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Effect of integrated management practices on yield and time of harvest in tomato (*Lycopersicon esculentum* Mill.)

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Abstract

The present investigation was carried out to study the effect of integrated management practices on yield and harvesting span of tomato. The experiment consisted of five cultural treatments and four varieties, planted in a split plot design. Number of primary branches, fruit trusses, fruits, fruit weight, marketable yield and incidence of fruit borer were the highest in November transplanted crop, allowed to grow as such, and were lowest in March transplanting. Topping in both November and February transplantings reduced fruit yield, characters contributing to yield and incidence of fruit borer. Hybrid TH2312 out performed other varieties for most of the characters. Harvesting span of November transplanted-topped crop was the longest and that of March transplanting the shortest. The effect of topping in delaying the harvesting span was more conspicuous in November transplanted crop compared with February transplanting. This effect also varied with the varieties/dates of transplanting, being well marked in TH2312 and CR-2-P8-5-1 in November transplanting and only in Nagcarlan in February transplanting. The incidence of blotchy ripening and sunscalding was highest in March transplanting and the lowest in November transplanting, whereas the reverse was true in case of incidence of fruit borer. Topping increased incidence of blotchy ripening, sun-scalding and decreased the incidence of fruit borer infestation in both November and February transplanting.

Key words: Tomato, *Lycopersicon esculentum* Mill., topping, transplanting time, hot-set, yield, varieties, fruit borer, sun-scald, prunning

Introduction

Under north-Indian conditions of Punjab, harvest from the tomato crop is available from second fortnight of April to first week of June-a period even less than two months. The lean availability of tomato during late summer is mainly because of high summer temperature prevailing in the preceding months. Temperature has a marked effect on the fruit-set in tomato, although tomato plant can grow under a wide range of temperature, yet fruit-set is usually poor when the average maximum day temperature is above 30°C and the average minimum night temperature is above 22°C. Night temperature plays an important role in fruit setting of tomatoes. The optimum night temperature of 15 to 20°C is required for fruit setting in tomatoes. Fruit fails to set when night temperature is below 13°C. During summer, day temperature in north Indian plains prevails generally above 40°C, which reduces flowering, fruit setting, fruit size and induces flower drop. In Punjab, the summer crop of tomato passes through two extremes of temperature *i.e.* nearly freezing minimum temperature during December-January and maximum temperature of 40-45°C in May-June. Fruit setting becomes a problem due to high temperature from April onwards. Moreover, fruits that set late in the season, parthenocarpically or otherwise due to weather fluctuations, are subject to adverse effect of high temperature at fruit ripening, resulting in poor pigment development and its uneven expression on fruit surface. Wide genotypic variability for flowering and fruit setting under high temperature conditions has been reported by Berry and Uddin (1988), Abdul-Baki (1991), Banerjee and Kalloo (1991), Dane *et al.* (1991), Cheema and Singh (1993), Shete *et al.* (1994) and many others. Besides identifying genotypes that can give mature fruits under high temperature, manipulation of cultural practices like topping and modifying the dates of sowing if involved to explore the possibility of extending the supply period of tomato, many ensure remunerative returns to the tomato growers and an affordable market price to the consumers, beyond the first week of June. Though several reports have highlighted the role of genotypes and temperature on fruit setting in tomato, not much information is available regarding the role of cultural treatments like topping individually as well as in conjunction with the genotypic variability, in extending the growth period of tomato. So, the present study was designed to make use of some genotypes, in conjunction with topping, and different dates of planting for late setting of fruit under relatively high temperature conditions.

Materials and methods

The investigation was carried out at the Vegetable Research Farm, Punjab Agricultural University, Ludhiana, on a sandy loam soil, during the 2001-2002 growing season. Seed of the determinate tomato cvs. TH2312 (V_1), Nagcarlan (V_2), CRXNSS-1-1 (V_3) and CR-2-P8-5-1 (V_4) were sown outside, in nursery beds that were 1.5 m wide and about 20 cm high on 17 Oct. 2001, 11 Dec. 2001 and 31 Jan. 2002. These varieties were being maintained in the Department of Vegetable Crops, where from the seeds were obtained for the experiment. Seeds were sown in rows, 10 cm apart and seeds were placed in the rows 2 cm part and 1 cm deep. While preparing beds well rotten cowdung manure was applied @ 2.5 kg m^{-2} and mixed well in the soil. NPK Fertilizer (12:32:16) was added along with cowdung manure @ 25 g m^{-2}. Nursery beds were applied light irrigation with watering can once or twice depending upon the weather conditions. A green manure crop of

Jantar (*Sesbania aculeata*) was grown in the field (July-August) and buried in the soil with furrow turning plough on 4th September and irrigated. Disk-harrow was run twice before making the beds. Beds were made with a tractor driven bed maker with attachment for fertilizer application. 20 kg N (45 kg urea) alongwith 25 kg P_2O_5 (155 kg Superphosphate) and 25 kg K_2O (45 kg Muriate of Potash) per acre was added in the soil. The remaining 35 kg N (75 kg urea) was supplied after the appearance of first flowers truss. For weed control, Stomp 30 EC (Pendimethalin 30% EC) litre/acre was applied 3-4 days before transplanting. Seedlings were transplanted at the 4-5 true leaf stage in single rows on beds spaced 1.35 m apart and with an -in-row spacing between plants of 45 cm. There were ten plants in each plot in rows. Seedling from the 17 Oct. sowing were transplanted on 28 Nov., those from the 11 Dec. sowing on 22 Feb., and those from the 31 Jan. sowing on 19 March. The plants from seed sown on 17 Oct. were protected from frost in the field by covering with polythene sheets until the middle of February. The plants from seeds sown on 11 Dec. were protected from frost with low tunnels of polythene sheets of 100 gauze thickness during December and January. It was not necessary to protect the plants for seed sown on 31 Jan. Plants developed from seedlings transplanted on 28 Nov. were not (T_1) or were topped (T_2) in the first week of March; 22 Feb. were not (T_3) or were topped (T_4) by mid-March; and 19 March were not topped (T_5). In T_5, plants were not topped because there is little vegetative growth and topping was not expected to benefit fruit set. The experimental design was a split-plot with three replications. Topping at the dates were main plots and cultivars were the split. The observations were recorded for number of primary branches, fruit trusses, number of fruits plant^{-1}, fruit weight, total yield plant^{-1}, marketable yield plant^{-1}, harvesting span, total soluble solids, colour development and incidence of fruit borer.

Results and discussion

The analysis of variance revealed that mean squares were significant, for main plot and sub-plot treatments, for most of the characters except for total soluble solids. Among the sub-plot treatments *i.e.* varieties, mean squares were also significant for all characters except for number of primary branches and total soluble solids. The mean squares for interaction were significant for number of fruits plant^{-1} and marketable yield plant^{-1}. The mean values for different characters (Table 1) revealed that the maximum number of primary branches, number of fruit trusses and fruit weight were observed in treatment T_1 (7.75, 25.00 and 32.80) significantly more than those of the other treatments. Thus, time of planting plays an important role in influencing the vegetative and reproductive growth of tomato. Early planting might have given higher number of primary branches than late planting because temperature prevailing at the time of planting was quite congenial for growth of plants, and sufficient time was available allowing for maximum expression of the genotypic potential for establishment and growth of underground and aerial plant parts. In case of later plantings *i.e.* February and March, the crop is subjected to higher temperature in field immediately after transplanting and reproductive phase sets in when the plants have not attained much of vegetative growth, which is reflected in reduced number of primary branches. Among varieties, the maximum number of primary branches plant^{-1}, fruit trusses plant^{-1} and fruit weight was observed in V_1 *i.e.* (6.53, 16.40 and 21.27). Sharma and Tiwari (1992) also obtained higher number of fruits plant^{-1} in February 13-transplanted crop compared with March 25-transplanted crop. Kadam *et al.* (1991) observed that number of fruits plant^{-1} was the highest in early transplanting *i.e.* on 15th November, followed by 15th December, 14th January, 13th February and 15th March. Joshi *et al.* (1992) concluded that topping decreased number of fruits plant^{-1}. The reduction in number of fruits plant^{-1} may have been due to reduced number of lateral branches on the topped plants. Campos *et al.* (1987) also reported that pruning above third truss decreased both yield and number of fruits plant^{-1}. The highest fruit weight (74.5 g) was observed in treatment T_1. Topping in both November and February transplanted crop produced less fruit weight compared with plants left as such of the corresponding time of planting. This may be due to reduced plant foliage, thereby reducing the

Table 1. Mean values of different characters as affected by cultural treatments and varieties

Treatments	Number of primary branches plant^{-1}	Number of fruit trusses plant^{-1}	Number of fruits plant-1	Average fruit weight (g)	Total yield (kg plant^{-1})	Marketable yield (kg plant^{-1})	Harvesting span (Days)	Total soluble solid (°Brix)	Incidence of fruit borer (%)
T_1 (November transplanting not topped)	7.75	25.00	32.80	74.5	2.45	1.36	29.00	4.9	46.20
T_2 (November transplanting topped)	6.16	14.50	19.12	71.5	1.37	0.74	30.75	4.9	42.22
T_3 (Mid-February transplanting not topped)	5.83	13.16	17.47	69.25	1.21	0.59	28.50	4.7	35.21
T_4 (Mid-February transplanting topped)	6.00	11.41	16.58	68.00	1.13	0.52	29.00	4.8	32.21
T_5 (March transplanting)	5.25	4.75	5.54	66.5	0.37	0.22	21.00	4.7	30.20
CD (P=0.05)	1.13	2.81	0.32	1.0	0.36	0.14	1.88	NS	0.09
Varieties									
V_1 (TH 2312)	6.53	16.40	21.27	71.8	1.55	0.90	27.66	4.9	35.00
V_2 (Nagcarlan)	6.13	11.66	14.65	68.8	1.03	0.51	28.73	4.9	37.70
V_3 (CRXNSS-1-1)	6.13	11.60	16.17	68.6	1.12	0.47	27.20	4.8	38.80
V_4 (CR-2-P8-5-1)	6.00	15.40	21.14	70.6	1.52	0.87	27.00	4.8	36.80
CD (P=0.05)	NS	2.21	0.25	1.9	0.26	0.11	0.98	NS	0.11

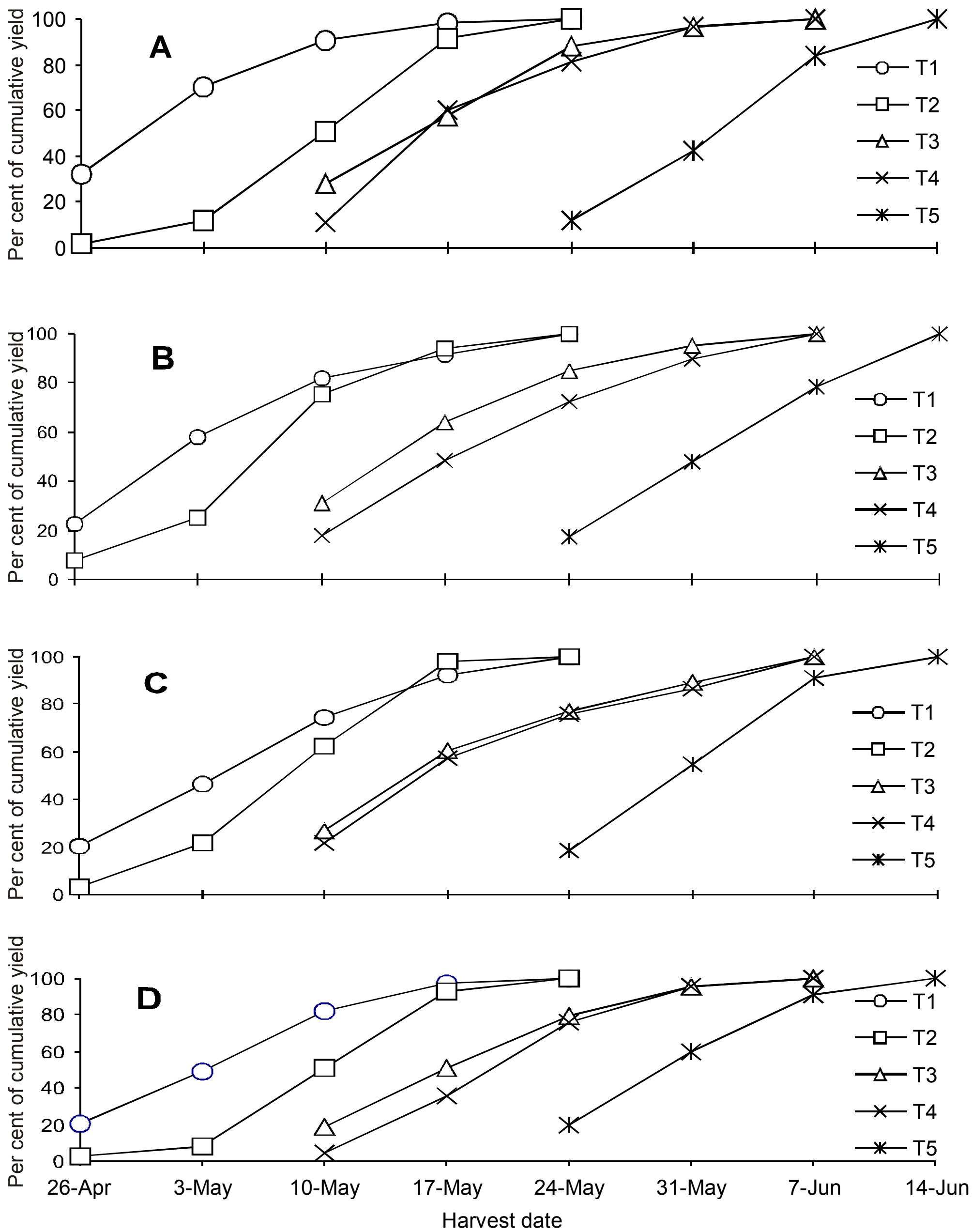

Fig 1. Yield of different genotypes (A=TH2312; B=Nagcarlan; C=CCR X NSS-1-1; D=CR-2-P8-5-1) of tomato on various dates of harvest.

photosynthetic function of the plant. Reduced photosynthates and their translocation could be responsible for impaired development of the fruit reflected as reduction in weight. Similar results were reported by Veliath and Ferguson (1972), Sharfuddin and Ahmed (1986) and Joshi *et al.* (1992). Among the varieties, the highest fruit weight (71.8 g) was observed in V_1. The maximum total (2.45 kg plant^{-1}) and marketable yield (1.36 kg plant^{-1}) were obtained in treatment T_1 (November transplanted allowed to grow as such). The lowest yield of 0.37 kg plant^{-1} was observed in T_5 (March transplanting). It was due to inadequate vegetative growth and in turn lower number of fruit trusses plant^{-1}. Moreover, the number of fruits/trusses was also low due to harsh weather conditions and these factors had pronounced cumulative effect for causing reduction in yield plant^{-1}. Kadam *et al.* (1991) also reported the highest yield when transplanting was done on 15th November. The succeeding transplantings made on 15th December, 14th January, 13th February and 15th March were accompanied by a continuous decrease in yield at an increasing rate. Nandpuri *et al.* (1974) also reported similar results. Topped plants *i.e.* treatment T_2 and T_4 produced lower yield as compared with untopped plants *i.e.* treatments T_1 and T_3. These results were in agreement of Matia-Rahman *et al.* (1988) and Anserwadekar *et al.* (1980). Among varieties, maximum total yield (1.55 kg plant^{-1}) and marketable yield (0.90 kg plant^{-1}) were obtained in variety V_1 followed by V_4 (1.52 kg plant^{-1}). Marketable yield being a function of total yield was affected by the same factors as influencing the total yield plant^{-1}. Marketable yield as per cent of the total yield was marginally (4-5%) decreased by topping, presumably due to reduced top growth and increased exposure to direct sun leading to higher percentage of scalded fruits. The longest harvesting span 30.75 days was observed in treatment T_2 (November transplanted topped crop) while treatment T_5 (March transplanting) had the shortest span of only 21 days. Topping during November and February planting *i.e.* treatment T_2 and T_4 increased harvesting span by 7 to 10 days compared with untopped plant left as such in respective planting. This was a positive factor to compensate the loss of yield by relatively higher market price late in the season. The harvesting span of variety V_2 was the longest while it was shortest in variety V_4. The effect of total soluble solids was non-significant. The intensity and uniformity of colouring pigments (particularly lycopene) is affected by the temperature conditions prevalent at the time of ripening. Fruits maturing late in the season generally suffer from blotchy ripening. Treatment T_5 showed the highest incidence of blotchy ripening (12.1) and sun-scalding (11.9%) while treatment T_1 showed lowest incidence of blotchy ripening (2.2%) and sun-scalding (2.1%). Topping in both November and February planted crop showed higher incidence of blotchy ripening and sun-scalding than plants left as such. This was due to reduced top growth and increased exposure of fruits to direct sunlight by topping which hindered the development of lycopene. Among varieties the incidence of blotchy ripening and sun-scalding was the highest in V_2 (8.4% and 10.2%) while variety V_1 showed less incidence of blotchy ripening (2.3%) and sun-scalding (3.07%) and developed normal colour evenly distributed over the entire fruit surface. The incidence of fruit borer was higher in treatment T_1 (46.20%) while it was lower in treatment T_5 (30.20%). Topping in both November and February transplanted crop reduced the incidence of fruit borer due to reduced vegetative growth leading to thorough coverage of insecticides. The lowest incidence was observed in variety V_1 (35%), while it was highest in variety V_3 (38.8%).

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