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The Effects Wheat Plant Residues Management, Sugar Beet Quantitative and Qualitative Characteristics under Conservation and Conventional Tillage Systems

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ABSTRACT

In order to investigate the effect of tillage kinds and wheat residues and their interactions on qualitative and quantitative yield sugar beet, an experiment in a split plot design 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 sub factor residues of wheat in 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 at the five percent probable on the leaf fresh weight, root dry weight and potassium has a significant effect, but on the root fresh weight, sodium, harmful nitrogen, sugar content, alkalinity, sugar molasses has not meaningful effect. Also the wheat residues and interaction effect of tillage with wheat residues had no significant effect on the measured parameters. The obtained results of mean comparison showed that the conventional tillage causes more leaf fresh weight, leaf dry weight and root dry weight and lower sodium than conservation tillage.
KEYWORDS: alkalinity, tillage, sugar beet, sugar molasses, 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). The quality of sugar beet is not a single attribute that can be quantified only by a number. The quality of the combination sugar beet is caused by all chemical and physical aspects that effect on the process of production, sugar performance and side products of it. The quality in the sugar beet determined by criteria that the most important of these include the impure sugar percent, pure sugar percent or recoverable, and syrup purity, the amount of nitrogen, sodium and potassium elements, sugar molasses and alkalinity (Harvey and Dutton, 1993). Researchers are working to develop sustainable growth of sugar beet production and to minimize any threat that depends on environment (Draycott, 2006). To provide practical methods seems essential for increasing the efficiency of farms. Such as wheat strategies in the sustainable agricultural can be mentioned to the plant residues management. The return of plant residues to the soil, especially in arid and semi-arid soils is the important pillars and inevitable of the sustainable agricultural systems. Maximization issue of the wheat performance through overuse of chemical inputs and high costs in the production of this wheat over the past 50 years has always been the policy of the dominant production methods in different countries. Experts and the agricultural science analysts have found the appropriate way to integrate technology and conservation of natural resources thereby creation of favorable the field for optimal utilization of available resources, reduce environmental problems and the possibility of increasing the amount of yield in the unit area and provide greater profitability in agriculture (Rathke et al., 2004). Burning or removal of plant residues can facilitate tillage operations but straw burning damage to beneficial microorganisms as well as cause the erosion of soil. Unlike the remaining wheat residues on the soil surface, reduces the soil erosion and improves physical and chemical characteristics and biological soil (Logsdon and Karlen, 2004). Raison (1979) observed that the in the farms, in effecting of burning residues a large amount of carbon, nitrogen and sulfur remaining in the residues disappears during the progression operation. But researchers (Haynes and Bears, 1996) stated that the use of conservation tillage in such fields increased organic matter and therefore caused the fertility of soil. Burning or removal of plant residues can facilitate tillage operation but straw burning damage to beneficial microorganisms as well as cause the erosion of soil. Unlike the remaining plant residues on the soil surface, the soil erosion is reduced and improves physical, chemical and biological soil characteristics (Logsdon and Karlen, 2004). In fact the key objectives are following in tillage include growing, creating a more favorable environment for root penetration, proper soil drainage, and weed control (Barzegar et al., 2004) as well as environmental protection and

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development of it as an environment for plant growth and more performance in the long-term in that in order to achieve this goal due to its great importance in the wet or dry tropical soils is difficult (Ania et al., 1991). Tillage effects on the important part of soil characteristics such as temperature, storage and distribution of moisture in the soil as well as the soil compaction (Lampurlanes et al., 2001). Therefore, by selection and implementation of tillage system and the proper effects on soil physical characteristics, a proper seed bed in order to plant emergence, growth and development of it and finally, to obtain the high performance can provide (Licht and AL-Kaisi, 2005). Lal in 1991 indicated that balanced tillage is a powerful tool to overcome some of the limitations of soil and leads to increase the production of wheat. It is generally observed that wheat cultivation can reduce 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 also allow proper air movement and exchange in the soil and cause enhancing of the root growth (Lapen et al., 2004). The effect of different tillage methods on corn yield and soil characteristics was investigated the wheat plant residues management effects (burning and leaving residues) with three tillage methods (conventional tillage, low tillage and minimum tillage). The results showed that the yield in the tillage treatments has reduced and conventional tillage has obtained the most grain yield and plant height and leaving the treatment residues, seed yield, and thousands seed weight and more organic material was obtained (Najafinezhad et al., 2007). Researchers compared two low tillage and conventional methods on soil parameters and sugar beet yield. Conventional tillage by moldboard plow and one time disc and low tillage by chisel plow and once disc operation was performed. After two years of experiments results showed that the soil resistance in conventional tillage method has significant difference in comparing with low tillage. Also soil especial apparent density was reduced in conventional tillage. The final results showed that the increasing of 30 percent of sugar beet yield in conventional tillage methods is associated with providing the better substrate conditions (Gyuricza et al., 1999).

By considering the impurities in the roots reduces the technical quality of sugar beet and the amount of the obtained sugar in the factory and in this respect, profits from agriculture reduces this plant, one goal of this study was to investigate the changes in the amount of impurities and consequently of it, is the amount of sugar molasses in the root through sustainable agriculture.

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 m^2. 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 in 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. In the sugar laboratory, the modification institute of sugar beet seed and seedlings, sugar content percent, the amounts of sodium, potassium and harmful nitrogen (according to the meq per one hundred g sugar beet root pulp) were determined.

To calculate the percentage of sugar molasses in 1974 to 1995 from Raynfld formula was used that this formula is as follows:

Sugar molasses percent: 0.343(Na+K) + 0.094AmN + 0.29

In this formula, Na the harmful sodium, k the harmful potassium and AmN the harmful nitrogen was observed.

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 remnants 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 remnants 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).

Sodium, potassium and harmful nitrogen: Obtained information of the variance analyze results showed that tillage has a significant effect on the potassium at five percent probable but has not significant effect on the sodium and harmful nitrogen. Also in effect of wheat residues and the interaction effect of tillage with wheat residues were not observed a significant effect on the sodium, potassium and harmful nitrogen (Table 2). The potassium mean comparison influenced by tillage showed that the amount of potassium in the conservation tillage is more than conventional tillage, in other words the amount of potassium in the conservation tillage 9.48 percent is more than conventional tillage (Table 3).

Sugar content, alkalinity, sugar molasses: The obtained results of variance analyze showed that the main effects of tillage and wheat residues and also the interaction of tillage with wheat residues have not a significant effect on the sugar content, alkalinity, sugar molasses (Table 2).

Table 2. Variance analysis results of tillage effect and wheat residues on the quantity and quality characteristics of the sugar beet

S.O.V	df	Leaf fresh weight	Leaf dry weight	Root fresh weight	Root dry weight	Sodium	Potassium	Harmful nitrogen	Sugar content	Alkalinity	Sugar molasses
Block	2	316.28^{ns}	40229.71^{ns}	2021.9^{ns}	238.73^{ns}	0.21^{ns}	0.71^{*}	0.09^{ns}	1.98^{ns}	15.28^{ns}	0.19^{ns}
Tillage (a)	1	1674.36^{*}	18941.68^{**}	3574.1^{ns}	1006.22^{*}	0.05^{ns}	1.27^{*}	0.001^{ns}	4.95^{ns}	11.17^{ns}	0.22^{ns}
Error	2	45.04	18941.68	2.97	35.18	0.74	1.45	0.35	4.32	44.38	0.65
Wheat residues (b)	3	107.53^{ns}	29157.67^{ns}	195.91^{ns}	127.22^{ns}	0.21^{ns}	0.22^{ns}	0.05^{ns}	0.51^{ns}	13.75^{ns}	0.06^{ns}
a*b	3	42.81^{ns}	15805.34^{ns}	425.56^{ns}	55.52^{ns}	0.05^{ns}	0.11^{ns}	0.1^{ns}	1.75^{ns}	7.25^{ns}	0.03^{ns}
Error	12	192.79	47420.45	775.46	179.37	0.17	0.15	0.05	2.94	6.25	0.08
CV%		30.19	46.63	29.35	27.56	35.15	8.31	23.24	10.5	30	15.32

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

Table 3. The mean comparison of tillage effect on the quantity and quality characteristics of the sugar beet

Tillage	Leaf fresh weight ($kg.ha^{-1}$)	Leaf dry weight ($kg.ha^{-1}$)	Root fresh weight ($kg.ha^{-1}$)	Root dry weight ($kg.ha^{-1}$)	Sodium ($mM.100\ gr^{-1}$)	Potassium ($mM.100\ gr^{-1}$)	Harmful nitrogen ($mM.100\ gr^{-1}$)	Sugar content (%)	Alkalinity	Sugar molasses (%)
Conservation	1495.72^{b}	322.32^{b}	7318.93^{a}	1887.37^{b}	1.22^{a}	4.96^{a}	0.907[a]	16.77^{a}	9.01^{a}	1.89^{a}
Conventional	3164.01^{a}	611.73^{a}	12250.63^{a}	3190.53^{a}	1.13^{a}	4.49^{b}	0.914	15.86^{a}	7.65^{a}	1.7^{a}

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

Table 4. The mean comparison of wheat residues on the quantity and quality characteristics of the sugar beet

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 ($kg.ha^{-1}$)	Sodium ($mM.100\ gr^{-1}$)	Potassium ($mM.100\ gr^{-1}$)	Harmful nitrogen ($mM.100\ gr^{-1}$)	Sugar content (%)	Alkalinity	Sugar molasses (%)
0	2973.8^{a}	567.3^{a}	8690.4^{a}	3144.43^{a}	1.22^{a}	4.79^{a}	0.86^{a}	16.7^{a}	8.26^{ab}	1.83^{a}
1	1900.5^{a}	407.57^{a}	9428.4^{a}	2467.2^{a}	1^{a}	4.86^{a}	0.68^{a}	15.99^{a}	9.64^{a}	1.76^{a}
3	2522.37^{a}	455.43^{a}	9626.03^{a}	2307.77^{a}	1.07^{a}	4.44^{a}	1.18^{a}	16.27^{a}	6.23^{b}	1.69^{a}
5	1922.78^{a}	437.8^{a}	11394.3^{a}	2236.4^{a}	1.41^{a}	4.81^{a}	0.93^{a}	16.29^{a}	9.19^{ab}	1.91^{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 effect and wheat residues on the quantity and quality characteristics of the sugar beet

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 ($kg.ha^{-1}$)	Sodium ($mM.100\ gr^{-1}$)	Potassium ($mM.100\ gr^{-1}$)	Harmful nitrogen ($mM.100\ gr^{-1}$)	Sugar content (%)	Alkalinity	Sugar molasses (%)
Conservation	**0**	1602.07^{ab}	347.8^{b}	10087.47^{a}	2494.53^{ab}	1.28^{a}	4.82^{a}	1.01^{a}	17.1^{a}	7.9^{a}	1.88^{a}
Conservation	**1**	1354.6^{b}	303.27^{b}	7699.67^{a}	2123.33^{ab}	1.08^{a}	5.18^{a}	0.73^{a}	16.18^{a}	10.55^{a}	1.91^{a}
Conservation	**3**	1652.67^{ab}	321.4^{b}	4886.47^{a}	1239.53^{b}	0.97^{a}	4.73^{a}	0.72^{a}	16.27^{a}	8.37^{a}	1.72^{a}
Conservation	**5**	1373.53^{b}	316.8^{b}	6602.13^{a}	1692.07^{ab}	1.53^{a}	5.09^{a}	1.17^{a}	17.52^{a}	9.24^{a}	2.07^{a}
Conventional	**0**	4345.53^{a}	786.8^{a}	12701.13^{a}	3794.33^{a}	1.16^{a}	4.75^{a}	0.7^{a}	16.3^{a}	8.62^{a}	1.78^{a}
Conventional	**1**	2446.4^{ab}	511.87^{ab}	11157.13^{a}	2811.07^{ab}	0.91^{a}	4.54^{a}	0.62^{a}	15.8^{a}	8.73^{a}	1.61^{a}
Conventional	**3**	3392.07^{ab}	589.47^{ab}	14365.6^{a}	3376^{ab}	1.16^{a}	4.15^{a}	1.63^{a}	16.27^{a}	4.1^{a}	1.66^{a}
Conventional	**5**	2472.03^{ab}	558.8^{ab}	10778.67^{a}	2780.73^{ab}	1.29^{a}	4.54^{a}	0.7^{a}	15.07^{a}	9.13^{a}	1.76^{a}

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

DISCUSSION

About the increasing of quality and quantity yield in the tillage systems in comparing with the conventional tillage have been some reports. 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. Also (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). 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. They believe that the reduction in yield is directly affected by the lack of oxygen or moisture and nutrient availability. Reports (Elliot et al., 1977) also suggest that the yield in the agriculture without irrigation and irrigation in the plow system by chisel plow have not significant difference between conventional tillage (plowing with moldboard plow). The study (2010) Suddick et al., Show that the use of rice residues with different tillage treatments on wheat yield components has been effective. Researchers (Karlen and Gooden, 1987) also were examined the effects of different tillage in wheat production, the result was that the average yield of wheat in moldboard plow has significant increase in comparing with the use of disc but in comparing with the chisel plow only in one of the five study case has significant effect. Das and Maity (1983) in their research based on the tillage effect after rice harvest on the wheat yield concluded that in terms of the number of grains per panicle, grain and straw yield was observed the significant differences between treatments. 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). The factors contributing in the plant residues decomposition can be to the combination of plant residues such as the C: N ratio (Recous et al., 1995), total nitrogen amount, (Frankenberger & Abdelmajed, 1985), the amount of soluble carbon in the residues (Kuo & Sunjo, 1998; Oglesby and Fownes, 1992), or residues lignin content (Muller et al., 1998) was indicated. In these study wheat residues with the above C: N ratio was decomposed very slowly that by (Edward et al., 1998) results were correspond.

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