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Effect of Different Irrigation Regimes and Polythene Mulches on Yield and Economics of Drip Irrigated Tomato (*Lycopersicum esculentum Mill*.)

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A B S T R A C T

The field experiment was carried out to study the effect of different irrigation regimes and mulches on yield and economics of drip irrigated tomato during two consecutive years of *rabi* 2016-17 and 2017-18 at the research farm of AICRP on Irrigation Water Management, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was laid out in a split plot design with three replications and twelve treatments combination comprising of three irrigation regimes viz. irrigation level at 0.6 PE (I_1), irrigation level at 0.8 PE (I_2) and irrigation level at 1.0 PE (I_3) in main plot and four polythene mulch treatments viz. black polythene mulch (M_1), silver black polythene mulch (M_2), transparent polythene mulch (M_1) and control (M_4) in sub plot. Based on the pooled results it was observed that higher fruit yield, gross monetary return and net monetary return was recorded in irrigation level at 0.8 PE with silver black polythene mulch (I_2M_2) over rest of treatment combination, however it was comparable with treatment combination of irrigation level at 0.8 PE with black polythene mulch (I_2M_1) and irrigation level at 0.6 PE with silver black polythene mulch (I_1M_2). Similarly higher benefit cost ratio was also obtained in irrigation level at 0.8 PE with silver black polythene mulch (I_2M_2).

Introduction

Tomato (*Lycopersicum esculentum Mill*.) belongs to solanaceae family which is one of the popularly grown and highly valuable vegetable in the world. India is the second largest producer of tomato and is grown on an area of 773.9 thousand ha with production of 18732 thousand metric tonne and productivity of 24.2 metric tonne per hectare. Tomatoes are a warm-season crop which is sensitive to frost and humidity at any growth stage. It requires various climatic range for seed germination, growth of seedling, flowering, fruit formation and fruit quality. In water deficit area, judicious use of water is essential for increasing area under crop production with adequate water supply. This can be achieved by adopting advanced irrigation methods. In Marathwada region of Maharashtra state, cold winter is the main hindrance for planting of tomato crop in winter season to get early spring crop.

Now a day different colored polythene mulches available in market. These mulches regulate soil temperature i.e. during winter it warms up and during summer it cools. Use of mulches with drip irrigation saves substantial amount of water enhancing crop productivity and quality. Considering this fact, information on the effect of drip irrigation alone and in combination with polythene mulch on yield and economics of tomato is vital for policy markets in developing new strategy. The use of drip irrigation in conjunction with polythene mulch may serve as an effective methods to manipulate the crop growing environment which may increase the yield as well as improve the quality parameter by ameliorating soil temperature, conserving soil moisture, reducing soil erosion, enhancing soil organic matter, improving soil structure and microbial activity of soil by moderating environment around root zone.

Keeping this in view the present study was conducted to evaluate the effect of polythene mulch and drip irrigation on yield and economics of tomato grown in Marathwada region of Maharashtra.

Materials and Methods

The field experiment was carried out during *rabi* season for two consecutive years viz. 2016-17 and 2017-18 at the research farm of All India Co-ordinated Research Project on Irrigation Water Management, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experiment was laid out in a split plot design with three replications and twelve treatments combination comprising of three irrigation regimes viz. irrigation level at 0.6 PE (I_1), irrigation level at 0.8 PE (I_2) and irrigation level at 1.0 PE (I_3) in main plot and four polythene mulch treatments viz. black polythene mulch (M_1), silver black polythene mulch (M_2), transparent polythene mulch (M_1) and control (M_4) in sub plot. Thirty days old healthy tomato seedlings of variety Namdhari NS-629 was transplanted at the spacing of 60 cm x 60 cm on broad bed furrow.

The drip irrigation was scheduled at an alternate days based on cumulative pan evaporation. The daily pan evaporation was collected from the Agrometeorology observatory, Department of meteorology, VNMKV, Parbhani. The quantity of water to be applied treatment wise was estimated by considering cumulative daily pan evaporation for two days and area to be irrigated. The following formula was used for determining the quantity of water applied.

$$V = PE \times A$$

Where, V = Volume of water to be applied (litre)

PE = Daily cumulative pan evaporation (mm) multiplied by factor of irrigation regimes i.e. 0.6, 0.8 and 1.0

A = Unit area of plot (m^2)

The operating time of drip system (t) was calculated by using the following formula.

$$t = \frac{V}{q \times Ne} \times 60$$

Where, t = time of operating system (min)

q = Average emitter discharge (lph)

Ne = Number of emitter per unit length of lateral

Treatment wise fruit yield of tomato from each treatment plot was recorded then converted into tonne per hectare. For economic analysis, the gross monetary return per hectare was calculated by considering the

prevailing market prices of tomato fruit. The net income was calculated by subtracting the total cost of cultivation from gross monetary returns and the benefit cost ratio (B: C) was worked out by dividing of gross monetary return with cost of cultivation. Analysis of variance (ANOVA) was used to evaluate the significance of treatment effect on yield and economics of drip irrigated tomato. The pooled analysis of tomato yield and economics data of two years was work out as per method described by Gomez and Gomez, 1984.

Results and Discussion

Fruit yield per hectare

The results presented in Table 1 revealed that fruit yield of tomato were influenced significantly by different irrigation regimes and mulches during both the years of study.

The application of irrigation at 0.8 PE (I_2) recorded significantly higher fruit yield (136.75, 120.31 and 128.53 t ha^{-1}) over rest of irrigation levels during 2016-17, 2017-18 and pooled mean respectively.

The probable reason for this might be that drip irrigation at 0.8 PE have proven sufficient as per crop water requirement which reflected in achieving higher fruit yield under this treatment. These results are parallel to the earlier findings reported by Sharma *et al.,* (2015).

Among various mulches, the silver black polythene mulch (SBPM) recorded significantly higher yield (150.98, 129.43 and 140.21 t ha^{-1}) over the rest of polythene mulches during 2016-17, 2017-18 and pooled mean respectively however it was found at par with black polythene mulch (BPM) during 2017-18. The higher yield obtained in silver black polythene mulch (SBPM) might be due to availability of optimum soil moisture content and favorable micro climate both beneath and above the soil surface. These findings are in agreement with views of Rajablariani *et al.,* (2012).

Interaction effect of irrigation regimes and mulches on fruit yield of drip irrigated tomato

The fruit yield was significantly influenced by interaction effect of different irrigation regimes and mulches during both the years of experimentation. The data pertaining to interaction effect of various treatments on fruit yield of tomato is furnished in Table 2.

The results revealed that the application of irrigation level at 0.8 PE with silver black polythene mulch (I_2M_2) recorded significantly higher fruit yield over rest of treatment combinations however it was comparable with treatment combination of irrigation level at 0.8 PE with black polythene mulch (I_2M_1) and irrigation level at 0.6 PE with silver black polythene mulch (I_1M_2) during both the years of study and pooled mean.

The maximum fruit yield obtained in silver black polythene mulch with drip irrigation at 0.8 PE might be due synergistic effect of drip irrigation and mulch which had helped in creating the favorable hydro thermal regime and optimum soil moisture content for better fruit yield of tomato.

The present results are in agreement with the earlier findings reported by Sreedevi *et al.,* (2017) for brinjal wherein drip irrigation at 0.8 ET with silver black polythene mulch produced significantly higher yield over control treatment. The results are in lined with Harish Kumar *et al.,* (2017).

Table.1 Fruit yield of drip irrigated tomato as influenced by different irrigation regimes and mulches during 2016-17, 2017-18 and pooled mean

Treatment	Yield (t ha^{-1})		
Irrigation regimes (I)	**2016-17**	**2017-18**	**Pooled**
I_1 = 0.6 PE	117.72	106.75	**112.24**
I_2 = 0.8 PE	136.75	120.31	**128.53**
I_3 = 1.0 PE	121.74	112.43	**117.08**
S.E.±	1.28	0.90	**0.71**
C.D.(P=0.05)	3.80	2.67	**2.11**
Mulches (M)			
M_1 =BPM	138.55	125.61	**132.08**
M_2 =SBPM	150.98	129.43	**140.21**
M_3 =TPM	112.11	106.12	**109.12**
M_4 =Control	99.97	91.50	**95.73**
S.E.±	1.80	2.45	**1.75**
C.D.(P=0.05)	5.35	7.26	**5.20**
Interaction(I x M)			
S.E.±	3.12	4.24	**3.03**
C.D.(P=0.05)	9.27	12.58	**9.01**
GM	**125.40**	**113.16**	**119.28**

Table.2 Fruit yield of drip irrigated tomato as influenced by interaction of different irrigation regimes and mulches during 2016-17. 2017-18 and pooled mean

Treatment	Yield (t/ha)		
Interaction (I X M)	**2016-17**	**2017-18**	**Pooled**
I_1M_1	130.29	123.62	**126.95**
I_1M_2	154.43	129.3	**141.87**
I_1M_3	93.51	89.56	**91.55**
I_1M_4	92.65	84.53	**88.59**
I_2M_1	155.7	133.17	**144.43**
I_2M_2	157.36	137.94	**147.66**
I_2M_3	127.09	113.05	**120.07**
I_2M_4	106.82	97.1	**101.96**
I_3M_1	129.67	120.03	**124.85**
I_3M_2	141.13	121.06	**131.09**
I_3M_3	115.71	115.74	**115.73**
I_3M_4	100.45	92.87	**96.66**
S.E.±	3.12	4.24	**3.03**
C.D.(P=0.05)	**9.27**	**12.58**	**9.01**

Table.3 Economic of drip irrigated tomato as influenced by different irrigation levels and mulches

Treatment	Cost of cultivation (Rs. ha^{-1})		GMR (Rs. ha^{-1})			NMR (Rs. ha^{-1})			B:C ratio	
Irrigation levels	**2016-17**	**2017-18**	**2016-17**	**2017-18**	**Pooled**	**2016-17**	**2017-18**	**Pooled**	**2016-17**	**2017-18**
I_1 -0.60 PE	290195	285108	588517	533771	561144	298322	248663	273493	2.01	1.86
I_2-0.80 PE	299033	291407	683625	601567	642596	384592	310159	347376	2.27	2.05
I_3-1.0 PE	291682	287743	604525	562129	583327	312843	274386	293615	2.06	1.95
SE±	-	-	7418	4519	3404	6729	4099	3087.8	-	-
CD at 5%	-	-	22009	13408	10099	19964	12162	9160.2	-	-
Mulches										
M_1: BPM	306083	300068	692761	628028	660394	386678	327960	357319	2.26	2.09
M_2: SBPM	313909	303911	754756	647161	700958	440846	343250	392048	2.40	2.13
M_3: TPM	291730	288948	560517	530583	545550	268787	241635	255211	1.91	1.83
M_4: Control	262824	259416	494189	457517	475853	231365	198100	214732	1.88	1.76
SE±	-	-	12372	12242	9814	11222	11105	8902.1	-	-
CD at 5%	-	-	36702	36319	29115	33291	32944	26409	-	-
Interaction (I X M)										
SE±	-	-	21428	21205	16998	19437	19234	15419	-	-
CD at 5%	-	-	63570	62906	50428	57662	57060	45742	-	-
GM	293637	288086	625556	565822	595689	331919	277736	304828	2.11	1.95

Table.4 Gross Monetary Return of drip irrigated tomato as influenced by interaction of different irrigation regimes and mulches during 2016-17. 2017-18 and pooled mean

Treatment	Gross Monetary Return (Rs. ha^{-1})		
Interaction (I X M)	**2016-17**	**2017-18**	**Pooled**
I_1M_1	651467	618083	**634775**
I_1M_2	772167	646483	**709325**
I_1M_3	467533	447783	**457658**
I_1M_4	462900	422733	**442817**
I_2M_1	778483	665850	**722167**
I_2M_2	786467	689683	**738075**
I_2M_3	635450	565250	**600350**
I_2M_4	534100	485483	**509792**
I_3M_1	648333	600150	**624242**
I_3M_2	705633	605317	**655475**
I_3M_3	578567	578717	**578642**
I_3M_4	485567	464333	**474950**
S.E.±	21428	21205	**16998**
C.D.(P=0.05)	**63570**	**62906**	**50428**

Table.5 Net Monetary Return of drip irrigated tomato as influenced by interaction of different irrigation regimes and mulches during 2016-17. 2017-18 and pooled mean

Treatment	Net Monetary Return (Rs. ha^{-1})		
Interaction (I X M)	**2016-17**	**2017-18**	**Pooled**
I_1M_1	349221	318939	**334080**
I_1M_2	456640	342635	**399637**
I_1M_3	184444	166529	**175487**
I_1M_4	202983	166549	**184766**
I_2M_1	464434	362267	**413351**
I_2M_2	469611	381821	**425716**
I_2M_3	336757	273081	**304919**
I_2M_4	267567	223468	**245518**
I_3M_1	346378	302672	**324525**
I_3M_2	396289	305294	**350791**
I_3M_3	285160	285296	**285228**
I_3M_4	223544	204283	**213914**
S.E.±	19437	19234	**15419**
C.D.(P=0.05)	**57662**	**57060**	**45742**

Economics of drip irrigated tomato

The data pertaining to economics of tomato as influenced by different irrigation level and mulches during 2016-17, 2017-18 and pooled mean are presented in Table 3.

The data furnished in Table 3 revealed that the gross monetary return and net monetary return of tomato was significantly influenced by different irrigation regimes, mulches and their interaction effect.

Significantly higher gross monetary return and net monetary return were observed in drip irrigation scheduled at 0.8 PE (I_2) as compared to rest of irrigation level during both the years of study and pooled mean.

The higher fruit yield obtained in irrigation level at 0.8 PE might have reflected in achieving higher gross monetary return and net monetary return. Similarly, higher benefit cost ratio was also obtained under irrigation level at 0.8 PE (I_2).

As regards to mulches, the silver black polythene mulch (SBPM) recorded significantly higher gross monetary return and net monetary return over rest of mulches during 2016-17, 2017-18 and in pooled mean. However it was found at par with black polythene mulch (BPM) during 2017-18.

The lower value of gross monetary return and net monetary return was recorded in control treatment during both the years and in pooled mean.

The higher benefit cost ratio was obtained in silver black polythene mulch (SBPM) followed by black polythene mulch (BPM) whereas the lowest benefit cost ratio was obtained in control treatment during both years of investigation.

Interaction effect of different irrigation regimes and mulches on gross monetary return and net monetary return

The gross monetary return and net monetary return was significantly influenced by interaction effect of different irrigation regimes and mulches during both the years of investigation and presented in table 4 and 5.

Among the various treatment combinations, higher values for gross monetary return and net monetary return were obtained in treatment combination of irrigation level at 0.8 PE with silver black polythene mulch (I_2M_2) and it was found at par with treatment combination of irrigation level at 0.8 PE with black polythene mulch (I_2M_1) and irrigation level at 0.6 PE with silver black polythene mulch (I_1M_2) during 2016-17, 2017-18 and in pooled mean.

The higher fruit yield obtained in treatment combination of irrigation level at 0.8 PE with silver black polythene mulch (I_2M_2) might have reflected in obtaining higher gross monetary return and net monetary return in same treatment combination. The results are in lined with the findings reported by Singh *et al.,* (2009).

The results obtained from present investigation concluded that application of drip irrigation at 0.8 PE either with silver black polythene mulch or black polythene mulch and drip irrigation at 0.6 PE with silver black polythene mulch were found equally effective in achieving higher yield as well as economics of tomato.

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