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Evaluation of Microbial Biomass and Soil Carbon as Well as Weed Parameters on Potato Production Affected Different Weed Management

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ABSTRACT

BACKGROUND: Application of plant mulches plays a significant role in development and expansion of sustainable farming systems.
OBJECTIVES: Assessment effect of chemical and non-chemical weeds management methods on weeds density and biomass and the properties of soil, including microbial biomass carbon (MBC) and soil organic carbon (SOC) in potato cultivation.
METHODS: Research was conducted in 2015 in two agricultural research stations of Alarogh and Samian in Ardabil city according randomized complete block design with three replications. The treatments included: 1) Trifluralin herbicide (TR), 2) Metribuzin herbicide (ME), 3) cultivator practice (CU), 4) wheat straw mulch (WH), 5) canola straw mulch (CA), 6) black plastic mulch (BPL), 7) transparent plastic mulch (TPL), 8) weed infested (WI), and 9) weed free (WF). Soil sampling was conducted at three stages. The first stage included control index sampling (CIS). The second and third soil sampling performed at 25 and 45 day after the treatment application.
RESULT: All treatments were affected by weed management methods ($P \leq 0.01$). The lowest density of weeds was related to the WH. Most weeds density was counted as 99.1 plants.m^{-2} of WI treatment. The WH deceased weeds density as 84% compared to weed infested. CA treatment deceased weeds density as 79% compared to WI treatment. Though, weed biomass in the treatments of transparent and BPL compared to the WI treatment had the highest weeds biomass as 48 and 40%, respectively. The lowest weed biomass was observed in CA and WH by 16 and 18% after the WI.
CONCLUSION: The highest rate of MBC observed in WH and CA treatments at the second and the third soil sampling stages, respectively, compared with other experimental treatments. WH and CA increased the rate of MBC in the second and the third sampling stages in comparison with CIS. The highest SOC was observed in WH and CA at the second and the third soil sampling stages.

KEYWORDS: *Herbicide, Mulch, Organic carbon, Tuber yield.*

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1. BACKGROUND

The capability of weed community to change in response to management practices in general and chemical methods in particular highlights the necessity of integrating and presenting various weed management methods. Applying a combination of appropriate management methods can lead to greater environmental confidence in implementation of herbicides as well as other methods to obtain effective weed control (Buhler *et al*., 2000). The weed management is carried out with agricultural, mechanical, chemical or combination methods in potato cultivation in most countries in the world (Hutchinson *et al*., 2011; Kunz *et al*., 2015; Weber *et al*., 2016). Currently, application of mulches can be considered as one of the weed management methods, which can be used to prevent or reduce the growth of weeds. Furthermore, application of plant mulches plays a significant role in development and expansion of sustainable farming systems (Rashed Mohassel *et al*., 2000). Metribuzin is used in potato fields before of planting and pre-emergence in potato, for control of annual grass and broad leaf weeds (Zand *et al*., 2007; Zaki *et al*., 2014). The use of Trifluralin is effective as pre- emergence for weed control of potato crop (Sheikhi *et al*., 2012; Borzouei *et al*., 2013). Application of cultivator along or with herbicide can control of weeds effectively and it used as one of the major methods of weed control in potato farms (Mohammaddoust *et al*., 2011). Application of herbal residues or plant mulch has a great importance to develop and expand sustainable farming systems. The need to increase farm productivity and profitability is a factor that stimulates the development of methods based on the ecological management of weeds. Considering that in industrialized countries as well as developing countries, increasing the inputs cost has been more than the products cost, so that has been endangered the economic support for farmers. If the better ecological process is used in weed management, agricultural income will be increased by reducing the inputs cost and this topic helping farmers to provide market friendly agricultural products (Dejam *et al*., 2010; Jafari *et al*., 2013; Najafi *et al*., 2016). Specifically, when using a weed control method, the competition of weeds with crop plants is reduced and as a result the use of other methods (as chemical control) to weed control is reduced. A good number of studies have reported that application of any weed management methods or any types of crop management methods usually affect many soil biological and chemical properties, though with varying degrees (Diekow *et al*., 2005; Ogle *et al*., 2005; Wright and Hons, 2005). Most of the soil microorganisms are sensitive to the management changes in the environment such as the changes occurring due to crop and weed management (Hernandez *et al*., 1997). As the role of soil microbial biomass in changing the soil organic matter has been definitely proved, soil microbial biomass is often employed in the circulation and mineralization of the organic precursors (Luo *et al*., 2015; Leite *et al*., 2010). Researchers apply the changes in microbial biomass carbon as an indicator of soil fertility and ecological conditions of the environment (Boerner *et al*., 2000).Such operations as tillage, fertilization, crop rotation, and application of various cover crop types, which affect the properties of soil, can influence soil microbial diversity, microbial dynamics, microbial biomass, and status of soil microorganisms (Kumar *et al*., 2014; Zhang *et al*., 2012). The tillage could affect nutrient cycling, soil organic matter, and microbial activity by changing the temperature and humidity conditions of soil. The above-mentioned changes depend on the type and intensity of tillage (Roldan *et al*., 2005). Moreover, utilizing plastic mulch in a variety of crop management methods could affect the chemical and biological properties of soil (Zhang *et al*., 2015). In Iran, very few scientific studies are conducted concerning the effect of various methods of weed management on microbial biomass soil organic carbon. Considering the crucial role of weed or crop management methods in improvement or degradation of soils in Iranian context and the role played by plant waste management in providing sustainable agriculture.

2. OBJECTIVES

The present study aimed at evaluating the effect of various weed management methods such as the application of crop residues mulch, plastic mulch, tillage, and herbicide on weeds density and biomass and the soil microbial activity and community.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

The experiment conducted in 2015 at two stations: 1. Alarogh Agricultural Research Station in Ardabil Province, Iran with an altitude of 1350 meters above sea level, a longitude of 48°, 20', a latitude of 38°, 15', a semi-arid and cold climate, and a soil pH of 7.6, and 2. Samian Agricultural Research Station in Ardabil Province, Iran with an altitude of 1320 meters above sea level, a longitude of 48°, 15', a latitude of 38°, 23', a semi-arid and cold climate, and a soil pH of 7.5-8. Two areas of Alarogh and Samian in Ardabil province are major areas under potato cultivation and many researches are being made on potato crop in these areas. Laboratory measurements were performed at the faculty of agricultural sciences and natural resources, university of Mohaghegh Ardabili, Ardabil, Iran. Current research carried out according randomized complete block design with three replications. The treatments included: 1) Spraying Trifluralin herbicide on the soil between the rows of potato plants (75% EC was formulated with the amount of 2 $L.ha^{-1}$ by the Matabi model with an 8001 nozzle and the constant speed and pressure of sprayer in all treatments based on the 250 $L.ha^{-1}$ spraying; thus, the Trifluralin was mixed with soil at the depth of 0-10 cm) immediately after the second hilling of potato plants 45 days after planting the potatoes. 2) Spraying Metribuzin herbicide on the soil between the rows of potato plants with the amount of 1000 $gr.ha^{-1}$ (with the formulation of 70% WP and sprayer specification such as the sprayer used for Trifluralin herbicides) immediately after the second soil hilling of potato plants 45 days after planting the potatoes. 3) Cultivator practice once for 20 days after the second hilling of potato plants 65 days after planting the potatoes. 4) Wheat straw mulch with the amount of 5 $t.ha^{-1}$ and thickness of 15 cm immediately after the second soil hilling of potato plants 45 days after planting the potatoes. 5) Canola straw mulch applied similar to WH treatment. 6) The application of black plastic mulch, covering the space between the rows with plastic sheets with the thickness of 50 microns immediately after the second soil hilling of potato plants 45 days after planting the potatoes in the plot or row. 7) The application of transparent plastic mulch was similar to that of BPL treatment. 8) Weed infested or no weed removal in the entire growing season.

9) Weed free or weed removal in the entire growing season in both stations.

3.2. Farm Management

The land was prepared for planting by secondary plowing immediately after favorable weather and soil conditions. On 5th June 2015, potato tubers (a variety of Agria) were hand-planted in rows, between which there was a distance of 75 cm and a distance of 25 cm on the ridge (the distance between the tubers planted on the planting row in each plot). Each plot had an area of 3 × 3.5 m. After selecting the locations of experiment and before the preparation actions, 10 points of each farm soil were randomly sampled to provide composite samples and to analyze soil. Then, based on the results of soil analysis, fertilization was performed with application of phosphate fertilizers (Triple superphosphate with amount of 178 $kg.ha^{-1}$ at two steps based on recommendation of research stations, 50 percent at planting time and 50 percent during the formation of tubers) and nitrogen (urea with amount of 300 $kg.ha^{-1}$ at three times, 25 percent during potato planting, 50 percent during emergence and 25 percent immediately after formation of tubers). Irrigation was also conducted after the first step of soil irrigation and emergence of plants with a 7-day interval. Two potato hilling steps were done for at the base of plants using a hoe at 25 and 45 days after potato planting, respectively.

3.3. Measured Traits

In the end of the growing season and a month before harvesting potato tubers (September), the weeds were sampled according to species and were counted. Weed sampling were performed in each plot with dimensions of 0.5 × 0.75 square cm of the soil surface and were transported to the laboratory. After counting the number of plants by species, shoots of weed of each species were separately and put in special bags and placed at oven for 72 hours at 75 °C and after drying completely, its were weighed with a balance with precision of 0.001g. Before performing statistical analysis and for data uniformity, conversion of $\sqrt{x} + 0.5$ was used for data related to density and dried weight of weed. In order to determine the potato yield, after completion of the growing season and ripening potato tubers, the middle two rows of plants (inside plots) were collected during a meter entirely. The sampling of soil performed in three stages. First sampling stage was the index-sampling (CIS) performed immediately before applying any treatments. The procedures in the first sampling stage were as follows: 5 samples were collected from each station (the samples were collected at the points of W from each station) and combined as one sample (combined data) to be compared with the samples collected from the following two sampling stages. The second sampling stage was conducted one month after applying the treatments (55 days after planting the potatoes). The third sampling stage was executed two months after applying the treatments (75 days after planting the potatoes). In the second and the third sampling stages, three soil samples were collected from a depth of 0-5 cm from different points of each plot (treatment) and subsequently mixed. All samples were collected, packaged in plastic bags, placed within the flasks containing ice, and transferred to laboratory. The samples were kept (a maximum of 7 days) in the thermal conditions of 4°C in darkness until the biological and chemical properties were measured. In order to determine the physical and chemical properties of soil, a portion of the soil collected was air-dried in the laboratory. Microbial biomass carbon (MBC) measured using the fumigation-extraction method (Wu *et al*., 1990). In summary, the first wet soil sample, 20g dried soil, was extracted from 40 mL of 0.5 M (Molar) K_2SO_4, shaken for 30 min, and refined in a vacuum extraction system by applying Whatman filter paper (No. 42). The second wet soil sample, 20-g dried soil, was fumigated by K_2SO_4 for 48h rather than being extracted by 40 mL of 0.5 M K_2SO_4 which was employed in the previous soil sampling preparation. To determine the level of carbon dissolved, the samples extracted were kept frozen until the time of analysis. Extractable carbon was measured, using Shimadzu total soil organic carbon analyzer. Moreover, MBC was measured by considering the disparity of organic carbon values between the fumigated and control samples and was differentiated by a Kec-factor of 0.45 (Yao *et al*., 2000). Soil organic carbon (SOC) specified using a dichromate or K_2CrO_4 oxidation and was then titrated by standard ferrous solution (Lu, 2000).

3.4. Statistical Analysis

Combined analysis of variance and mean comparisons were done by SAS (Ver.8) software and Duncan multiple range test at 5% probability level.

4. RESULTS AND DISCUSSIONS

4.1. Potato Tuber Yield

Potato yield significantly affected (P≤ 0.01) by application of treatments in the experiment (Table 1 and Fig. 1) except transparent plastic mulch treatment. The highest potato tuber yield in experiment obtained at weed free treatment that compared to the treatments of plant mulch, cultivator, herbicides and black plastic mulch were not significantly different but the transparent plastic mulch was significantly different compared to weed free treatment and transparent plastic mulch had the lowest tuber yield (19.3 $t.ha^{-1}$) after the weed infested treatment (6.6 $t.ha^{-1}$). The lowest tuber yield (83%) was related to weed infested treatment and then transparent plastic mulch (47%), and weed infested treatment was not significantly different with transparent plastic mulch (Fig. 1), It seems that this is related to the lack of proper control of transparent plastic mulch to repress weeds in the experiment region in present study (Jafari *et al*., 2013; Majd *et al*., 2014). Majd *et al*. (2014) applied also plastic mulch, herbicide and cultivator to control weeds, Mohammadduost Chamanabad *et al*. (2011) reported same result.

Table 1. Combined analysis of variance of the effects of treatments on tuber yield of potato

S.O.V	df	Potato tuber
Station	1	4.5^{ns}
Replication (Station)	4	0.5
Treatments	8	8.0^{**}
Rep. × Treat.	8	1.1^{ns}
Error	32	1.5
CV	-	4.91

^{ns},**, *: non-significant, significant at 1 % and 5% probability level, respectively.

4.2. Weed Density

In present study, the treatments had a significant effect (P≤ 0.01) on weeds density in both stations (Table 2) so that the lowest total weeds density was obtained in wheat straw mulch and then, Metribuzin herbicide. The maximum total weeds density was counted as 99.1 plants per square meter in the weed infested treatment and the lowest total weeds density were related to the wheat straw mulch as 15.5 plants per square meter (Fig. 2). Total weed density decreased by about 84% under influence use of wheat straw mulch comparing to weed infested treatment (Fig. 2).

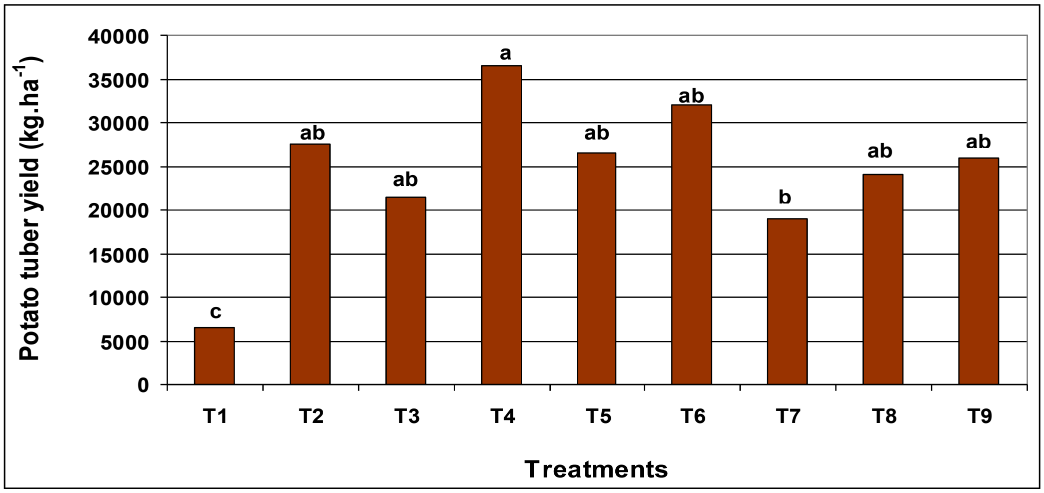

Fig. 1. Effect of treatments on potato tuber yield via Duncan test at 5% probability level. T_1: Weed infested, T_2: Cultivator, T_3: Canola straw mulch, T_4: Weed free, T_5: Wheat straw mulch, T_6: Metribuzin, T_7: Transparent plastic mulch, T_8: Black plastic mulch, T_9: Trifluralin.

Table 2. Combined analysis of variance of the effects of treatments on weeds biomass and density in potato cultivation

S.O.V	df	Weed biomass	Weed density
Station	1	3.3^{ns}	1.5^{ns}
Replication (Station)	4	22.2	2.3
Treatments	7	56.1^{**}	21.3^{**}
Rep. × Treat.	7	5.1^{ns}	0.8^{ns}
Error	28	8.5	1.4
CV	-	30.6	20.1

^{ns},**, *: non-significant, significant at 1 % and 5% probability level, respectively.

Canola straw mulch also decreased total weed density comparing to weed infested treatment by about 79% so that weed density difference in canola straw mulch compared to weed infested treatment was significant at ($P \leq 0.01$) (Table 2), however in terms of reducing the number of weeds it was less successful than wheat straw mulch, although this difference between two mentioned treatment was not significant (Fig. 2). Decrease of weed density in plant mulch treatments, may be because of inhibition of weed germination and growth at this stage of potato growth or as result of the release of Allelopathic substance, the results of the research of many researchers (Dhima *et al*., 2006; Judice *et al*., 2007) also showed that plant mulches prevent weed germination or growth by preventing of light or the release of Allelopathic materials. Herbicides had a significant effect at ($P \leq 0.01$) on weeds density in present study (Table 2). Total weed density was lower in Metribuzin and Trifluralin treatments compared to the weed infested treatment (Fig. 2). Total weed density in Metribuzin and Trifluralin treatments was less than the weed infested treatment as 72 and 69%, respectively. So that the Metribuzin herbicide treatment after wheat straw mulch had the greatest effect in reducing weed density in potato cultivation and showed a better effect than the Trifluralin herbicide treatment to prevent from germination and growth of weed during the cultivation period, it had no significant differences with mentioned treatments in terms of reducing weed density.

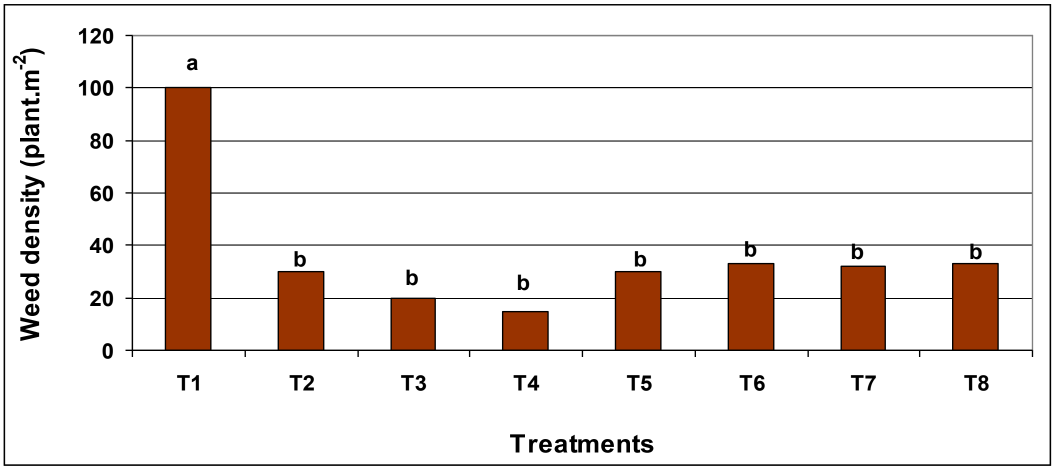

Fig. 2. Effect of treatments on total weed density via Duncan test at 5% probability level. T_1: Weed infested, T_2: Cultivator, T_3: Canola straw mulch, T_4: Wheat straw mulch, T_5: Metribuzin, T_6: Transparent plastic mulch, T_7: Black plastic mulch, T_8: Trifluralin.

Channappaguar *et al.* (2007) showed among herbicides of Alachlor, Pendimethalin, Diuron and Metribuzin, Metribuzin had maximum efficiency in controlling broadleaf and grass weeds of potato cultivation because effectively prevents of weeds germination. Black and transparent plastic mulch significantly controlled total weed density, black color of plastic prevents reaching full light to light-dependent weeds for their germination and this point indicates inhibitory effect of black plastic on germination of weeds (Majd *et al.*, 2014). Application of Poaceae mulches effectively prevents weeds seeds germination (Maldonado *et al.*, 2001; Shiyam *et al.*, 2011; Didon *et al.*, 2014).

4.3. Weed Biomass

Application of herbicides had a significant effect on weeds biomass at ($P \leq 0.01$) (Table 2). Weed biomass in transparent and black plastic mulch treatments were 120.3 and 101.7 $gr.m^{-2}$, respectively had maximum biomass values comparing to weed infested treatment (250.92 $gr.m^{-2}$) (Fig. 3), however application of plastic mulches had not significant difference to herbicides and plant mulches treatments. Least amount of weed biomass observed in wheat and canola mulches treatments and it was found these treatments can reduce weed biomass compared to weed infested treatment by rate of 83% and 81% decrease, and reflects ability of plant residues in suppressing weeds and preventing their growth as well as preventing spread of weeds and reducing crop yield (Duppong *et al.*, 2004). Herbal mulches are not only affect soil but can affect properties such as germination, growth and competitive ability of weed and crops (Majd *et al.*, 2014; Pawlonka *et al.*, 2015; Azadbakht *et al.*, 2017).

4.4. Microbial Biomass Carbon

Amount of Microbial biomass carbon was affected by treatments administration (Tables 3 and 4). Highest Microbial biomass carbon obtained in both second and third sampling stages treatments. Wheat and canola straw mulch treatments could increase microbial biomass carbon in second sampling stage in compared to CIS sampling stage. Wheat and canola straw mulch increased microbial biomass carbon rate by 29.30% and 21.39% in second stage 58.45% and 55.19% in third stage, respectively, compared to CIS (Fig. 4).

Table 3. Combined ANOVA effects of treatments on microbial biomass carbon, soil organic carbon, and microbial quotient in the second sampling stage

S.O.V	df	Microbial biomass carbon	Soil organic carbon
Station	1	7709.3^{ns}	9.2^{ns}
Rep. (Station)	4	14287.5	0.1
Treat.	8	108821.1**	0.2**
Rep×Treat	8	7546.3^{ns}	0.1^{ns}
Error	32	9631.3	0.08
CV	-	9.03	21.03

^{ns},**, *: non-significant, significant at 1 % and 5% probability level, respectively.

Table 4. Combined analysis of variance of the effects of treatments on microbial biomass carbon, soil organic carbon, and microbial quotient in the third sampling stage

S.O.V	df	Microbial biomass carbon	Soil organic carbon
Station	1	753421.8^{ns}	8.5^{ns}
Rep. (Station)	4	168997.03	0.04
Treatments	8	587555.6**	0.5**
Rep×Treat	8	138760.4^{ns}	0.05^{ns}
Error	32	87327.5	0.1
CV	-	16.43	26.8

^{ns},**, *: non-significant, significant at 1 % and 5% probability level, respectively.

It seems that plant mulches in comparison with plastic mulches, herbicide, and cultivator treatments, have provided more energy for the growth of microorganisms so that they have increased the biological factor activity of soil due to increasing the organic matters and elements (Alvear *et al*., 2005; Li *et al*., 2013). Lowest Microbial biomass carbon observed in the second sampling stage in Trifluralin herbicide and Metribuzin herbicide treatments. The Microbial biomass carbon rate decreased in Trifluralin herbicide and Metribuzin herbicide treatments compared to wheat straw mulch and canola straw mulch treatments. Moreover, Microbial biomass carbon rates in Trifluralin herbicide and Metribuzin herbicide treatments at the second sampling stage were13.86% and 1.57% that decreased in compared to CIS (Fig. 4). Based of Shahrad (2010) study, the rates of microbial respiration, microbial population, and soil organic matter were measured in a spectrum of time after applying Trifluralin herbicide. The results indicated that the amount of CO_2 production decreased with the passage of time, and this reduction continued until the fourth week; however, the amount of CO_2 production was reported to increase in the fifth week. Based on Song *et al*. (2013) study, application of Trifluralin herbicide in the potato crop had a minor effect on soil bacteria and fungi. Highest activity of Metribuzin herbicides in soil is 30 days after application. Over this period, the activity and population of soil microorganisms decline. This process occurs due to the herbicides that inhibit the enzymatic and biological activity of the microorganisms. During herbicides degradation by soil microorganisms, metabolites are produced which are later applied as food sources for soil microorganisms. Mentioned process leads to the growth in population and increase of respiration in soil microorganisms (Zaki *et al*., 2014). Lowest Microbial biomass carbon rate in third sampling stage was related to cultivator practice application, that significantly decrease the Microbial biomass carbon rate compared to wheat straw mulch and canola straw mulch (Tables 3 and 4). Microbial biomass carbon rate showed a few increase in cultivator practice treatment in second and third sampling stages; however, other treatments had shown a significant increase in microbial biomass carbon rate (Fig. 4).

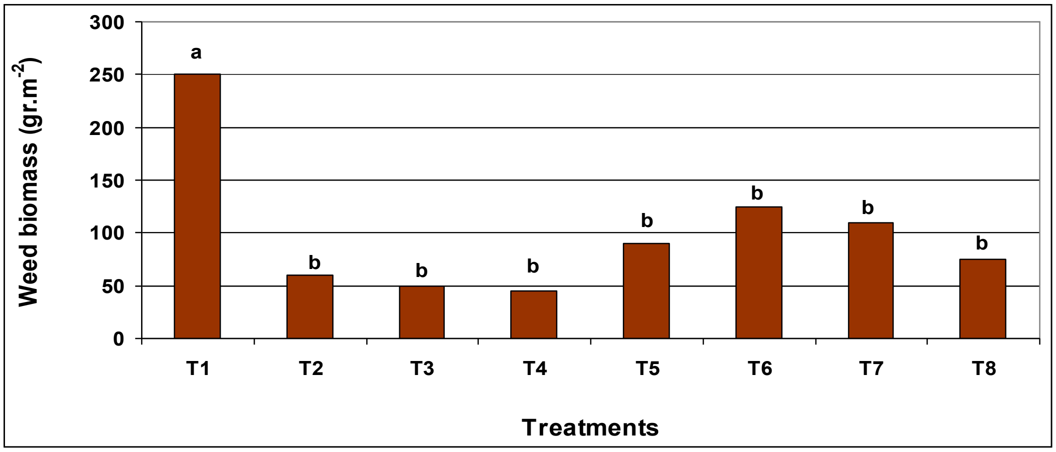

Fig. 3. Effect of treatments on total weed biomass via Duncan test at 5% probability level. T_1: Weed infested, T_2: Cultivator, T_3: Canola straw mulch, T_4: Wheat straw mulch, T_5: Metribuzin, T_6: Transparent plastic mulch, T_7: Black plastic mulch, T_8: Trifluralin.

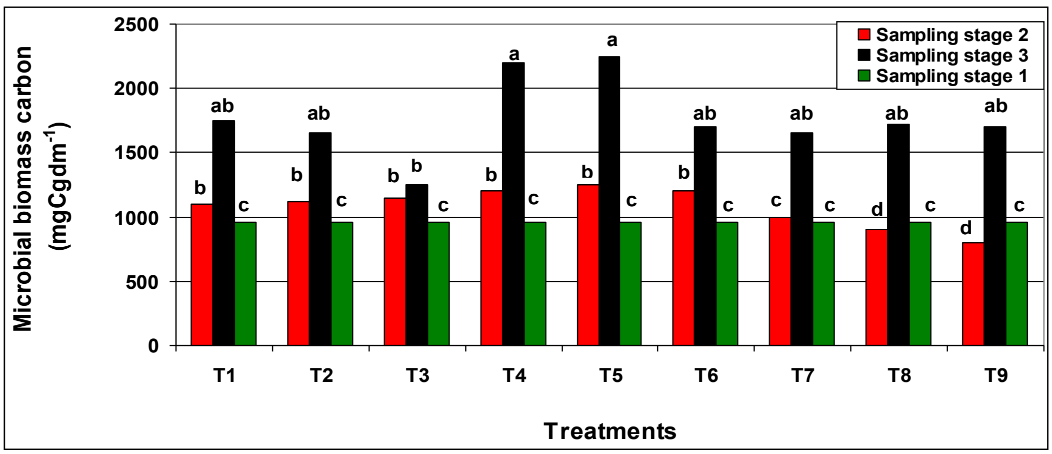

Fig. 4. Effect of treatments and stages of sampling on microbial biomass carbon of soil via Duncan test at 5% probability level. T_1: Weed infested, T_2: Weed free, T_3: Cultivator, T_4: Canola straw mulch, T_5: Wheat straw mulch, T_6: Black plastic mulch, T_7: Transparent plastic mulch, T_8: Metribuzin, T_9: Trifluralin.

Microbial activity and biomass are higher in no-tilled soils compared to tilled soils (Helgason *et al*., 2010; Leite *et al*., 2010). Improved microbial habitat formation and stability of soil aggregates in no-tillage condition is reason for increase in microbial activity (Balota *et al*., 2004).

4.5. Soil Organic Carbon

Based on results of study the experimental treatments had a significant effect on the Soil organic carbon (Tables 3 and 4). Highest Soil organic carbon rate was observed in wheat straw mulch and canola straw mulch treatments in compared to other treatments during the second and the third sampling stages. Soil organic carbon rate increased up to 31.92% and 29.81% in wheat straw mulch in second and third sampling stages, respectively. Soil organic carbon rates were 36.51% and 31.05% respectively in second and third sampling stages in canola straw mulch treatment (Fig. 5). Amount of input carbon in soil increased when plant mulch used on soil. Moreover, as organic matter constitutes approximately 50% of the soil mass, adding plant straw mulch to soil improves the chemical and biological properties of the soil, provides the conditions for decomposition of plant straw, improves microbial activity, and consequently increases the total organic carbon of soil (Certini, 2005; Li *et al.*, 2013). Lowest Soil organic carbon was related to the transparent plastic mulch treatment in the second sampling stage (1.06%), being lower than the 6.6% rate of Soil organic carbon in CIS. With respect to the third sampling stage, lowest Soil organic carbon was related to transparent plastic mulch and black plastic mulch which presented lower Soil organic carbon rates in compared to CIS. Plants growth response and photosynthetic activity, the present Soil organic carbon in atmosphere is converted into the organic compounds by the plant. These compounds are shifted from the leaves as the source to the roots; in addition, in the form of seeping, they are transferred into the soil of farm, where plastic mulch is employed to cover the soil surface by adding the residue. Furthermore, the waste of plants is prevented from seeping into the soil during the crop growing season; hence, the microbial demand for the carbon source quickly reduces in the soil as it is dependent on this carbon source (Fontaine *et al.*, 2007).

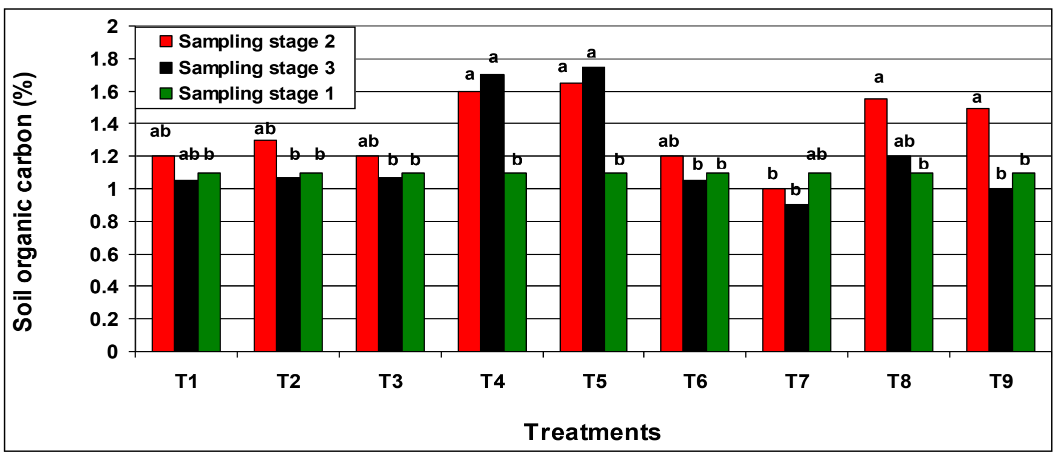

Fig. 5. Effect of treatments and stages of sampling on soil organic carbon of soil via Duncan test at 5% probability level. T_1: Weed infested, T_2: Weed free, T_3: Cultivator, T_4: Canola straw mulch, T_5: Wheat straw mulch, T_6: Black plastic mulch, T_7: Transparent plastic mulch, T_8: Metribuzin, T_9: Trifluralin.

5. CONCLUSION

The ecological treatments in present study can control weeds as much as the herbicides. However, no significant difference between treatments of mulch and herbicides in terms of weeds biomass, because mulches and cultivators can prevent of germination, growth and development of weeds as well as herbicides, both in the initial stage of weeds growth and in the subsequent stages it can be concluded that the use of mulches can be more costly than the use of herbicide due to labor costs and costs related to mulch preparation. The ecological methods such as application of plant residues can be more environmental friendly. The presence of herbicides in the ecosystem is harmful for health humans and animals. The treatments employed could make a significant difference in the amount of microbial biomass carbon and soil organic carbon. Highest rate of microbial biomass observed in the wheat straw mulch and canola straw mulch treatments. Highest rate of Soil organic carbon obtained in wheat and canola mulch treatments compared to other treatments. Plant residues typically increased the values of all biological parameters of soil, causing a significant and positive effect on the management of organic materials.

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