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Full Length Research Paper

Mulching and field burning influence on soil seedbank and wheat crop performance in rainfed conditions

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Increasing yield per unit area with maintaining soil properties and preserving the ecosystem at the same time is the chief concern for agronomists all over the world. Field burning along with the history was considered a cheaper tool which is still use by most farmers for weed control in open fields. A study was therefore applied to investigate the effect of mulcher (subsurface tillage) and field burning on soil seedbank, soil properties, and performance of subsequent wheat crop under rainfed conditions of Duhok region. This study was conducted at the faculty of Agriculture and Forestry/University of Duhok during 2011-2012 growing season. The results indicated that both soil seedbank and field weed population were significantly increased by mulcher and decreased when the field was burnt in the summer; meanwhile, some soil properties such as balk density and porosity were improved by mulcher and were not or slightly affected by field burning. As for wheat growth and yield, excluding the number of tillers per plant (2.34) in field burning treatment, all other traits were not affected significantly by the factors under the study.

Key words: Mulcher, field burning, Seedbank, Wheat, Rainfed.

INTRODUCTION

In Iraqi Kurdistan Region, open field burning of straw after combine harvesting is a common practice among farmers in order to ensure early preparation of fields for the next cropping season. Burning agricultural waste in open fields after harvesting may cause some effects on soil, ambient air, and living organism and moisture and the impact of fire on soil conditions including seedbank can be moderate to severe.

The fire impact is determined by numerous factors including fire severity, temperature, fire frequency, soil type and moisture, vegetation type and amount, topography, season of burning, and pre- and post-fire weather conditions. This eventually affects structure and soil organic matter, reduces porosity, and increases pH (National Wildfire Coordinating Group, 2001). McFarland and Mitchell (2000) concluded that climatic conditions are considered a primary factor which influences field burning consequence for subsequent crop especially for the number of tillers; also they demonstrate that only a small portion of tillers advanced to the reproductive stage.

Hansen and Carlson (2004) illustrates that field burning reduces weed numbers in soil but also reduces storage of precipitations by 1-2 inches. Gel and Holmes (1997) mention that summer fires effectively destroy the surface seedbank of many weeds and at the same time they found that not all weed seedbank can be decreased; also some weeds are not affected and others benefit from burning. Also, CRC (2008) reported that autumn burns are an effective alternative method for weed control and have shown to successfully decrease weed seed densities and seeds close to soil surface are more likely to be killed than seeds that are buried more deeply in soil; also, burning can stimulate weed germination of some weed or stimulating germination of hard or dormant seeds. Mazzola et al., (1997) found that wheat seedlings growth was better in burnt field than none burnt field. On the other hand, Garg (2008) illustrates that burning open fields reflects negatively on soil and atmospheric; he reports that after field burning, the soil losses its organics as well as nitrogen (27-73%), bacterial (about 50%) and

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Table 1. Effects of mulcher and field burning on some wheat traits at field.

Treatments	Wheat Traits								
	No. narrow leaved weeds/m^2	**No. broad leaved weeds/m^2**	**Plant height (cm)**	**No. tillers**	**Spike length (cm)**	**Seeds Number /spike**	**Seed yield/spike (gm)**	**Seed yield/ha (kg)**	**Straw Yield/ha (kg)**
Mulcher	21.00 b	28.67 a	40.12 a	1.40 b	5.35 a	26.37 a	0.77 a	755.47 a	2244.10 a
Field Burning	2.52 a	22.67 a	42.50 a	2.34 a	5.54 a	27.77 a	0.78 a	732.27 a	2270.60 a
Control	23.00 a	31.34 a	41.75 a	1.44 ab	5.33 a	25.34 a	0.74 a	698.53 a	1958.40 a

- For main factor, the means that shared the same letter within a column are not significantly different according to Duncan multiple range test at probability 0.05.

fungal population in repeated burns which cause severe decreases in subsequent crop growth and yield. Similarly, Tiwana et al. (2007) reports that burning wheat and other crops straw contributes to loss of soil fertility apart from causing air pollution. Singh et al., (2008) mentions that field burning reduces soil fertility due to loss of nutrients, organic matter and causes air pollution.

Several initiatives practices for proper management of agricultural waste may be necessary for promoting other alternative ways of field preparation instead of burning it in the field. According to numerous studies, mulcher (subsurface tillage) after harvesting the main crop has positive influence on subsequent grown crop as it may have significant effect on reducing weed population, improving soil traits and increasing soil organic matter:

Wojciechowski and Sowiński (2005) found that pre-sowing wheat tillage had a considerable effect on weed species and weed seedbank in soil. Swanton et al., (2012) demonstrates that the vertical distribution of weed seedbank will be influenced by type of tillage, depth of tillage, and type of soil; also they illustrate that tillage alters the size and composition of seedbank; in no-till systems, most weed seedlings emerge from the seedbank near the soil surface, while in conventional tillage systems; a high proportion of seedbank is located in deeper soil layers. Kouwenhoven (2000) reports that mouldboard ploughing mostly relocates seeds from the surface to a depth from where they cannot emerge.

Also, Shrestha et al. (2002) found that weed density was greater in conventional tillage than in no-tillage systems; the authors attribute the higher weed density to ploughing which could have brought weed seeds from lower soil profiles to a depth that was favorable for germination and emergence. Similarly, the results of Boguzas el al., (2006) indicate that no-tillage significantly increases weed infestation, compared to conventional deep plowing in the field but the tillage systems have no effect on weed seedbank.

Accordingly, the study was conducted to investigate the effects of mulcher and field burning on soil seedbank, soil characters, growth and yield of wheat crop under rain-fed environments.

MATEREAL AND METHODS

The research was carried out in the fields of Faculty of Agriculture and Forestry/University of Duhok, Iraqi Kurdistan region, during 2011 to 2012 growing season to study the influence of mulcher (subsurface tillage) and field burning on wheat crop performance and soil seedbank. A fallow field was mulched, another part was burnt in summer (July) and the remaining part of the field was left without any treatments (control). Three soil samples were taken before wheat sowing (in November) from each treatment for soil physical analysis; also a quarter (¼) square meter of two soil depths (0-15 and 15-30cm) was taken from each treatment for soil seedbank experiment and further soil tests implemented in pots.

Both field and pots experiments were designed according to Randomized Complete Block Design (RCBD) with three replications. Three soil samples from each treatment were placed in special plastic containers (40 x 50 cm a parts) and located under field conditions with supplementary irrigation when required; the average for both narrow and broad leaved weed populations in

Table 2. Effects of mulcher and field burning on soil seedbank and some soil properties.

Treatments	Weeds and Soil Traits					
	No. narrow leaved weeds/m²	**No. broad leaved weeds/m²**	**Electric Conductivity ds/m**	**Porosity %**	**pH**	**Bulk Density gm/cm³**
Mulcher	1166.7 b	538.7 a	0.18 a	38.39 a	7.48 a	1.61 a
Field Burning	387.3 a	302.0 a	0.23 a	38.16 ab	7.51 a	1.63 a
Control	517.3 b	340.0 a	0.30 a	34.83 b	7.49 a	1.70 a
	No. narrow leaved weeds/m2	**No. broad leaved weeds/m2**	**Electric Conductivity ds/m**	**Porosity %**	**pH**	**Balk Density gm/cm³**
15 cm soil depth	415.6 a	436.4 a	0.18 a	37.39 a	7.52 a	1.65 a
30 cm soil depth	965.3 b	350.7 a	0.29 a	37.52 a	7.45 a	1.64 a

•For main factor, the means that shared the same letter within a column are not significantly different according to Duncan multiple range test at probability 0.05

consequent periods were calculated from each treatment and then the accumulative number for each kind of weeds were calculated.

Regarding the field experiment, local rough wheat (*Triticum durum* L.var. *smito*) was sowed manually at the beginning of December in a rate of 30 kg/donum (120 kg/hectare) using mouldboard and cultivator for plowing and covering respectively. Chemical fertilizer NPK (15:45:15) was applied with sowing (120 kg/ha). Weed population was calculated also in the field in addition to wheat growth and yield characters such as number of tillers, plant height, and seed and straw yield. The rainy season spans from November to April. During the 2010/2011 growing season when the experiments was carried out, a total of 278 mm was recorded.

The data were analyzed statistically according to RCBD using the statistical analysis system (SAS, 2001); Duncan Multiple Range test (1955) was used for means of verification and for discussion of the results under the probability level of 0.05.

RESULTS AND DISCUSSIONS

Data in table (1) clearly showed that the mulcher and field burning had significant effects on the number of narrow leaved weeds and number of tillers only in the field experiment. Field burning surpassed other factors in both mentioned traits that gave 2.52 weeds per square meter and 2.34 tillers per plant, respectively. Also, field burning gave higher results in most of other traits, but this increase was not significant. The field burning may have positive influence on crop growth or yield of wheat crop in the first year accompanied with low weeds population (Table 1 and 3), but the drought conditions (278 mm) which accompanied this season precluded reflecting this effect on weeds on the growth or wheat yield. These results are in agreement with those of McFarland and Mitchell (2000), Hansen and Carlson (2004), CRC (2008) and Mazzola et al. (1997).

Table 2 summarized the effects of mulcher and field burning on some soil properties and soil seedbank during the study. Laboratory analytical results showed that all soil prosperities excluding porosity were not significantly affected by the factors of the study. Both mulcher and field burning increased significantly the porosity in the field; mulcher gave the highest value (38.39%) followed by field burning (38.16%) as compared control unit (34.83%). As for soil seedbank from the pot experiment, field burning significantly gave the lowest number of narrow leaved weeds (387.30 weeds/m²) as compared with mulching or check unit, which gave 1166.70 and 517.30 weeds per square meter respectively. Also, field burning recorded the lowest number of broad leaved weeds in square meter (302.00 weeds), but statistically this surpass was not significant with both mulcher and control. We can illustrate from the mentioned results that field burning in summer retarded or destroyed the

Table 3. Effects of the interaction of soil depths with mulcher, field burning and control on soil seed bank and some of soil properties

Treatments		Weeds and Soil Traits					
Field Practices	**Soil Depth**	**Narrow leaved weeds/m^2**	**broad leaved weeds/m^2**	**Electric Conductivity ds/m**	**Porosity %**	**pH**	**Balk Density gm/cm^3**
Mulcher	**15 cm**	2189.3 b	952.0 b	0.336 a	34.71 b	7.51 a	1.73 a
	30 cm	645.3 ab	276.0 a	0.286 a	41.37 a	7.36 a	1.55 b
Field burning	**15 cm**	129.3 a	328.0 a	0.081 a	37.35 ab	7.56 a	1.67 ab
	30 cm	61.3 a	81.3 a	0.267 a	36.47 ab	7.48 a	1.68 ab
Control	**15 cm**	973.3 ab	598.7 ab	0.335 a	33.19 b	7.50 a	1.74 a
	30 cm	144.0 a	125.3 a	0.138 a	41.62 a	7.51 a	1.54 b

- For main factor, the means that shared the same letter within a column are not significantly different according to Duncan multiple range test at probability 0.05.

germination of weed seeds and also mulcher turned the seeds up from the beneath soil; these results are entirely similar to those in table 1 in which they were under dry conditions. These findings are in harmony with those of Gel and Holmes (1997), CRC (2008), Wojciechowski and Sowinski (2005), Swanton et al. (2012), Kouwenhoven (2000) and Shrestha et al. (2002).

The same table (2) included the effects of soil depths (15 and 30 cm) on the studied traits. Soil traits were not affected significantly by the depth of soil. Regarding the soil seedbank, shallower depth (15 cm) significantly recorded the lowest number of narrow leaved weeds per square meter (415.6) as compared to 965.3 weeds from 30 cm depth in contrast with broad leaved weeds which gave a higher number of weeds in shallower depth as compared to depth soil (436.4 and 350.7 weeds/m^2 respectively). This can be explained by which the vertical distribution of the weed seedbank will be influenced by tillage type, depth of tillage, and soil type (Swanton et al., 2012). Also, tillage alters the size and composition of the seedbank (Shrestha et al., 2002) but in contract with those of Boguzas et al., (2006).

Table 3 illustrated that the interaction among factors of the study had significant influence on most of the traits under investigation. Mulcher (subsoil tillage) was the significantly gave highest number of narrow leaved weeds in the depth of 15 cm (2189.3 weeds/m^2) and field burning at the same depth gave the best results of narrow leaved weeds population (129.3 weeds/m^2). Also, the later gave best results (lower weed population) in the depth of 30 cm (61.3 weeds/m^2) as compared to mulcher treatment or control units (645.3 and 144.0 weeds/m^2 respectively). In the same direction, field burning gave lowest weed population for broad leaved weeds at the depth of 30 cm (81.3 weeds/m^2).

The results inflect positive effect of field burning for reducing weed population which may have good influence on the yield later at least for the short term period or during the first subsequent crop production. The reason behind increasing weed population by mulcher may belong to the fact that plowing specially moldboard plough overturns the soil which led to incorporate the soil seedbank causing the seed density to increase in the surface in contrast to the burning which causes reduction of the seed germination. These outcomes are similar to those found by Wojciechowski and Sowiński (2005), Swanton *et al*. (2012), Kouwenhoven (2000), Hansen and Carlson (2004) for mulching (tillage) and Shrestha *et al*. (2002), Gel and Holmes (1997) and CRC (2008) for field burning.

Electric conductivity and soil pH were not significantly influenced by the mulcher or field burning, but each of porosity and soil balk density were affected differently. Both mulcher and control in the depth ploughing gave the best results of porosity (41.37 and 41.62% respectively); also, they significantly resulted in best soil balk density but at the shallower depth (1.73 and 1.74 gm/cm^3 respectively) as compared to summer burning values. These results are in agreement with those of CRC (2008) and National Wildfire Coordinating Group (2001).

CONCLUSION

Under the condition of this study, mulcher improved some soil properties (porosity and bulk density) and at the same time increased the weed population in both field and pot experiments. Despite the fact that some soil traits may affect by the burning of remain wastes at the field, it (field burning) decreases weeds soil seedbank and weed population in the field remarkably; this may positively influence the subsequent growth and yield crop (wheat). However, severe drought conditions in the region blocked to reflect this decrease of weed population in the growth and yield of wheat crop. Long term experiments on mulcher and field burning are highly recommended in different sites to ensure and support such foundations.

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