



Weed Control in Tomato through Mulching Approaches

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Authors' contributions

This study was carried out with the collaboration of all authors. All authors read and approved the final manuscript.

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ABSTRACT

The objective of this study is to evaluate effect of different types of mulches on weed control and yield of tomato in the farm of Agriculture, Livestock and Irrigation Department were conducted in the year 2019. The method for study is completely randomized block design with three replications and four treatments such as transparent plastic, black plastic, barley straw and control (without mulch). According to the study, the control treatment, black plastic mulches were a significant effect on the number of weeds and yield of tomatoes. The maximum yields were 48.05 (ton/ha) in black plastic and the minimum yields were 19 (ton/ha) in control mulch. The present work suggests that the application of different types of mulches can be an effective method to reduce the number of weeds in a tomato farm. The black plastic mulch is recommended due to increase in the yield of tomato and also an effective practice on controlling the weeds.

Keywords: *Mulching; weed control; tomato; transparent plastic mulch; black plastic mulch; barley straw.*

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1. INTRODUCTION

Tomato (*lycopersicum esculentum* L.) is one of the most valuable plant species (*Solanum*) in the Middle East, which is the second-largest economy in the world after potatoes [1]. Tomato is a significant source of minerals and antioxidants such as carotenoids, lycopene, vitamins C, E, and phenolic compounds that play an important role in human nutrition in preventing certain cancers and cardiovascular diseases [2]. Tomatoes have good adaptation and are extensively cultivated in the provinces of Kunduz, Samangan, Baghlan, Takhar, Parwan, Nangarhar, Ghazni, and Helmand [3]. Out of the total, 87.4% of vegetable cultivated land in Afghanistan, approximately 7.4% is tomatoes [4]. Weeds reduce yields by competing in space, light, water and nutrients, weakening the crop base and reducing harvest yields. Some weeds can increase other pest problems by serving as an alternative host for insects, diseases or nematodes. Although weed control has always been one of the most important components of tomato production, its importance has been increased by the introduction of sweet potato whiteflies and the problem of improper handling [2]. One of the main limitations for achieving optimal plant yield is the competitive pressure of weeds. In recent years, the prevalence of intensive agricultural systems has been accompanied by an increase in energy consumption to control weeds, mainly through the use of herbicides [5]. Improper use of these chemical pesticides not only poses problems in weed management but also poses a risk to human health and the environment. For this reason, the use of non-chemical and environmentally friendly methods in the control of weeds is gaining attention. On the other hand, increasing yield of plants per unit area and maintaining the health of production crops is necessary to increase in the nutritional needs of the growing population of the world. In this regard, the use of different types of mulch can be considered as a means of weed control and also to increase the yield of tomato. Traditionally, growers of vegetables have been using long thin plastic strips as mulch to reduce weed growth, prevent soil erosion and also to prevent leaching, especially on light sandy soils [6].

There are different types of mulches based on the type of purpose and there mulches have some advantages as well as disadvantages. The most common type of soil cover used in agriculture is the use of polyethylene plastics.

Plastic mulch directly affects the climate around the plant by changing the amount of radiation falling on the surface and reducing soil water evaporation [7]. Mulches are known to increase soil temperature due to the heat from the sun and it passes through the air and soil under the mulch. Polythene and straw mulch have been effective in controlling the weed infestation. Different mulch materials have shown different effects on soil temperature. Polythene mulch increased the soil temperature by about 6°C at 5 cm depth and 4°C at 10 cm depth. Mulches prevent water evaporation from the soil and retain soil moisture [8]. The black plastic prevents the germination of photoblastic seeds by blocking the passage of light and then disrupts the photosynthesis of weed-germinating plants. For this reason, black plastic shows more successful control over weeds compared to transparent plastic and other soil covers (Now Jawan, 2003). The findings on black plastic mulch were consistent with the findings of Anu et al. [9] and 10. Ngoujio [10] who reported significant weed control under plastic mulch. Several studies have reported increased yield by using different mulch, this increase in yield is not the direct effect of mulch on the plant, but the effect of these coatings on soil temperature and microclimate of the areas, diseases control and pests, better access to nutrients, permanent root access to water and soil moisture retention, increase in soil microorganism activity and weed control [11]; Hankin et al. [12]; & Lamont [13], which leads to the final increase in the yield.

2. MATERIALS AND METHODS

In order to investigate the effect of different mulches on weeds and tomato production, this work was conducted in 2019 in the farm of agriculture, livestock, and irrigation department. The study area is located in the center of Aybak city, Samangan province of Afghanistan, at a latitude of 36°26' N, longitude of 68°02' E and an elevation of 959 m. This experiment is in the form of a completely randomized block design with three replications and four treatments, including; transparent plastic, black plastic, barley straw, and control (without mulch). Each experimental plot was 2.5 m wide and 5m long with a distance of 40 cm between plants, and 150 cm between rows. The tillage operation and preparation of the cultivation bed were done by leveling and creating ridges by workforce using hand tools. After initial irrigation and adaptation of soil moisture, mulches were placed on the surface, and seedlings were transferred in the month of

May. In the present study, the tomato cultivars "Beafstick" produced by Karavan Sabz Company located in Mazar-i-Sharif were used. The requirements of plant fertilizer were applied at the rate of 20 tons per hectare. Completely rotted animal manure was mixed with soil in early March, and an amounts of 200 kg/ha of urea were applied before planting and before flowering, and 100 kg/ha DAP was applied before planting. The Irrigation methods were farrow at intervals of five days. No control measures were taken against weeds in all treatments. The harvesting took place in two stages, during 25 July and 18 August. At the end of the growing seasons before one week of harvest, the diversity of weeds were examined with their number as well as the number of fruits per plant, the weight of tomato fruit, etc. were measured. The data were analyzed by SPSS 26 software. The comparison of means traits was 1% probability with the least significant difference (LSD) test.

The Simple linear regression is a linear regression model with a single explanatory variable. This model is the relationship between a dependent variable and one or more independent variables. A linear regression has an equation of the form $Y = a + bX$, where X is the explanatory variable and Y is the dependent variable. The slope of the line is b , and a is the intercept.

A specification of the variable selected was described below in Eq. 1.

$$Y = a + bX \quad (1)$$

Where,

Y = Tomatoes yield (Ton/ha)

a = Constant

x = Number of weeds

b = Yield elasticity of factors x

Thus, one dependent variable and one independent variable were selected for the simple linear regression. This was selected as the explanatory variables to determine the number of weeds affecting the tomatoes yield.

3. RESULTS AND DISCUSSION

According to the results of one-way ANOVA, there was a statistically significant difference at the 1% level, in the average tomato yield among the tomato treatment groups as a whole ($F = 93.65$; $P = 0.000$). Therefore, there was a

significant difference among the treatment groups in the average yields of total tomato. The average yields of tomato was calculated at 30.3807 (ton/ha). The results showed that the highest yields of tomato was obtained from the treatment of black plastic mulch and the lowest yield of tomato in the non-mulch (19.1 ton/ha), and it shows a 60.27% decline from black plastic mulch. In the present study, mulches with effective control of weeds showed an increase in the yield of tomatoes. Among mulches, the black plastic and transparent plastic were more effectively for controls of weeds than the barley straw [2] studied on poly ethylene black plastic resulted in significantly highest fruit yield among treatments. [14] researched on effects of three mulch types on the growth and yield of tomato and weed suppression found that the mean pooled fruit yield from all mulched plots, unweeded treatment reduced tomato fruit yield by about 65% and 66%, respectively. Moreno et al. [15] studied the comparison of different mulch materials in a tomato crop in Ciudad Real, Spain, found that the marketable and total yields showed a similar behavior related to the type of mulch employed, ranging from 6.85 to 9.82 kg m² and 7.43 to 10.33 kg m², respectively. [16] found that mulching increases marketable yield with respect to bare soil. The plants grown on silver/black plastic mulch indicated a 65% increase in yield compared to control treatment.

In the terms of the number weeds, there were significant differences among the treatment groups in terms of the number of weeds in each treatment ($F = 18.61$; $P = 0.001$). Therefore, it can be said there is a significant difference among the treatment by the number of weeds in each treatment. Thus, the highest number of weeds was observed at the treatment of black plastic mulch and the lowest in non-mulch (control). All treatments showed a significant difference in terms of decreasing weeds density compared to the non-mulch (control). The average numbers of weed were estimated 160.6250 (weed/ treatment). [17] found that the black plastic was the most successful in weeds control, so that up to one month after sowing times (the first time sampling), some weeds were controlled 100 percent, and all traits were reduced in some others. Two months after sowing time (the second sampling time), also all traits of weeds presented under black plastic were significantly reduced.

Weeds density refers to the type of weeds that the nut grass (*Cyperus rotundus*), field bindweed

(*Convolvulus arvensis* L.) and pigweed (*Chenopodium album* L.) were the dominant weeds in the treatments. The results of study shown that are the mulching has significantly effect for the controlling of weed diversity in the treatments. Especially black plastic mulch has the most successful and significant effect in controlling of weed diversity, and it observed one type of weed (Nut grass). Whereas, in the barley straw mulch 2 types of weeds, transparent plastic mulch 6 types of, and in the control treatment 10 types of weeds were observed. It is supposed that the larger type of weeds in the treatments, which has a negatively and significantly affects the quantity of tomato yields.

Fruits weight were significant differences among the treatment groups ($F = 44.02$; $P = 0.000$). Therefore, it can be said there is a significant difference among the treatment groups by the average of total tomato fruit weight. The averages of fruit weight were estimated at 83.9667 (fruit/ gr).

In the terms of the number of fruit in each plants were a statistically difference at the 10% level with the treatment groups as a whole ($F = 3.31$; $P = 0.078$). Therefore, a significant difference among the treatment groups by the number of

fruit in each plant at a 10% level was noticed. The average number of fruit in each plant were calculated as 57.647599 (fruit/ plant), as shown in Table 1.

3.1 Effect of Weeds on Tomato Yield

The number of weeds: This refers to the total number of weeds in the plots. It is supposed that the larger the type and number of weed in the treatments, which has a negative impact on the quantity of tomato yield. So it is hypothesized that the size of weeds under the plots negatively and significantly affects the quantity of tomato yield. The number of weeds as a variable has a coefficient of -0.081 and the odds ratios of -0.759 most likely to decrease on tomato yield. This negative coefficient is an indication that the number of weeds has direct relationships with tomato yield. The results that the one unit increases in the number of weeds would decrease gross returns by -0.081 percent in tomato yield. The adjusted linear determination coefficient (R^2) is used to verify the adequacy of the linear regression model. Therefore, $R^2 = 0.576$, and the model explained that 53 percent of the variations in tomato yield values, as shown in Table 2.

Table 1. Effect of mulches on weeds control and yield of tomato

Treatments	No. of weed	Weed density	Yield (Ton/Ha)	Average fruit weight (fruit/gr)	No. of fruit in each plant
Transparent plastic	48.67***	2.00	29.71***	87.27***	54.54*
Black plastic	48.00***	1.00	48.05***	127.10***	60.60*
Barley straw	208.50***	6.00	24.67***	68.07***	58.10*
Control	337.33***	10.00	19.10***	53.43***	57.35*
Average	160.63	4.75	30.38	83.97	57.65
CV (%)	87.11	86.58	41.31	38.01	4.32

Notes: (1) ***, **, and * significance levels at 1%, 5% and 10%, respectively

Table 2. Effect of weeds on tomato yields

Variables	Coefficient	Std. Error	odds ratios	t-Statistic	Sig.
Constant	50.941	4.517		11.279	0.000
No. of weeds	-0.081	.022	-.759	-3.688	0.004***
R-squared	0.576				
Adjusted R-squared	0.534				
Std. Error of the Estimate	9.8231				
F-statistic	13.603 (0.004)				

Notes: (1) ***, **, and * significance levels at 1%, 5% and 10%, respectively

4. CONCLUSION

The results of the present study can be concluded that the transparent plastic, black plastic and straw mulches on weed control cause the competition between cultivated plants and weeds to absorb water and nutrients, which leads to increased growth and performance. According to the results obtained in this study, it can be said that the use of mulch can be one of the alternatives to herbicides to weed control and thus can reduce its destructive effects on tomato plants. The low levels of agricultural production in Afghanistan despite of the favorable soil and climate conditions can be overcome by the use of modern farming methods. The use of mulch as one of the important practice in modern agriculture is getting increased due to its effectiveness in controlling weeds, more water retention, direct change of climate around the plant, and preventing soil temperature fluctuations and expansion of plant roots. In this study, the effect of soil cover types on the control of tomato plants and the performance in the climate of Samangan conditions is compared to determine the best soil cover to control weeds and tomato production and to be used as a model by the farmers.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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