The Bioscan 12(1): 283-286, 2017 (Supplement on Agronomy)
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
www.thebioscan.com

EFFECT OF CLIMATE RESILIENT TECHNOLOGIES ON THE QUALITY, DISEASE AND INSECT PEST INFESTATION IN TOMATO (*SOLANUM LYCOPERSICUM* L.)

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KEYWORDS
Growth
Hybrids
Mulch
Quality
Yield

Received on :
21.11.2016

Accepted on :
13.02.2017

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ABSTRACT
An experiment was carried out to study the effect of different planting methods with and without mulch on the quality, disease and insect pest infestation in five commercially important tomato hybrids namely Heem Sohna, Sonali, NS 2535, US 3383 and NS 816. Soil moisture (15.34%) and soil temperature(23.6 °C) was recorded highest in Ridge-furrow mulch method followed by Wide ridge mulch method as compared to non-mulch method. Sunscald was recorded highest (22.13%)in Ridge-furrow mulch method followed by (17.94%) in wide ridge mulch method as compared to non-mulch method(6%). Ascorbic acid (27.24mg/100g) and TSS (4.73%)was also recorded highest when crops were grown under mulch method. Fruit borer (12.03%) and early blight (19.54%) incidence were lowest in crops grown under mulch method. Mulch proved best for all the observations except for sunscald.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.*)* is one of the most important vegetable. The crop outranks all others vegetables in total contributions towards human nutrition as it is consumed fresh and cooked. It supplies Vitamin A, Vitamin C, minerals, certain types of hormone precursors, proteins and adds variety of colours and flavours to food. In modern health conscious era it possesses anti-ageing, intestinal antiseptic, gastric secretion and blood purifier properties. Tomato and its products reduce carcinogenesis, particularly prostate and mouth cancer due to the presence of anti-oxidant, beta-carotene and lycopene contents (Giovannucci *et al*., 2002). Tomato seeds possess strong anti-clotting properties which lower the risk of heart attack and cerebrovascular and neurological diseases (La Vecchia and Tavani, 1998).

In India, tomato is well adapted to all regions and occupies an area of about 9.20 lac ha with an annual production of 168.26 lac MT (Nighat *et al*., 2016). In Jammu and Kashmir region, tomato is cultivated over an area of 3.58 thousand hectares with an annual production of 88.09 thousand metric tonnes (Anonymous, 2013a). In spite of its wide cultivation, the average yield is rather low because little attention is paid towards scientific methods of production. In North India, cold winter and danger of frost are the main hindrance for planting tomato in winter to get early spring crop. The climate plays a pivotal role in the growth and development of tomato crop. Important techniques used for low temperature prevention are mulching, screening, use of heaters, wind machines, overhead sprinkler irrigation, wind breaks etc. Out of this technique, mulching is considered to be the best as it is cheap and ameliorate the microclimate of the crop by modifying soil temperature, evaporation, soil moisture etc. The main functions that mulches provide including: weed suppression, soil water conservation, moderation of soil temperature fluctuations (daily and seasonal), increased infiltration of water droplets from precipitation or irrigation, soil protection from traffic compaction, improved soil structure for organic mulches and the slow release of nutrients. (Kumar, 2014). Mulches have been found very effective in raising crop yield by increasing soil temperature (Ossom *et al*., 2003). Plastic mulches directly affect the microclimate around the plant by modifying the radiation budget of the surface and decreasing the soil water loss (Moreno *et al*., 2009). Keeping in view the importance of tomato crop the present investigation deals with the effect of planting method and mulch techniques as an attempt to meet the vagaries of climate change for successful production of tomato crop.

MATERIALS AND METHODS

The present investigation entitled "Effect of climate resilient technologies on the growth, yield and quality of tomato (*Solanum lycopersicum* L.)"was planned during the year 2013 and experiment comprised of five tomato hybrids and four method of planting was laid out during Spring-Summer season

of 2014 at Experimental area of Division of Vegetable Science and Floriculture, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Chatha, Jammu. The soil was sandy loam in texture, slightly alkaline in reaction, low to medium in electrical conductivity, low in organic carbon and available nitrogen and medium in phosphorus and potassium.

Five commercially important tomato hybrids, V_1 = Heem Sohna V_2 = Sonali, V_3 = NS 2535 V_4 = US 3383 V_5 = NS 816 with different planting methods viz. P_1 = Conventional ridge-furrow method (0.75m. × 0.60 m. with 0.15 m. deep furrow) P_2 = Ridge-furrow mulch method (0.75 m. × 0.60 m. with 0.15 m. deep furrow) P_3 = Non-conventional wide ridge method (1.0 m. × 0.90 m. with 0.30 m. deep furrow) P_4 = Wide ridge mulch method (1.0 m. × 0.90 m. with 0.30 m. deep furrow). The design used was Randomized Block Design (Factorial) replicated three times. The mulches were spread manually and holes were made, with the help of GI pipe for planting. Spacing of 60 × 60 cm in Conventional ridge-furrow method and Ridge-furrow mulch method and 60 × 80 cm in Non-conventional wide ridge method and wide ridge mulch method was maintained. The initial doses of nutrients were applied to the plots before layout of the mulches and subsequent doses were directly applied in the holes.

Soil temperature was measured throughout the plant growing period using mercury-in-glass geothermometers, it is buried at 10cm depth in the mulch plots with in rows of tomato plants and soil temperature measurements were taken at 11 am. Soil moisture (%) was calculated by using formula

$$\text{Soil moisture (\%)} = \frac{\text{Initial weight - Final weight}}{\text{Final weight}} \text{ X } 100$$

The estimation of total soluble solids was carried by putting drop of juice on the prism of hand refractometer and reading on per cent scale was noted.

For calculating ascorbic acid following formula is used.

$$\frac{\text{Titration} \times \text{dye factor} \times \text{volume make up}}{\text{Aliquate of extraction taken} \times \text{Weight of volume of sample taken to estimation}} \text{ X } 100$$

The incidence of tomato fruit borer was calculated using the following formula

$$\text{Fruit borer incidence (\%)} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits examined}} \text{ X } 100$$

The incidence of Sunscald was calculated using the following formula

$$\text{Sunscald (\%)} = \frac{\text{Number of infested fruits}}{\text{Total number of fruits examined}} \text{ X } 100$$

Disease severity was assessed in three stages of development at fifteen days interval by using 0-5 scale (Mayee and Datar, 1986) and described as 0= less than one per cent leaf area infected, 1= 5-11 per cent leaf area infected, 2= 6-20 per cent leaf area infected, 3= 21-40 per cent leaf area infected, 4= 41-70 per cent leaf area infected and 5= more than 71 per cent leaf area infected. Per cent disease index (PDI) was calculated by using the formula given by (Wheeler 1969).

$$\text{Per cent disease Index} = \frac{\text{Sum of individual ratings}}{\text{No. of plants examined} \times \text{Disease scale}} \text{ X } 100$$

RESULTS AND DISCUSSION

The data obtained on soil temperature shows significant differences among months and between planting methods. Maximum soil temperature (31.1°C) was recorded in the month of June followed by (27.8°C) in the month of May. Among different planting methods, maximum soil temperature of (23.6°C) were recorded in P_2 (Ridge-furrow mulch method) and in P_4 (Wide ridge mulch method). Interaction among various planting methods and months showed that in the month of June maximum soil temperature (32.7°C) was recorded under P_4 (Wide ridge mulch method). The results are in conformity with (Morene *et al*., 2009, Hooda *et al*., 1999, Singh., 2005, Singh and Shashi., 2012 and Singh *et al*., 2005). The proper justification of such result might be that the soil temperature under plastic mulch depends upon thermal properties (reflectivity, absorptivity or transmittance) of particular material in relation to incoming solar radiation. Black plastic mulch is the predominant colour used in vegetable production is an opaque blackbody absorber and radiator.

Maximum soil moisture (14.35%) was recorded during flowering stage followed by 13.96 per cent during transplanting stage. Among different planting methods, maximum soil moisture per cent (15.34) was recorded in P_2 (Ridge-furrow

Table 1: Effect of planting method on soil temperature °C in commercial hybrids of tomato (*Solanum lycopersicum* L.)

P.M MON.	February	March	April	May	June	Mean
P_1	11.2	16.5	21.7	26.8	29.7	21.2
P_2	13.3	18.6	24.5	29.2	32.5	23.6
P_3	11.2	16.5	21.6	26.4	29.5	21.0
P_4	13.2	18.6	24.5	29.0	32.7	23.6
MEAN	12.2	17.5	23.0	27.8	31.1	

Factors	SE (m)	C.D (P= 0.05)
Planting method	0.03	0.10
Month	0.04	0.11
Planting method x Month	0.08	0.23
C.V	0.63	

Table 2: Effect of planting method on soil moisture (%) in commercial hybrids of tomato (*Solanum lycopersicum* L.)

P.M G.S	Transplanting Stage	FloweringStage	FruitingStage	HarvestingStage	Mean
P_1	11.50	13.33	12.94	11.35	12.28
P_2	16.83	15.84	14.53	14.17	15.34
P_3	11.04	12.85	11.48	11.16	11.63
P_4	16.47	15.38	13.75	13.95	14.88
MEAN	13.96	14.35	13.17	12.65	

Factors	SE (m)	C.D (P= 0.05)
Planting method	0.04	0.11
Growth stage	0.04	0.11
Planting method × Growth stage	0.08	0.23
C.V	1.04	

Table 3: Effect of different planting methods and varaties on the quality, disease and insect pest infestation in tomato (*Solanum lycopersicum* L.)

Treatments	TSS (%)	Ascorbic acid (mg/100 g)	Fruit borer (%)	Early blight (%)	Sunscald (%)
P_1V_1	4.32	24.28	21.48	31.01	12.77
P_1V_2	4.00	23.10	21.26	40.72	17.75
P_1V_3	4.22	25.48	17.47	26.39	13.71
P_1V_4	4.27	24.32	32.46	30.60	11.69
P_1V_5	4.66	26.68	31.44	24.54	16.21
P_2V_1	4.70	25.52	13.85	18.45	17.44
P_2V_2	4.10	23.93	12.53	30.72	21.33
P_2V_3	4.53	26.68	7.76	13.61	19.42
P_2V_4	4.48	25.52	7.81	20.49	23.73
P_2V_5	4.83	28.15	18.21	14.45	28.74
P_3V_1	4.58	25.61	28.75	32.66	4.30
P_3V_2	4.41	23.54	23.80	50.20	3.69
P_3V_3	3.80	25.61	21.62	29.57	5.74
P_3V_4	4.08	25.62	29.44	23.29	5.85
P_3V_5	4.35	26.66	29.40	21.53	10.40
P_4V_1	5.26	26.44	12.62	19.58	13.72
P_4V_2	4.70	27.70	21.51	32.68	19.77
P_4V_3	4.44	27.70	13.19	19.35	16.59
P_4V_4	4.32	25.61	15.71	15.63	14.77
P_4V_5	4.97	28.74	21.31	16.46	24.87
C.D (P= 0.05)	N.S.	N.S.	4.38	3.43	4.50

mulch method). Interaction among various planting methods and growth stages showed that during transplanting stage maximum soil moisture (16.83%) was recorded in P_2 (Ridge-furrow mulch method). The result are in conformity with (Singh, 2005 and Awodoyin *et al*., 2007). It might be due to prevention of contact between the soil and dry air, which reduce water loss into atmosphere through evaporation.

Heem Sohna recorded the maximum TSS (4.71%). Among different planting methods, maximum TSS (4.73%) was recorded in P_4 (Wide ridge mulch method). The results are in conformity with (Tabasi *et al*., 2013; Mamnoie and Ali., 2013; Aruna *et al*., 2007 and Moreno *et al*., 2009). Mulching helps in maintaining optimum soil moisture which increases nutrient availability and promoted excellent crop growth with excellent quality.

Maximum ascorbic acid (27.56mg/100g) was recorded in NS 816. Among different planting methods, maximum ascorbic acid (27.24mg/100g) was recorded in P_4 (Wide ridge mulch method). The results are in conformity with (Aruna *et al*., 2007 and Tabasi *et al*., 2013). Mulching increases soil porosity reduces compaction, leaching of nutrients, weed problems, evaporation of soil moisture and increases water use efficiency which ultimately improves quality of produce.

Minimum incidence of fruit borer was recorded in NS 2535 (15.01%). Among different planting methods, minimum fruit borer incidence (12.03%) was recorded in P_2 (Ridge-furrow mulch method). Interaction among various planting methods and varieties showed that,minimum fruit borer incidence (7.76%) was recorded in NS 2535 with planting method P_2 (Ridge-furrow mulch method).It might be due to high soil temperature and intensity of light that affects fruit borer incidence.

Minimum early blight incidence was recorded in NS 816 (19.24%). Among different planting methods, minimum incidence of early blight (19.54%) was recorded in P_2 (Ridge-furrow mulch method). Minimum early blight incidence (13.61%) was recorded in NS 2535 with planting method P_2 (Ridge-furrow mulch method). Our results are in conformity with the findings of (Tewari and Vishunavat, 2012; Hooda *et al*., 1999). The proper justification for such result might be due to low level of initial inoculum from the soil reaching the plant at the begning of season which keeps disease at low level (Iyimo *et al*., 1998)

Heem Sohna showed minimum incidence of sunscald (12.03%). Among different planting methods, minimum incidence of sunscald (6.00%) was recorded in P_3 (Non-conventional wide ridge method). Interaction among various planting methods and varieties showed that minimum incidence of sunscald (3.69%) was recorded in Sonali with planting method P_3 (Non-conventional wide ridge method). It might be due to the increase in fruit pericarp temperature and the reflective effect of mulch. These results are in conformation with the findings of Moreno *et al*. (2009).

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