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EFFECT OF TILLAGE AND WEED CONTROL METHODS ON WEEDS DENSITY AND TOMATO (*Lycopersicon esculentum*) PRODUCTIVITY

Tabassum Yaseen[1], Waheed Ullah[2], Masod Ahmad[3], Naveedullah[2], Kawsar Ali[4*], Abdullah[4] and Muhammad Amin[5]

ABSTRACT

Researchers have substantiated that efficient weeds control play key role in crop growth and development and total dry matter production. For sustainable improvement in crop yield and effective weeds control, long term investigations are needed to quantify the judicious use of resources. To evaluate the integration of tillage practices and weeds control methods in tomato production, an experiment was conducted at farmer field in District Charsadda of Khyber Pakhtunkhwa, Pakistan. Three tillage practices (Deep, conventional and reduced tillage) and five weeds control methods such as Plastic mulching, news paper, wheat straw and stone as mulch and hand weeding were used. A weed check treatment was included for comparison. Tillage practices have considerably affected weeds density, weed fresh and dry weight Deep tillage reduced weeds density by 11, 17 and 27% at 20, 40 and 60 days after sowing, respectively, as compared to reduced tillage . Likewise, 23, 11 and 17% increase was noted in tomato plant height, branches plant^{-1} and fruit yield in deep tillage over reduced tillage . Regarding weeds control methods, hand weeding reduced weeds population followed by plastic mulching and stone mulching at 20, 40 and 60 days after sowing. Plant height and fruit yield of tomato was higher in hand weeding followed by plastic mulching as compared to weedy check . All weeds control methods effectively reduced weed density and hence improved tomato yield over weedy check. It is concluded that deep tillage in combination either with hand weeding or plastic mulching is recommended for effective weeds control and improving yield of tomato under agro-ecological conditions of District Charsadda, Pakistan.

Key words: Mulching, tillage, tomato, weed density and yield.

[1]Dept. of Botany, Bacha Khan University, Charsadda, Pakistan.
[2]Dept. of Water Management, [3]Dept. of Horticulture, [4]Dept. of Agronomy, [5]Dept. of Agricultural Mechanization, The University of Agriculture, Peshawar Pakistan.
*Corresponding author's email: kawsar@aup.edu.pk

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INTRODUCTION

Tomatoes (*Lycopersicon esculentum*), a foremost vegetable crop in Pakistan and worldwide, is often grown outdoors and in tunnels to be used fresh or processed (Lucier *et al*., 2000). It is considered one of the most important source of mineral deposits and antioxidants such as carotenoids, lycopene, vitamins C, E and phenolic compounds, which have a important role in individual diet to put off firm cancer and cardiovascular diseases (Adalid *et al*., 2004). Several product of tomato are used in daily life such as sun-dried, juice, soup, sauce, ketchup and unsullied as salad (Frusciante *et al.*, 2007). In Pakistan, tomato was grown on 53.40 thousand hectares with a production of 561.9 thousand tons and in the area of Khyber Pakhtunkhwa the statistics were 16.50 thousand ha and 161.8 thousand, in that order with a normal capitulate of 9.8 tons ha-1 during 2008-09 (PSY, 2010). Among the different countries of the world, China is the world's leading tomato producing country with 45,365,543 t per year tomato production, followed by USA (14,141,900 tons), India (11,148,800 tons), Turkey (10,260,600 tons) and Italy (6,877,400 tons), whereas Pakistan lines at the 35th with production of 561,900 tons yearly. The per hectare production of tomato in our country is very low as compared to the other tomato producing countries. Several reasons are responsible for the low yields among which weeds are also considered one of the potential factor responsible for reduction in yield as well as the quality of tomato They are also undesirable from an economical point of view. Weeds can cause an 80% crop production loss in some cases if not controlled (Weaver *et al.* 1987). Weeds are considered strong competitor for crop at early growth stage (Arif *et al*., 2012; Ali *et al*., 2011). The soils of the experimental site are poor in terms of organic matter (Ali *et al*., 2015) and weeds further decrease nutrients availability to crops. Cultivar weed competitiveness include crop performance to compete weeds with less or no compromise on yield or growth. Moreover, some crop can compete with weeds and suppress weeds growth. Zhao *et al*. (2006) are of the view that most of the commercial growers are interested in weed competitiveness character of vegetable specially tomato. Different tomato cultivars were evaluated for weed-competitiveness. It was found that some cultivars performed spuriously and compete with weeds while some of them were drastically affected by weeds population (Ngouajio *et al.,* 2001). The role of selective herbicides cant be ignored in crop

production and are frequently used for better weeds control in vegetables worldwide (Tei *et al*., 2003). However, during herbicides application crop injuries might happen due to cultivar genetic variations as different variety has different genetic makeup. In response to herbicides application, the tomato cultivars were found to show differential tolerance or susceptibility to application of herbicides (Portarfeild *et al.,* 2002; Bunnal *et al.,* 2003). Dear *et al*. (1995) and Al-Khatib *et al.* (1997) reported that a cultivar resistant to injuries due to herbicide application is a desirable characteristic that leads to better weeds control with out any reduction in yield due to injuries. Most common selective herbicides used in tomato are metribuzin and sethoxydim. Metribuzin [4-amino-6-(1, 1-dimethelethyl) - 3-(methylthio)-1,2,4-triazin-5(4H)-one] is a selective pre-emergence and post-emergence herbicide that controls many broadleaf weeds vegetables specially in tomato. Likewise, Sethoxydem (2-[1-(ethoxyemino) butyl-5-[2- (ethylthao)-propyl]-3-hydroxy-2-cyclo-hexaen-1-one) is another important selective herbicides mainly used as post-emergence herbicide that help in controlling annual and perennial weeds in crops and vegetables, including tomato (Sensoman, 2007). Soil moisture plays key role in improving herbicides effectiveness and mulching play important role in preserving soil moisture content. Although, pre emergence herbicides kill germinating seeds or embryo still it fail to effect dry weeds seeds. We cant ignore the importance of wet soil in herbicides application, however, care must be exercised in application of herbicides to wet soil as application equipments can cause soil compaction and seeds suppression, mainly where power driven rotary tillers are used for soil incorporation. In order to avoid loses or damage due to herbicides application, scientist like George *et al.* (2013) and Shamim *et al.* (2013) believe that organic or on farm weeds control methods (Mulching and weeds free seeds) should be integrated with chemical weeds control methods. Plastic mulching in tomato not only present soil moisture and reduce crop water requirement but also helps in efficient weeds control in crops (Ali *et al*., 2014; Abbasi *et al.*, 2013). Tillage could be another important field operation that helps in weeds control. Ali *et al.* (2011) reported that deep tillage convincingly control or reduced weeds population in maize as compared to reduced or zero tillage practices. Deep tillage not only preserves soil moisture and insures better crop growth but also disturbs weeds bank in the soil and most of the weeds seeds are not able to germinate wither its exposure to sun or buried too deeply (Ali *et al*., 2012). Though weed control has always been top priority of tomato growers, yet they failed to insure weeds free crop or better weed control. The logic behind this study was to evaluate different on farm weeds control method for better growth of tomato.

MATERIALS AND METHODS

In order to study the effect of various tillage practices and weeds control methods on weeds and growth of tomato, an experiment was conducted at Farmer Field in District Charsadda, Khyber Pakhtunkhwa Pakistan during 2014. The experiment consisted of three tillage practices namely deep, conventional and reduced tillage and five weeds control methods (Plastic mulch, news paper mulch, wheat straw mulch, stones as mulch material and hand weeding). Black plastic and news papers were kept between tomato ridges soon after the transplantation process and small stones were kept on the surface of the black plastic and news papers in order to avoid removal of the applied materials by wind blow. In another treatment, soil surface between maize rows was covered by wheat straw as a mulching technique. Moreover, in stones mulching, the space between tomato ridges were covered with small stones completely. A control (weedy check) was included for comparison. Randomize complete block design with split plot arrangement was used for the conduction of the experiment and all treatments were replicated three times. Tillage practices were allotted to main plots while mulching materials were kept in sub plots. Before the execution of experiment, tomato nursery was raised in an area of 5 m^2 and plants were transplanted after 30 days. Sowing of seed for nursery and transplantation of seedling for experiment were performed on 27th May and 27th June 2014, respectively. Before the start of experiment, field was ploughed as per tillage treatments. The size of sub plot was maintained to 3 x 4 m and mulching materials were spread in sub plots after transplantation of seedlings. Care was exercised during irrigation of the plots not to disturb the mulching materials. Canal water was used for irrigation. Data were recorded on weeds density at 20, 40 and 60 days after transplantation, plant height, number of branches plant^{-1} and fruit yield.

Statistical analysis

The data recorded were subjected to statistical analysis according to the procedure described by Jan *et al*. (2009) recommended for RCB design. Least significant difference test ($LSD_{0.05}$) was performed for treatment means comparison.

RESULTS AND DISCUSSION

Weeds density

The effect of tillage practices and mulching materials on weed density 20, 40 and 60 days after sowing (DAS) are presented in Table-1. Overall, both experimental factors (Tillage and mulching materials) significantly affected weed density at all growth stages. Generally, weed density were higher at 60 DAS as compared to 40 and 20 DAS.

Weed density was higher in reduced tillage followed by convetional tillage while deep tilage resuted in lower weed density at all growth stages (20, 40 and 60 DAS). The possible reason for this could be the increased disturbance in soil by tilling it deep that reduced the weeds diversity and density (Cardina *et al*., 1991). Likewise, Kang *et al*. (1999) also reported alike results that weed density was increased in no-till soil compared to the reduced or conventional tillage. Comparing various mulching treatments, plastic mulching had lower weed density at 20, 40 and 60 DAS that was at par with plots where stones were used as mulch materials. However, least number of weeds was recorded in hand weeded plots. Weedy check plots (no control stratagy) resuted in highest weeds density at all growth stages. This higher density of weeds in control plots (no mulch) might be due to the open soil surface and niches available to weeds for free aggressive growth. The variation in weeds density as a result of different tillage practices could be attributed to their variable weed control efficacy. Our results are confirmed by the finding of Aslam *et al*. (2007) who reported 79% reduction in weed density in hand weeded plots. Similarly, Naveed *et al*. (2008) also reported that hand weeding and post emergence herbicides significantly reduced weed density. Our results are in greatly analogy with Bakht *et al*. (2009) who reported that among mulches, white plastic mulch minimized weed density.

Growth and yield of tomato

The plant height, branches plant^{-1} and fruit yield of tomato as affected by Tillage practices and mulching materials are shown in Table-2. Tillage practices and mulching materials significantly influenced plant height, branches plant^{-1} and fruit yield of tomato. Taller tomato plants were recorded by tilling the soil deep while reduce tillage resulted in short stature plants. The increase in plant height under deep tillage might be due to lower weed density that reduced the resources competition between crop and weeds. Likewise, taller plants were noted in hand weeding plots while shorter plants were measured in control plots. More branches plant^{-1} was counted in plots where soil was deeply tilled while lesser branches plant^{-1} was produced in reduced tillage. Hand weeded plots produced more branches plant^{-1} while lesser branches plant^{-1} was recorded in weedy check. The probable reason for more branches plant^{-1} might be because of lesser competition with weeds for soil moisture and nutrients. Higher fruit yield was recorded in deep tillage plots while lower fruit yield was recorded in reduced tillage plots. This increase in fruit yield might be due to the well aerated soils, favorable soil moisture and nutrients uptake. Higher fruit yield was found in plots where hand weeding was done while lower fruit yield was recorded in control. The hand weeded plots with lesser competition for nutrients and moisture with the host

plants due to reduced weeds density (Ali *et al.*, 2012) may have increase fruit yield of tomato. Our results indicated that hand weeding has performed best in the enhancement of the tomato yield, indicating that the weeds were effectively control in hand weeded plots. The plastic mulching treatments gave lower yields than hand weeding which may be actually because of the fact that plastic mulching cannot eliminate the weeds completely and weeds were in competition for resources with crop that leaded to reduce yield as compared to hand weeded plots. Yield losses in crops occur due to biomass and density of weeds (Mamolos and Kalburtji, 2001).

Table-1. Response of weeds density at different growth stages (days after sowing) to tillage practices and mulching treatments.

Tillage Practices	Weeds density (m^{-2})	Weeds density (m^{-2})	Weeds density (m^{-2})
	20 DAS	40 DAS	60 DAS
Deep tillage	23 c	37 b	62 c
Conventional tillage	29 b	41 b	76 b
Reduced tillage	40 a	70 a	105 a
$L.S.D_{(0.05)}$	5.12	8.43	12.32
Mulching materials			
Plastic	11 d	22 d	53 e
News paper	17 c	29 c	75 c
Wheat straw	25 b	42 b	102 b
Stones	09 d	21 d	65 d
Hand weeding	02 e	4 e	12 f
Control	31 a	55 a	121 a
$L.S.D_{(0.05)}$	2.3	3.5	8.23
Interaction	Significance Level	Significance Level	Significance Level
T x M	NS	NS	NS

Means followed by different letter(s) in the same rows are significantly different from one another at 5% level of probability.
NS = non significant

Table-2. Response of tomato growth and yield to tillage practices and mulching treatments.

Tillage Practices	Plant height (cm)	Branches plant^{-1}	Fruit yield (t ha^{-1})
Deep tillage	70 a	8 a	3.23 a
Conventional tillage	65 b	7 a	3.15 a
Reduced tillage	54 c	5 b	2.29 b
L.S.D$_{(0.05)}$	4.5	1.98	0.14
Mulching materials			
Plastic	67 b	7 b	2.27 b
News paper	56 d	6 b	2.21 b
Wheat straw	51 e	5 bc	1.83 c
Stones	64 c	8 ab	2.37 b
Hand weeding	71 a	9 a	3.21 a
Control	45 f	4 c	1.15 d
L.S.D$_{(0.05)}$	2.7	1.41	0.12
Interaction	Significance Level	Significance Level	Significance Level
T x M	NS	NS	NS

Means followed by different letter(s) in the same rows are significantly different from one another at 5% level of probability.
NS = non significant

CONCLUSION

From the finding of the experimental results it is concluded that deep tillage in combination with either hand weeding or plastic mulching had reduced weed density and enhanced tomato yield under the agro-ecological conditions of Charsadda, Pakistan.

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