the sugar beet yield and soil food elements

Tillage	Leaf fresh weight ($kg.ha^{-1}$)	Leaf dry weight ($kg.ha^{-1}$)	Root fresh weight ($kg.ha^{-1}$)	Root dry weight ($kg.ha^{-1}$)	Soil potassium (ppm)	Soil phosphorus (ppm)	Soil nitrogen (%)
Conservation	1495.72^{b}	322.32^{b}	7318.93^{a}	1887.37^{b}	219.33^{a}	6.26^{b}	0.056^{a}
Conventional	3164.01^{a}	611.73^{a}	12250.63^{a}	3190.53^{a}	216.33^{a}	6.92^{a}	0.056^{a}

Each value is the mean of three replicates. Values followed by different letters in each column are significantly different at P≤5

Table4. The mean comparison of wheat residues effect on the sugar beet yield and soil food elements

Wheat residues ($ton.ha^{-1}$)	Leaf fresh weight ($kg.ha^{-1}$)	Leaf dry weight ($kg.ha^{-1}$)	Root fresh weight ($kg.ha^{-1}$)	Root dry weight ($kg.ha^{-1}$)	Soil potassium (ppm)	Soil phosphorus (ppm)	Soil nitrogen (%)
0	2973.8^{a}	567.3^{a}	8690.4^{a}	3144.43^{a}	234.33^{a}	6.23^{a}	0.056^{a}
1	1900.5^{a}	407.57^{a}	9428.4^{a}	2467.2^{a}	191.83^{c}	6.59^{a}	0.056^{a}
3	2522.37^{a}	455.43^{a}	9626.03^{a}	2307.77^{a}	224.67^{ab}	6.87^{a}	0.057^{a}
5	1922.78^{a}	437.8^{a}	11394.3^{a}	2236.4^{a}	220.5^{b}	6.38^{a}	0.056^{a}

Each value is the mean of three replicates. Values followed by different letters in each column are significantly different at P≤5

Table 5. The mean comparison of tillage and wheat residues effects on the sugar beet yield and soil food elements

Tillage	Wheat residues ($ton.ha^{-1}$)	Leaf fresh weight ($kg.ha^{-1}$)	Leaf dry weight ($kg.ha^{-1}$)	Root fresh weight ($kg.ha^{-1}$)	Root dry weight ($kg.ha^{-1}$)	Soil potassium (ppm)	Soil phosphorus (ppm)	Soil nitrogen (%)
Conservation	0	1602.07^{ab}	347.8^{b}	10087.47^{a}	2494.53^{ab}	214^{b}	5.44^{c}	0.054^{a}
Conservation	1	1354.6^{b}	303.27^{b}	7699.67^{a}	2123.33^{ab}	188.33^{c}	5.9^{c}	0.052^{a}
Conservation	3	1652.67^{ab}	321.4^{b}	4886.47^{a}	1239.53^{b}	221^{b}	6.82^{b}	0.058^{a}
Conservation	5	1373.53^{b}	316.8^{b}	6602.13^{a}	1692.07^{ab}	254^{a}	6.89^{b}	0.058^{a}
Conventional	0	4345.53^{a}	786.8^{a}	12701.13^{a}	3794.33^{a}	254.67^{a}	7.61^{a}	0.058^{a}
Conventional	1	2446.4^{ab}	511.87^{ab}	11157.13^{a}	2811.07^{ab}	197.33^{c}	7.28^{ab}	0.058^{a}
Conventional	3	3392.07^{ab}	589.47^{ab}	14365.6^{a}	3376^{ab}	228.33^{b}	6.91^{b}	0.056^{a}
Conventional	5	2472.03^{ab}	558.8^{ab}	10778.67^{a}	2780.73^{ab}	187^{c}	5.87^{c}	0.052^{a}

Each value is the mean of three replicates. Values followed by different letters in each column are significantly different at P≤5

DISCUSSION

In one study suggested that the main reason to reducing the soil content elements is the addition of large amount of plant wheat residue. Soil organic matter is the main energy source for soil microorganisms. Soil microorganisms to continue activity in addition to carbon, needs to the nitrogen and nutrients that provides these food elements from the soil and by increasing soil organic carbon and intensified microorganisms activity, their needs to the food elements was increased and a large amount of soil food elements are absorbed by them. Also the reason of lack of wheat residue effect on phosphorus and nitrogen into the wooden and declared a long time to rote residue (Due Preez et al., 2001). In the no till system and the tillage farming system, the water infiltration due to the pores existence which is formed by soil creatures can be increased. In the no till system and the tillage cropping system, deep gaps are formed in the soil that these gaps also can help to increase the soil moisture storage (Meek et al., 1990). Researchers (Wright and Hons, 2005) also reported that the using of no-tillage methods caused a significant increase in the aggregates, organic carbon and nitrogen amounts in the soil. Researchers (Ismail et al., 1994) implementation of minimum tillage farming method considered as a factor that has beneficial effects on soil characteristics such as improving the structure and increasing the organic matter and production have reported. The increasing of volumetric soil moisture holding capacity in the no tillage system and the minimum tillage crop by (Cox et al., 1990) has been reported. According to (Ossible et al., 1992) underlay compaction of the soil and to become thicker and shorter of roots in the soil compression area reduces grain and straw yield in no tillage system. About the increasing of qualitative and quantitative yield, there are some reports in the tillage systems in comparing with the conventional tillage. Researchers (wright et al., 2007) stated that the yield increasing in the low tillage systems in comparing with the conventional tillage has more accessible to phosphorus and nitrate at the soil surface. Zabilske et al., 2002) reported that in the low tillage system, physical, chemical and biological characteristics in the soil surface and in the root activity region is improved and due to change in mineralization and more stability of the nutrient in the soil by increasing the activity of the microbial population, the supply of nutrients to plants was increase (wright et al., 2005). No tillage system reduces the erosion and runoff and increase water infiltration in the soil and supply more moisture for plants increases the organic matter in the soil surface and in addition, causes the availability of nutrients for plants (Waddell and Weil, 2006; Fang et al., 2003). The study (2010) Suddick et al., Show that the use of rice residues with different tillage treatments on wheat yield components has been effective which has not correspond with the obtained results in the experiment.

Tillage operation effects on biological activity, access to food sources, receiving, storage and transport of water in the soil, erosion resistance, hydraulic conductivity, ventilation, soil heat and also by releasing the nutrients effect on the plant growth and production and mechanical resistance of the soil (Lopez-Fando & Almendros, 1995; Malicki et al., 1997; Mikanova et al., 2009). According to beer et al., (1994) researches, the conventional tillage cause the more and faster of plant residues decomposition and the available carbon and nitrogen in the organic matter that turned to the mineral very fast and therefore the organic matter is lost faster. In a study, the effect of different methods of tillage on corn growth was evaluated. The results showed that the maximum amounts of growth and corn plant emergence in conventional tillage (moldboard plowing) and the transition or displacement methods in amount of 30 cm from the seed establishment place is more than the without plowing (no tillage). They the reason of this issue, the high temperatures in the plowed area (20 cm depth) and seed establishment place (5 cm depth) was noted (Azooz et al., 1995).

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