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Effect of different dates of transplanting using low plastic tunnel and black plastic mulch on the yield of capsicum plants

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Abstract
In order to study the effect of different dates of transplanting on fruit yield of sweet pepper using low plastic tunnel and black plastic mulch under tarai condition of Uttarakhand, an investigation was carried out at Vegetable Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar, U. S. Nagar, Uttarakhand during the cropping season October, 2014 to May, 2015. The dates of transplanting were 20th November, 20th December& 20th January, whereas low cost protected technologies used were low plastic tunnel with black plastic mulch, low plastic tunnel without black plastic mulch, with black plastic mulch only and control (traditional practice). The trial was replicated thrice in Two Factorial Randomized Block Design.
Out of 12 treatment combinations, although treatment $D_2T_1M_1$ (transplanting of capsicum on 20th December under poly tunnel with black plastic mulch) had recorded highest fruit yield (346.550 q/ha) and net return (3,54,130/ha). Based on overall performance, it could be concluded that under prevalent climatic condition of Uttarakhand tarai region, transplanting of capsicum under poly tunnel on 20th December ($D_2T_1M_0$) is the best and most economical, hence recommended for commercial cultivation of small and marginal farmers.

Keywords: Low plastic tunnel, black plastic mulch, capsicum plants

Introduction
Bell pepper or sweet pepper (*Capsicum annuum* var. *grossum*) is a high value luxury vegetable belongs to family Solanaceae. It occupies a pride of place among vegetables in Indian cuisine because of its delicacy and pleasant flavour. The fruit is a potential antioxidants and rich in vitamin A and vitamin C.
Capsicum is highly sensitive to environmental stresses particularly temperature. High temperature promoted flower drop and reduced fruit set (Erickson and Markhart, 2001) [5]. High day temperature (20-24 ºC) along with low light intensity (30 per cent shade) or higher night temperature (24 ºC) prompted flower drop in bell pepper (Rylski and Halevy, 1974) [15]. During high temperature certain physiological changes occur within the plant system like decrease in sugar content and lower enzymatic activities which encourage abnormal pollen and anther development, resulting in decrease in pollen viability, pollen tube growth and abortion of buds, flowers and young fruits (Turner and Wien, 1994) [22].
Lower / higher night temperature, high day temperature, high rainfall, hails, frost, water logging, higher relative humidity and cold wind are major limiting factors for successful cultivation of capsicum under open field condition. However, on the other hand, experimental findings reveal that this vegetable can successfully be cultivated under protected conditions (Chandra *et al*., 2000 and Singh *et al*., 2004 and 2010) [4, 19, 20].
The optimal planting date is a date in which all environmental factors (water, light, soil, etc.) will interact in a most favourable manner to produce the maximum yield (Ghovatia *et al*., 1993) [9]. The planting date should therefore be identified in such a way that the crop has the required time for germination, growth, flowering and seeding and appropriate synchronization of flowering with temperatures so that it can use the maximum light and favorable temperatures and produce a high quality yield (Nahardani *et al*., 2013) [14].
Optimum planting time vary with regions depending on growing conditions of a specific area that could be assessed by planting cultivars at different times. The planting time is the variable with the largest effect on crop yield (Calvino *et al*. 2003a, b) [2, 3]. The reduction in yield and its attributes with delay in planting time is the result of exposure of plants to high temperature and incessant rains which reduces the season length (Hamma *et al*. 2012, Seyyed and Seyyed 2013) [11, 16]. Transplanting date either under protected condition or open field environment has found to have marked influence on vegetative growth and yield of vegetable crops.

A delay in sowing/transplanting time of any vegetable leads to yield reduction not only because it allows less time for crop production but a late sown crop also become more prone to environmental stresses and incidence of insect-pest and diseases. This clearly indicates the necessity to identify the optimum planting time of bell pepper.

Green house has been found the most practical method of achieving the objective of protected agriculture where natural environment is modified by using sound engineering principles to achieve optimum plant growth and yield. Besides, protected technology has potential to produce more produce per unit area with increased input use efficiency. Research results have shown that by adopting protected cultivation, productivity of vegetables crops can be increased by 3-5 times as compared to open environment. Not only large poly houses are beneficial in vegetable production, but on the other hand, vegetables can also be grown successfully in low plastic tunnels. The low plastic tunnels are miniature green house like structures (1 m high and 75 cm wide at base), made of steel wires, bamboo or willow twigs or cane or any other locally available suitable material to cover rows of plants in field providing protection against unfavorable environment like low temperature, frost, wind, insect-pest etc. Further low tunnels can be easily dismantled and utilized in the next year.

Similar to polyhouse / poly tunnel technology, use of mulching materials in vegetable production has also been found an effective tool in the enhancement of vegetable productivity. The use of mulch has become an important cultural practice in many regions of the world for the commercial production of vegetable crops. Mulches create favourable micro-climate by retaining soil moisture and changing root zone temperature and the quantity and quality of light reflected back to the plant which alters plant growth and development. Plastic mulches also affect plant micro-climate by modifying the soil water evaporation, thereby affecting plant growth and its yield**.** The benefits from the use of plastic mulches include earlier and higher yield, negligible weed population, low soil evaporation, less soil compaction, greater water use efficiency, control of certain pests and a cleaner harvested product (Lamont, 1993) [12].

Materials and Methods

A field experiment on Effect of dates of transplanting on fruit yield of sweet pepper using low plastic tunnel and black plastic mulch under tarai condition of Uttarakhand was carried out during the cropping season October, 2014 to May, 2015. The field work was carried out at Vegetable Research Centre of G. B. Pant University of Agriculture and Technology, Pantnagar, U. S. Nagar, Uttarakhand.

The experiment was laid out in two Factorial Randomized Block design with 3 replications, consisting of 12 treatments. The detail of experimental plan is given as under:

Variety : Indra (F_1 hybrid)
Design : Two Factorial Randomized Block Design
Replications : 03
Treatments : 12

A. First factor (Dates of transplanting)

a. D_1 (1^{st} date of transplanting i.e. 20.11.14)
b. D_2 (2^{nd} date of transplanting i.e. one month after 1^{st} date of transplanting i.e. 20.12.14)
c. D_3 (3^{rd} date of transplanting i.e. one month after 2^{nd} date of transplanting i.e. 20.01.15)

B. Second factor (Use of low cost protected technology)

a. T_0M_0 (traditional practices i.e. without poly tunnel and black plastic mulch)
b. T_0M_1 (with black plastic mulch)
c. T_1M_0 (poly tunnel without black plastic mulch)
d. T_1M_1 (poly tunnel with black plastic mulch)

Row to Row spacing : 50 cm
Plant to Plant spacing : 40 cm
N: P_2O_5: K_2O (kg/ha) : 150: 75: 75
Experimental area : 486 m^2

Treatment combinations

1. $D_1T_0M_0$
2. $D_1T_0M_1$
3. $D_1T_1M_0$
4. $D_1T_1M_1$
5. $D_2T_0M_0$
6. D2T0M1
7. D2T1M0
8. D2T1M1
9. D3T0M0
10. D3T0M1
11. D3T1M0
12. D3T1M1

Application of black plastic mulch

Black plastic mulch of 40 micron thickness was spread over each experimental plot with their corner and sides tugged in the soil and holes are made at a spacing of 50 x 40 cm for easy transplanting of seedlings

Application of low plastic tunnel

Low plastic tunnel made up of clear plastic (100 micron) in dome shape with 100 cm wide at the base and 100 cm height were structured with the help of flexible bamboo woods

Transplanting of seedlings

The healthy seedlings were transplanted in the experimental plot on three different dates (20-Nov-2014, 20-Dec-2014 and 20-Jan-2015) at a spacing of 50 x 40 cm. The transplanting was done in the evening hours and just after transplanting a light irrigation was also given. The gap filling was done after seven days of transplanting.

Observations Recorded

The observations were recorded in 3 randomly selected tagged plants under each treatment.

Number of fruits per plant

The fruits were harvested in fully developed immature stage. The number of fruits harvested from 3 tagged plants in each picking were counted and the total number of fruits from the overall of the picking was computed. The average was drawn by dividing the total fruits with the number of plants under observation.

Fruit length (cm), fruit diameter (cm) and fruit circumference (cm)

Fruit length, fruit diameter and fruit circumference were measured at first harvest of each treatment. The fruit length was measured from the base of the fruit to tip, excluding the fruit stalk. While the fruit circumference was measured with the help of thread at a point of maximum thickness of fruit.

Whereas, the fruit diameter was recorded at the middle portion of the fruit. The average fruit length, fruit diameter and fruit circumference were calculated by dividing the total length/ diameter/ circumference with the number of fruits under observation.

Yield per plant (kg)

To get average fruit yield per plant, the total fruit weight of fruits of three randomly selected tagged plant obtained from all picking was divided by the number of plants (3).

Yield per hectare (q)

To get green fruit yield per hectare, the plant population in one hectare area was multiplied by fruit yield per plant.

Result and Discussion

Number of fruits per plant

Data depicted in Table 2 clearly shows that dates of transplanting significantly differed from each other in respect to their number of fruits per plant. Out of three dates of transplanting, it was D_2 (second date of transplanting) which produced maximum number of fruits per plant (17.57) followed by D_1 (12.64). The third date of transplanting i.e. D_3 recorded minimum number of fruits (3.17/plant) and it was about 6 times less compared to the best treatment D_2. Amongst different protected technologies, highest number of fruits per plant (14.99) was obtained in treatment where poly tunnel was used as protected structure and black plastic mulch was used as mulching material. Treatment with poly tunnel and without mulch had shown poor performance in fruit production compared to the treatment T_0M_1 (open field conditions along with black plastic mulch). The minimum fruit number (6.13) was harvested in open field conditions without black plastic mulch (T_0M_0).

Significant interactive effect between dates of transplanting and low cost protected technology was also observed in respect to number of fruits per plant. Like other parameters, $D_2T_1M_1$ was proved best treatment combination in respect to fruit number (22.22 per plant) and it was closely followed by $D_2T_0M_1$ (21.34), whereas the least number of fruits per plant (1.30) was harvested in $D_3T_0M_0$.

The highest number of fruits per plant obtained in D_2 planting may be attributed to high fruit set because of presence of congenial weather conditions especially temperature and humidity at the time of flowering. Sweet pepper grown under plastic tunnel got conductive conditions for maximum growth, flowering and fruiting in comparison to other treatments resulting in more number of fruits per plant. Similar observations with respect to fruit number per plant in pepper, when grown under plastic tunnel were also recorded by Kacjan and Osvald (1997), Hamma, *et al.*, (2012) [11] and Sharma *et al*., (2015) [17, 18] in their agro-climatic conditions.

Table 1: Interaction effect of dates of transplanting and low cost protected technology on plant spread (cm)

Dates of transplanting	Plant spread (cm) at final harvest				
	T_0M_0	**T_0M_1**	**T_1M_0**	**T_1M_1**	**Mean**
D_1	43.66	46.66	38.33	45.66	43.58
D_2	38.00	55.66	48.33	53.66	48.91
D_3	29.33	52.66	41.66	52.66	44.08
Mean	37.00	51.66	42.77	50.66	
				S.Em±	**C.D at 5%**
Dates of transplanting				0.410	1.211
Low cost protected technology				0.474	1.399
Interaction (D x L)				0.821	2.422

Table 2: Interaction effect of dates of transplanting and low cost protected technology on number of fruits per plant

Dates of transplanting	Number of fruits per plant				
	T_0M_0	**T_0M_1**	**T_1M_0**	**T_1M_1**	**Mean**
D_1	6.20	12.82	14.63	16.91	12.64
D_2	10.90	21.34	15.83	22.22	17.57
D_3	1.30	2.53	3.01	5.83	3.17
Mean	6.13	12.23	11.16	14.99	
				S.Em±	**C.D at 5%**
Dates of transplanting				0.144	0.424
Low cost protected technology				0.166	0.489
Interaction (D x L)				0.287	0.847

Fruit length (cm)

Measurement for fruit length at different dates of transplanting and low cost protected technology was taken at first harvest of crop only. Table 3 reveals that both dates of transplanting and low cost protected technology significantly influenced the fruit length of capsicum under agro-climatic conditions of *tarai* region of Uttarakhand. Out of three dates, neither the first date (D_1) nor last date (D_3) could produce good quality of fruits (fruit length). It was the date D_2 i.e. transplanting on 20th of December which produced the longer fruits in the experiment. In this treatment, the average fruit length was measured 7.02 cm. With respect to low cost protected technology, the best fruits in length were harvested in poly tunnel treatment. Here in poly tunnel, the longest fruit of average length 7.43 cm were obtained where black plastic was used as mulching material under poly tunnel. In open conditions, the fruit length was measured in between 4.80cm (without mulch) to 6.03 cm (with black plastic mulch) only.

Interaction between dates of transplanting and low cost protected technology was also observed. Best interaction with respect to fruit length was observed when capsicum crop was transplanted under poly tunnel with the use of black plastic mulch on 20th December, 2014 (8.20cm) followed by $D_1T_1M_1$ (8.00 cm). Shortest fruits were formed when plants were grown in open conditions without mulch material.

The better length fruit in capsicum plants under poly tunnel with the use of black plastic mulch at second dates of transplanting might due to persistence of congenial

environmental conditions particularly temperature, soil moisture etc. during winter season. Similar increase in fruit length at different dates of transplanting in sweet pepper was also observed by Sharma *et al*. (2015) [17, 18].

Fruit diameter (cm)

Perusal of the data in Table 4 shows that fruit diameter in bell pepper significantly influenced by dates of transplanting and low cost protected technology. Out of three dates of transplanting, maximum (6.32 cm) fruit diameter at the middle portion of fruit, measured at first harvest was obtained in second date of transplanting (D_2) followed by D_1 (first transplanting). Capsicum under poly tunnel with black plastic was proved best in respect to fruit diameter. Table 4 also shows more significant difference in fruit diameter when plants were grown in open environment with or without use of black plastic mulch.

With respect to interaction, a close relationship for the fruit diameter was observed between dates of transplanting and low cost protected technology. In present investigation, maximum fruit diameter (7.80 cm) was recorded in treatment $D_2T_1M_1$ followed by $D_1T_1M_1$ (7.40 cm). All the fruits obtained in different dates of transplanting in open environment, with or without black plastic mulch, had shown more or less poor fruit diameter and here the fruit diameter was ranged from 4.00 cm to 5.50 cm.

Similar results were also obtained by Farooq *et al.* (2015) [6] in their field studies and they reported higher fruit diameter under poly tunnel environment.

Fruit circumference (cm)

Dates of transplanting and low cost protected technology had also shown their influence on fruit circumference (Table 5). Significantly higher fruit circumference (22.30 cm) was measured in second date of transplanting, whereas lowest fruit circumference of 19.50 cm was recorded in third date of transplanting. As far as low cost protected technology is concerned, more fruit circumference (23.33 cm) was obtained in treatment (T_1M_1), whereas it was found least (16.83 cm) in control i.e. T_0M_0.

Interaction effect of dates of transplanting and low cost protected for fruit circumference parameter was also observed in this study. Out of 12 treatment combinations, maximum fruit circumference (26.50 cm) was noted in treatment combination $D_2T_1M_1$ i.e. plants grown under poly tunnel with black plastic on transplanting date 20th December. Earliest transplanting (D_1) under open field conditions without use of black plastic mulch, was found inferior in fruit circumference. Earlier studies made by Farooq *et al.* (2015) [6] and Sharma *et al*. (2015) [17, 18] also support the findings of this study.

Average fruit weight (g)

Data pertaining to average fruit weight are presented in Table 4.12. It is evident from the table that dates of transplanting and low cost protected technologies had significantly affected the average fruit weight. The maximum fruit weight (61.924 g) was obtained when crop was transplanted on 20th December (D_2), followed by D_3 (61.215 g). In low cost protected technology, compared to open environment, more fruit weight was obtained under poly tunnel environment.

Table 3: Interaction effect of dates of transplanting and low cost protected technology on fruit length (cm)

Dates of transplanting	Fruit length (cm) at 1st harvest				
	T_0M_0	T_0M_1	T_1M_0	T_1M_1	Mean
D_1	4.60	5.80	7.20	8.00	6.40
D_2	5.50	6.60	7.80	8.20	7.02
D_3	4.30	5.70	6.60	6.10	5.67
Mean	4.80	6.03	7.20	7.43	
				S.Em±	C.D at 5%
Dates of transplanting				0.056	0.164
Low cost protected technology				0.064	0.190
Interaction (D x L)				0.111	0.328

Table 4: Interaction effect of dates of transplanting and low cost protected technology on fruit diameter (cm)

Dates of transplanting	Fruit diameter (cm) at 1st harvest				
	T_0M_0	T_0M_1	T_1M_0	T_1M_1	Mean
D_1	4.30	5.50	6.50	7.40	5.92
D_2	5.30	5.50	6.70	7.80	6.32
D_3	4.00	5.50	6.20	5.70	5.35
Mean	4.53	5.50	6.46	6.96	
				S.Em±	C.D at 5%
Dates of transplanting				0.040	0.119
Low cost protected technology				0.047	0.138
Interaction (D x L)				0.081	0.239

Table 5: Interaction effect of dates of transplanting and low cost protected technology on fruit circumference (cm)

Dates of transplanting	Fruit circumference (cm) at 1st harvest				
	T_0M_0	T_0M_1	T_1M_0	T_1M_1	Mean
D_1	16.00	21.00	22.50	22.50	20.50
D_2	16.50	22.20	24.00	26.50	22.30
D_3	18.00	19.00	20.00	21.00	19.50
Mean	16.83	20.73	22.16	23.33	
				S.Em±	C.D at 5%
Dates of transplanting				0.172	0.508
Low cost protected technology				0.199	0.586
Interaction (D x L)				0.344	1.016

Table 6: Interaction effect of dates of transplanting and Low cost protected technology on average fruit weight (g)

Dates of transplanting	Average fruit weight (g)				
	T_0M_0	T_0M_1	T_1M_0	T_1M_1	Mean
D_1	40.160	42.077	67.057	61.053	52.587
D_2	48.723	73.400	65.670	59.903	61.924
D_3	52.240	55.757	66.990	69.873	61.215
Mean	47.041	57.078	66.572	63.610	
				S.Em±	C.D at 5%
Dates of transplanting				0.988	2.917
Low cost protected technology				1.141	3.368
Interaction (D x L)				1.976	5.834

With respect to interaction, maximum average fruit weight was recorded in treatment $D_2T_0M_1$ (73.400g) followed by $D_3T_1M_1$ (69.873g), however statistically, these two treatments were at par with each other. Out of twelve treatment combinations, the minimum average fruit weight (40.160g) was obtained in $D_1T_0M_0$.

Seedlings transplanted on 20th December under poly tunneled with black plastic mulch, received most congenial temperature and moisture, which increased photosynthetic activity and proper translocation of photosynthate in plants, required for growth. The above findings are in accordance to the results reported by Singh *et al.* (2013) [21] in sweet pepper, More *et al.* (2014) [13] and Firoz *et al*. (2009) [7] in tomato.

Yield per plant (kg)

The fruit yield per plant was significantly influenced by both the factors under study (Table 7). A wide variation in fruit yield per plant ranging from 0.199 to 0.934 kg at different dates of transplanting was observed. The above table clearly shows that fruit yield was significantly increased from first date of transplanting to second date of transplanting but it was abruptly reduced by 78.69 per cent when date of transplanting was delayed by one more month, from 20th December 2014 to 20th January 2015. Similarly, use of plastic tunnel had also left its impact on fruit yield per plant. On an average about 845 gm yield of fruits was obtained under poly tunnel environment. Whereas, the fruit yield under open field conditions was recorded only 460 gm per plant, thus, poly tunnel environment on an average gave 83.69 per cent more fruit yield than open field condition. Mulching with black plastic had also shown better fruit yield performance over control treatment. Overall, fruit yield increase of 60.05 per cent in mulched treatment was observed than that of unmulched treatment.

Interaction between dates of transplanting and low cost protected technology was also found significant. Out of 12 treatment combinations, the highest fruit yield was obtained in treatment $D_2T_1M_1$ (1.353 kg/plant) followed by $D_1T_1M_1$ (1.107 kg/plant) and $D_2T_1M_0$ (1.057 kg/plant). The minimum yield of 0.630 kg/plant was obtained in last transplanting date, where crop was grown under open environment without plastic mulch ($D_3T_0M_0$).

Highest yield in second date of transplanting could be mainly due to increase in harvesting span of the crop. Further, the sweet pepper crop at this date got most ideal environment for its growth, flowering and fruiting than the 1st and 3rd dates of transplanting. The increase in fruit yield per plant under tunneled environment with plastic mulch might be due to enhanced photosynthesis and food accumulation activities during the frost period on account of rise in temperature, which resulted in better plant growth and subsequently higher fruit yield. Earlier studies made by Hamma, *et al.* (2012) [11], Singh *et al*. (2013) [21] and Sharma *et al*. (2015) [17, 18] had also given the similar views in their experiments on dates of transplanting and low cost protected technology.

Yield (q) per hectare

Dates of transplanting played a significant role in the fruit yield of capsicum. A critical examination of Table 8 indicates that one month delay in transplanting dates from 20th Nov,14 to 20th Dec,14 and from 20th Dec,14 to 20th Jan,15 had shown significant impact on fruit yield. Initially, from first date of transplanting to second date, there was an increase of 30.13 per cent in fruit yield but later on, planting date had shown drastic reduction in yield. Maximum yield of fruits (236.729 q/ha) was obtained in second date of transplanting (D_2), whereas the fruit yield of last date of transplanting i.e. D_3, was only 41.874 q/ha.

A wide range of fruit yield variation in low cost protected technology under different dates of transplanting was also observed in this study. When fruit yield of capsicum was compared between open and poly tunnel environment, it was observed that poly tunnel cultivation without mulching had made tremendous enhancement in the fruit yield to the tune of 202.07 per cent, compared to open field conditions. The average yield obtained in poly tunnel environment was about 192.85 q/ha. The fruit yield under poly tunnel was further increased when black plastic was used as mulching material.

A close relationship in this study was noticed between dates of transplanting and low cost protected technology. The fruit yield increased significantly, particularly in early transplanting, when black plastic mulch was used as mulching material. A highest yield of 346.550 q/ha was obtained in treatment $D_2T_1M_1$ followed $D_2T_1M_0$ and $D_1T_0M_1$. Treatment $D_3T_0M_0$ i.e. transplanting on 20th Jan, 15 under open condition without mulch, recorded minimum yield of 12.770 q/ha.

Table 7: Interaction effect of dates of transplanting and low cost protected technology on green fruit yield (kg) per plant

Dates of transplanting	Yield (kg) per plant				
	T_0M_0	T_0M_1	T_1M_0	T_1M_1	Mean
D_1	0.303	0.933	0.957	1.107	0.825
D_2	0.433	0.893	1.057	1.353	0.934
D_3	0.063	0.133	0.197	0.403	0.199
Mean	0.267	0.653	0.737	0.954	
				S.Em±	C.D at 5%
Dates of transplanting				0.018	0.053

Low cost protected technology		0.021	0.062
Interaction (D x L)		0.036	0.107

Table 8: Interaction effect of dates of transplanting and low cost protected technology on green fruit yield (q) per hectare

Dates of transplanting	Yield (q) per hectare				
	T_0M_0	T_0M_1	T_1M_0	T_1M_1	Mean
D_1	75.300	232.600	197.353	222.410	181.916
D_2	103.463	231.913	264.990	346.550	236.729
D_3	12.770	28.880	43.157	82.690	41.874
Mean	63.844	164.464	168.500	217.217	
				S.Em±	**C.D at 5%**
Dates of transplanting				2.984	8.809
Low cost protected technology				3.446	10.172
Interaction (D x L)				5.969	17.618

The fruit yield in capsicum is dependent on several plant attributes but the prime contributing characters having direct relationship with yield are fruit set per cent, number of fruits, fruit size etc. It is commonly experienced that capsicum plants flower profusely but only few flowers set in the fruits. Fruit setting is influenced by various factors, but among them temperature either low or high plays very crucial role and temperature intensity totally depends upon the transplanting dates and protected structures used.

The possible reason for increase in yield at second date of transplanting under poly tunnel environment with black plastic mulch could be induction of more branches, increase in plant height and better development of root system. All these factors ultimately provided largest photosynthetic area favourable for the production of more carbohydrates. This process of synthesis of higher amount of carbohydrates stimulated the induction of more flowering and fruit setting, which in turn gave rise to higher yields. The other important yield contributing traits which could have been affected by the dates of transplanting and low cost protected technology might be number of fruits per plant, fruit length, fruit diameter etc.

These results are in contrast of the finding reported by Alam *et al.* (2011) [1], who obtained highest fruit yield of sweet pepper (19.36 t/ha) under early planting date. But on the other hand, the present results are in agreement with those reported by Gandhi and Bains (2006) [8], Hamid *et al.* (2010) [10] and Singh *et al.* (2013) [21].

Conclusion

Based on overall performance, it could be concluded that under prevalent climatic condition of Uttarakhand tarai region, transplanting of capsicum under poly tunnel on 20th December ($D_2T_1M_0$) is the best and most economical, hence recommended for commercial cultivation of small and marginal farmers.

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