Response of Spring Season Tomato (*Lycopersicon Esculentum* Mill.) to Different Mulching Materials in Gulariya, Bardiya District, Nepal

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ABSTRACT

In Bardiya, western Nepal, a field experiment was carried out in 2x5 randomized complete block design (RCBD) with 3 replications to investigate the effects of different mulching treatments viz. rice straw, rice husk, black plastic and red plastic in two commercial varieties of tomato i.e. Pusa Ruby and F_1 hybrid Abinash-2 during spring season 2004. Treatment without mulching served as control. Plants of Pusa Ruby were significantly taller (114.37 cm) than Abinash-2 (72.09 cm). Number of flowers per truss, number of fruits per truss, percent fruit set and fruit yield of Abinash-2 were significantly higher than Pusa Ruby. Total marketable fruit yield was almost 50 percent higher in Abinash-2 (29.35 ton/ha) than in Pusa Ruby (20.45 ton/ha). In general, all the mulching treatments resulted better plant growth and yield as compared to control. Rice husk produced highest number of fruits per plant (38.48) and highest marketable yield (31.03 tons/ha). However, earliest flowering, highest number of flowers per truss (5.79), highest percentage of fruit set (81.47%), highest average fruit weight (48.49 gram) and earlier harvest were observed with red plastic mulch. The overall performance was found superior in rice husk mulching followed by rice straw.

Key words: Plastic mulches, growth, light, phytochrome, yield, quality

INTRODUCTION

Tomato is one of the most important vegetable crop grown all over the world, including Nepal. It has been described as a versatile commodity that can be eaten fresh or processed for a wide range of products; and can be utilized to improve the flavours and characters of other foods (Villareal, 1979). In Nepal, it is grown in an area of about 10,500 hectares with a total production of about 72,600 tonnes resulting with an average yield of 6.9 tonnes per hectare (Shrestha and Ghimire, 1996). Bardia is one of the tomato producing districts in western Nepal covering 126 ha. of land. The average productivity of tomato in Bardiya district is 16.0 ton/ha. (DADO, 2004). Lower productivity of tomato in Nepal including Bardia is due to excessive rainfall, drought, weeds, pests and diseases, poor cultural practices and low soil fertility. The high night and day temperature are the common phenomenon in the tropical climate of terai region that may be accounted for the reduced flowering, fruit set and ultimately lower yield in tomato (Aung, 1979; Kuo *et al*. 1979).

Apart from the different environmental and climatic conditions, differences in cultural profiles and its applications make differences in tomato yield. Mulching is one example of cultural practice which can be used in tomato cultivation to improve yield. Mulching plays an important role in controlling weeds (Noling and Becker, 1994), conserving soil moisture, providing favourable environment for root development, maintaining uniform temperature and hastening fruit maturity (Sajjapongese *et al*. 1989; Thompson and Kelly,

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1983), reducing insect population (Conway *et al*. 1989; Lamont *et al*. 1990) and disease incidence (Manna *et al*. 2001). Soil temperature is modified by mulches to various degrees. Plastic mulches warm the soil, increasing early plant development in the cooler months whereas organic mulches act as insulation and help keep soil cooler. In addition, it also help reduce fertilizer loss, increases chlorophyll content of leaves, number of flowers and fruit yield with extended growing period of the crop (Lamont, 1991).

The benefitial effects of mulching have been well documented in several reports. Experiments conducted at AVRDC revealed that tomato yield was increased by 67.5% when the crop was mulched with black plastic and by 15% when rice straw was used as mulch (Sajjapongese *et al*. 1989). Patil *et al*. (1973) and Sukla and Prabhakar (1988) also obtained increased yield of tomato with polythene mulching. Gunadi and Suwandi (1987) observed that the application of straw mulch increased 15% of total yield and 16.3% of marketable yield compared to no mulching. Similar observations were made by Gupta and Gupta (1987) when straw mulching was used together with light and frequent irrigation in a sandy loam soil and obtained increased tomato yield up to 100%. Among the coloured plastic mulches best performance of tomato crop under red plastic mulch have been reported by several authors (Decoteau *et al.*,1989; Csizinszky *et al*. 1995; Schut, 2001;). The higher yield under mulched treatments was due to increase in number of clusters and flowers, fruits per plant, and early yield (Vandenberg and Tiessen, 1972; Famoso and Bautista, 1983; West and Peirce 1988).

Mulching in tomato is not a usual practice in Bardiya. However, farmers in Bardiya use mulch in some other vegetable crops like potato, cucumber, pointed gourd etc. In Nepal, use of mulching in tomato cultivation has not been reported. This study therefore, aims to evaluate the performance of different mulching materials on production of two commercial varieties of tomato.

MATERIALS AND METHODS

The study was conducted in the Guleriya Municipality- 4, Bardiya district of Nepal in the 2004 spring growing season. The field experiment was laid in 2X5 randomized block design (RCBD) with 10 treatments replicated thrice. The treatments consisted of two tomato cultivars viz. Pusa Ruby and Abinash-2 and five different mulching materials viz. rice straw, rice husk, black plastic, red plastic and control (without mulching). Each plot consisted of 24 plants planted at a distance of 60 cm × 75 cm. There were 6 rows and 4 plants were planted within a row. The outer 16 plants were taken as border plants which surrounded the inner 8 observational plants.

Tomato seeds were sown in nursery beds on December 21, 2003 and were transplanted on Feb 1, 2004. The main plot was prepared by one deep ploughing followed by two harrowings. Then, the field was levelled and divided into blocks and plots as in the layout. Farm yard manure (FYM) at the rate of 20 tons/ha and chemical fertilizer at the rate of 80:60:50 N:P:K kg/ha were given. After preparation of the field and application of fertilization, a light irrigation was given one day prior to the transplanting. Organic mulches were applied after transplanting the seedlings at the distance of 60 cm × 75 cm. However, in case of plastic mulching, seedlings were transplanted at the pre-perforated hole (5 cm diameter) on plastic sheets at the given distance. In the control plots seedlings were transplanted accordingly. Timely irrigation were given to all the plots. Weeding were carried out for rice straw, rice husk and control plots and the fresh weight of the

weeds were recorded. In case of plastic mulches fresh weight of weeds were recorded only after final fruit harvest when plastics were removed.

The plant morphological characters like plant height at 15 days interval, days to 50% flowering, days to first harvest, number of flowers per truss, number of fruits per truss were recorded. Similarly yield and yield attributing characters like percent fruit set, number of fruiting trusses per plant, number of fruits per plant, marketable fruit yield, average fruit weight were also recorded. Statistical analysis was done using Microsoft Excel, Minitab and MStatc softwares. The means of all the observed characters which are significant at 5% level were separated by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Effects of mulching on plant morphological characters.

The two commercial cultivars showed significant difference in plant height, days to first harvest, number of flowers per truss and number of fruit per truss. The plant height was non-significant between the two cultivars during early stage of growth while during later stages Pusa Ruby were found significantly taller than the Abinash-2 (Table 1). The significant differences in plant height between two cultivars is due to differences in their growth habit. Pusa Ruby having a indeterminate type of growth (Pun, 1985), obviously grows more taller than the semi-determinate variety Abinash-2. The effects of different mulching treatments were significant on days to 50% flowering, days to first harvest, number of flowers per truss and number of fruit per truss while it was non significant for final plant height.

Days to 50% flowering after sowing which could be one of the characters to indicate early maturity of the crop was observed significant among the mulching treatments (Table 1). However no significant difference was found between the two cultivars. The 50% flowering occurred earliest (60.0 days after sowing) in red plastic. The most delayed flowering (74.3 DAS) was in rice straw mulched plot. Significant varietal differences were found in days to 1st fruit harvest after sowing (Table 1). The earlier flowering in the plastic mulch may be attributed to the increased soil temperature and reduced weed growth with the use of plastic mulch compared to the control. Several reports have indicated increased soil temperature level by plastic mulch treatments (Teasdale and Abdul-Baki, 1995; Hooda *et al.,* 1999; Díaz-Pérez and Dean Batal, 2002).

The first harvest date was significantly earlier in Pusa Ruby (129.53 DAS) than in Abinash-2 (133.20 DAS). Differences for number of days to first harvest after sowing were also found significant among mulching treatments. Earliest harvest (128.67 DAS) was obtained in red plastic mulch and the delayed harvest (133.50 DAS) was obtained in rice straw followed by control plots (132.67 DAS). The earliness in yield with the use of red plastic mulch in tomato have been reported by several authors (Csizinszky *et al*., 1995; Decoteau *et al*., 1989). According to the report, the positive effect of red mulch on earliness is due to the reflection of higher far-red to red (FR/R) ratio from red mulch (Kasperbauer, 1971; Kasperbauer, 1987; Kasperbauer *et al*. 1984; Kasperbauer and Hunt, 1998).

The two tested cultivars differed significantly in respect of the number of flowers and fruits per truss. Abinash-2 had significantly higher number of flowers and fruits than Pusa Ruby.

The number of flower and fruits per truss were influenced significantly by mulching. The highest number of flowers (5.79) and fruits (4.72) per cluster were observed in red plastic mulching followed by rice husk (5.45 and 4.22 respectively) and the least number in the control plots (4.86 and 3.01 respectively). The positive effects of red mulch on earliness could be due to the reflection of higher far-red (FR)/ red ratio in red mulch (Kasperbauer, 1971; Kasperbauer, 1987; Kasperbauer *et al*. 1984 and Kasperbauer and Hunt, 1998).

Table 1 Morphological characters of two varieties of tomato plant as affected by mulching treatments at Bardiya 2004.

S.N.	Treatments	Plant height (cm) at different growth stages			Days to 50% flowering after sowing	Days to first harvest after sowing	Number of flowers per truss	Number of fruits per truss
		85 DAS	115 DAS	160 DAS				
	Variety							
1	Abhinash-2	22.05	57.96b	72.09b	69.60	133.20a	5.50a	4.35a
2	Pusa Ruby	20.52	68.35a	114.37a	68.47	129.53b	4.97b	3.50b
	F test	ns	**	**	ns	*	**	**
	Mulching							
1	Rice Straw	17.43	60.37	96.83	74.33a	133.50a	4.94c	3.71b
2	Rice Husk	23.50	69.43	99.23	73.00ab	130.50ab	5.45ab	4.22ab
3	Black Plastic	22.73	62.17	88.35	65.67bc	131.50ab	5.13bc	3.98b
4	Red Plastic	22.77	64.57	100.63	60.00c	128.67b	5.79a	4.72a
5	Control	20	59.23	81.1	72.17ab	132.67a	4.86c	3.01c
	F test	ns	ns	ns	*	*	**	**
	F test Variety×Mulching	ns	ns	ns	ns	Ns	ns	ns
	C.V.	18.54%	10.76%	18.49%	9.76%	1.98%	7.51%	12.77%

DAS = Days after sowing, C.V. = Coefficient of variation, ns = non significant (P>0.05)

Figures within the column having common letters are not significantly different at 5% level by DMRT.

Effects of mulching on yield and yield attributing characters

Fruit setting rate was significantly affected by mulching treatments (Table 2). The highest fruit setting rate (81.47%) was recorded in red plastic mulch followed by rice husk (77.20%) and the lowest (62.01%) in the no-mulch treatment. In all mulched treatments fruit set was significantly higher than the control.

The number of fruiting trusses per plant differed significantly for the two tested cultivars (Table 2). Pusa Ruby had significantly higher number of fruiting trusses (17.63) per plant than Abinash-2 (12.24). This significant differences may be attributed to their differences in growth habit.

The effect of mulching treatments on number of fruiting trusses per plant was also significant (Table 2). Rice straw mulched plots showed significantly higher number of fruiting trusses (19.47) followed by rice husk (16.23) and red plastic (14.20). Least number of fruiting trusses per plant were shown by black plastic mulch (11.83). The number of fruiting trusses in a plant seems to be correlated with the overall vegetative growth of the plant and branching which may be further influenced by the soil temperature. Olasantan (1985) had reported that mulched plants had more branches than unmulched plants. Arin and Ankara (2001) also observed increased plant height in tomato with the use of straw mulch.

Table 2. Yield and yield attributing characters of two tomato varieties as affected by mulching at Bardiya 2004.

SN	Treatments	Fruit set percent	No. of fruiting trusses per plant	Number of fruits per plant	Marketable yield per hectare (T/ha)	Average fruit weight (g)
	Variety					
1	Abhinash-2	78.87a	12.24b	27.15 b	29.64 a	56.23 a
2	Pusa Ruby	69.97b	17.63a	33.98 a	20.66 b	29.24 b
	F test	**	**	**	**	**
	Mulching					
1	Rice Straw	74.34a	19.47a	33.45 ab	29.78 a	42.76 abc
2	Rice Husk	77.20a	16.23ab	38.48 a	31.35 a	40.28 bc
3	Black Plastic	77.06a	11.83c	27.23 bc	21.81 bc	44.97 ab
4	Red Plastic	81.47a	14.20bc	34.05 ab	28.14 ab	48.49 a
5	Control	62.01b	12.93bc	19.60 c	14.69 c	37.16 c
	F test	**	**	**	**	**
	F test Variety×Mulching	ns	ns	ns	ns	ns
	C.V	10.96%	19.86%	20.85%	25.70%	11.35%

C.V. = Coefficient of variation, ns = non significant (P>0.05)
Figures within the column having common letters are not significantly different at 5% level by DMRT.

The two tested cultivars differed significantly in producing number of fruits per plant (Table 2). Pusa Ruby produced significantly higher number of fruits per plant (33.98) compared to the Abinash-2 (27.15). The differences in the number of fruits per plant between the two tested cultivars may be due to the differences in growth habit. Having indeterminate growth habit, Pusa Ruby grew taller (Table 1) and produced more number of fruiting trusses per plant which ultimately resulted in higher number of fruits per plant. The effect of mulch on the number fruits per plant differed significantly among mulching materials. The highest number of fruits per plant was recorded in plants with rice husk (38.483) and lowest in the control (19.60).

The two tested cultivars showed significant difference in terms of marketable yield per hectare. Abinash-2 (a F1 hybrid), obviously gave significantly higher yield (i.e. 29.64 T/ha) than Pusa Ruby (20.66 T/ha). Marketable yield per hectare also differed significantly among mulch treatments. The highest marketable yield was recorded in plants with rice husk (31.35 T/ha) followed by rice straw (29.78 T/ha) and the lowest (14.69 T/ha) was produced from the control plots. The results have some similarities with Arin

and Ankara (2001) in which wheat straw increased the total fruit yield in tomato. The benefitial effect of rice husk was also reported by Singh *et al.* (1977) in which rice husk gave the highest total marketable yield in case of potato. Some researchers have also reported a yield benefit for tomato with the use of organic mulch (hairy vetch) compared to black plastic or no mulch (Abdul-Baki and Teasdale, 1993). The results that organic mulch gave higher yield than the other application could be explained in light of beneficial effects of organic mulch which not only help in retention of soil moisture and cooling down soil temperature during warmer months but also help increase concentration of CO_2 around the plant because the soil under organic mulch give CO_2 emmision during its decomposition (Hartley *et al.*, 1996) which ultimately results in increased photosynthesis (Witter and Honma, 1979).

Among the two tested cultivars Abinash-2 produced significantly heavier fruits (56.23 g/fruit) than that of Pusa Ruby (29.24 g/fruit). The difference may be attributed to the thier varietal characters. Average fruit weight differed significantly among mulching materials (Table 2). The heaviest fruits were obtained from plants mulched with red plastic (48.49 g/fruit) followed by those mulched with black plastic (44.97 g/fruit). Minimum average fruit weight was obtained from the unmulched plants (37.16 g/fruit). No significant differences in average fruit weight were observed among rice straw, rice husk and black plastic mulched treatments. However black plastic mulch produced heavier fruits than rice straw and rice husk mulch. The overall effect of mulching treatments on fruit characters of tomato is that red plastic mulch produced significantly bigger and heavier fruits than rest of the treatments. Cooper (1999) has supported this finding. In his report mulch color had no effect on total marketable yield of tomato but average fruit weight was significantly greater with the red mulch.

From the above results, it can be concluded that application of rice husk or rice straw as mulch proved to be the best for tomato production in the spring season under Bardiya condition. Abinash-2 performed better than Pusa Ruby particularly in yield and yield components. Red plastic mulch was found effective to produce bigger and heavier fruits, higher number of flowers and fruits per truss and early yield. For spring season tomato production in areas like Bardiya application of rice husk and rice straw as a mulch can be suggested.

ACKNOWLEDGEMENTS

The authors acknowledge the support from the advisory committee of this research and members of Institute of Agriculture and Animal Science, Rampur, Chitwan.

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