

Original Research Article

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Impact of Different Shades of Plastic Mulch and Plant Geometry on Yield and Economics on Tender Stem Broccoli in Punjab, India

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ABSTRACT

A field experiment was conducted at ACE Farm Field Fresh Foods Pvt. Ltd. Ludhiana, Punjab during Rabi season, 2006-17 to find out the most excellent colour plastic mulch and plant spacing on a new crop- Tender stem broccoli production for export market. Three colour plastic mulch viz. (i) black, (ii) Silver and (iii) non-mulch on the four plant spacing (i) 35 X 30 cm, (ii) 45 X 30 cm, (iii) 35 x 35 cm and (iv) 30 X 35 cm were included in the study. Yield and yield contributing characters were significantly influenced by the treatments. Black colour mulch produced the highest yield (2475 kg/acre) and without mulch produced the lowest yield (2129 kg/ acre) of tender stem broccoli. On the other hand, closer spacing (45 x 30cm) produced the highest yield (2549 kg/ acre) which was statistically superior over the others plant spacing and lowest yield (2050 kg/ acre) was obtained from 35 x 30 cm spacing. Black colure mulch and 45 x 30cm plant spacing combination produced the highest yield (2680 kg/ acre) which was statistically similar to Black colure mulch sowing and 35 x 35cm plant spacing (2625 kg/acre) and the lowest yield (1420 kg/acre) was produced from without mulch and 35 x 30cm plant spacing combination. The economics of black colour of mulch as well as plant spacing of 45 X 35 was found better based on maximum yield, gross return as well as net return.

Keywords

Colour plastic mulch, Plant spacing, Yield, Tender stem broccoli, Return.

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Introduction

Tender Stem or tender stem broccoli is a green vegetable similar to tender stem broccoli but with smaller floret and longer, thin stalks. Often misidentified as young tender stem broccoli, it is a hybrid of tender stem broccoli and Chinese Kale which was first developed in 1993 by Sakata Seed Company in Yokohama, Japan, Sakata. Presently due to its small florets and subtle sweet flavor it is very popular in European market.

Broccoli (*Brassica oleracea* L.) is one of the most prominent vegetables grown all over the world. This vegetable, closely resembling

cauliflower but usually green in colour, introduced in India many years after cabbage and cauliflower, has gained popularity in short span of time. Besides being used as vegetable, the tender fresh leaves are served as salad and are extensively used in the preparation of pickles. It has very high nutritional value due to its high content of protein, carbohydrates, fibers, calcium, iron, carotene, thiamine, riboflavin and ascorbic acid. It also helps in digestion and assimilation of food in human body. With the increased popularity of the vegetable in recent years and its high nutritional value, it is a

good candidate for expanded production in India. High level of cancer fighting chemical “sulforaphane” in it mobilizes the human body to combat cancer naturally and increase resistance to cancer.

The main mulches in vegetable crops cultivation is to protect the soil surface from the influence of unfavorable factors and to improve the growing conditions for the crop plants (Olfati *et al.*, 2008). They reduce soil wind and water erosion, conserve soil moisture and help maintain stable soil temperature (Kar and Kumar 2007). Mulch increases soil porosity and suppresses weed growth (Uwah and Iwo 2011). Tan *et al.*, (2000) claim that plant’s growth conditions are the main determinant of the quality of their yield. The application of plastic covers can have a significant influence on the vegetables yield. Covers are used to modify plants environment in order to optimize plants growth, increase yields and improve their quality. The profitable conditions under the covers resulted in higher yield for early potato (Hamouz *et al.*, 2007).

According to Gordon *et al.*, (2010) an increase in soil temperature and moisture under covers will not always cause an increase in the yield of plants. Spacing of plant affects both total yield and the size of Tender stem broccoli head. According to recent field tests, wider spacing contributes towards larger and heavier heads while, yield per hectare can be increased by close spacing. Hence, it is necessary to optimize proper plant spacing for obtaining higher yield with better quality. The study aimed to determine which colour mulch and plant spacing perform better on the yield and quality of Tender stem broccoli cultivated for early harvest.

Materials and Methods

A field experiment was conducted to study the influence of different colour plastic mulch

(Black mulch, silver mulch and non-mulch) and plant spacing (35 X 30 cm, 45 X 30 cm, 35 x 35 cm and 30 X 35 cm) on growth and yield of Tender stem broccoli. It is a new crop for India. Plant height, yield, fruit number and dry weight of plant increased with increasing K levels and mulching. The advantages of mulching in vegetable crop production have been well documented. Various mulching materials are utilized and these include weed or grass clippings, paddy straw, bark, sawdust and plastic. Mulches can effectively minimize water vapour loss, soil erosion, weed problems and nutrient loss. The most common response to mulch is an increase in total yield. The reflective plastic mulches can reduce the incidence of aphid-borne viruses and exclude some species of pest. Little information is available concerning the use of mulches in India although its application has been gradually expanding. Most local vegetable farmers use plastic and plant residue mulching. The current recommended rates of fertilizer for chilli are normally for planting system without mulching. However, mulches are already known to be effective in reducing nutrient losses through leaching. This experiment was conducted to determine the effect of various colour plastic mulch and plant spacing materials on the growth and yield of Tender stem broccoli.

Layouts and treatments

An experiment was conducted at Agri centre of excellence, Ladhowal to observe the impact of plant spacing under black plastic, silver mulch and non-mulch condition on vegetative traits and yield of Tender stem broccoli. Both under mulch and un-mulch, four different plants to plant spacing were taken as treatment. Plants to plant spacing were as follows: i. 35 X 30 cm, ii. 45 X 30, iii. 35 x 35 cm, iv. 30 X 35 cm. The experimental design was a split plot with three replications. Main plots were different colour plastic mulch viz., Black mulch, silver

mulch and non-mulch, while subplots were treated with plant spacing 35 X 30 cm, 45 X 30 cm, 35 x 35 cm and 30 X 35 cm. Firstly, nursery was raised in plug tray in the month of 6 September 2016 and seedlings were transplanted in the 19 October 2016. Transplanting was done on 90 cm raised beds both in mulch and un-mulch conditions.

Results and Discussion

No significant interaction of mulching materials was observed with plant spacing in any of the measured parameters; thus, only main effect data are reported. Height (cm), No. of leaves, Days taken to first harvest, No. of curds harvested/plant, No. of curds/acre, Avg. wt. (g) of the curd and Yield/acre (kg) Recovery (%) were significantly higher than those without mulches (Table 1).

Effect of mulch

It has been observed in the experiment that height of the plant was significantly different in between mulch and un-mulch planting. In black plastic mulch condition, highest plant height was observed as 78.6 cm, where as in silver mulch condition (73.7 cm) and lowest plant height was recorded highest as only 61.5 cm in non-mulch condition.

In case of number of leaves also black mulching condition showed maximum number of 47 leaves /plant was recorded followed by silver colour (45 leaves/plant) and non-mulch (42 leaves /plant). In case of days taken to first harvest no significant difference recorded with 65 day first harvest taken in all colour of mulch and non-mulch.

The black mulch showed superiority with maximum number of curd/plant in comparison to silver colour mulch and non-mulch condition. In black colour mulch maximum 14.0 curd/plant was recorded after

that silver colour (13.8 curd /plant) and non-mulch (13.5 curd /plant). Number of curds per acre was also varied significantly in comparison both mulching and un-mulching plots. Highest number of curds harvested in black colour mulch (30175 numbers) and followed by silver colour mulch (29576 numbers).

This figure was significantly higher than the un-mulching plot where in non-mulch condition number of curds harvested was recorded as 29123 numbers of curds. If comparison is done among all spacing of mulching and un-mulching plot, it has been observed that number of curds were higher in maximum plant spacing in mulching plot than the un-mulching plot. In case of average weight per curd, also black colour mulch was found most effective with highest weight 7.6g in comparison to other mulch and non mulch and lowest curd weight 6.8g was noticed in non-mulch plots.

Maximum Tender stem broccolii yield 2475 kg/ acre was recorded by black colour plastic mulch along with highest 55.1 % recovery of produce followed by silver colour mulch 2310kg yield/acre with 53.6 % recovery and minimum yield 21.29 kg/acre was noticed in non-mulch plots with 49.6 % recovery. Kosterna (2014) recorded the application of polypropylene fibre contributed to a significant increase in the marketable yield of Tender stem broccoli on average by 5.25 t/ha, weight of head by 0.10 kg and length of arc by 1.44 cm. In the study by Awodoyin *et al.*, (2007) mulching increased growth of plants and yield of tomato fruit. Sinkeviciene *et al.*, (2009) reported that yield of vegetables depended on the kind of mulch application to soil mulching.

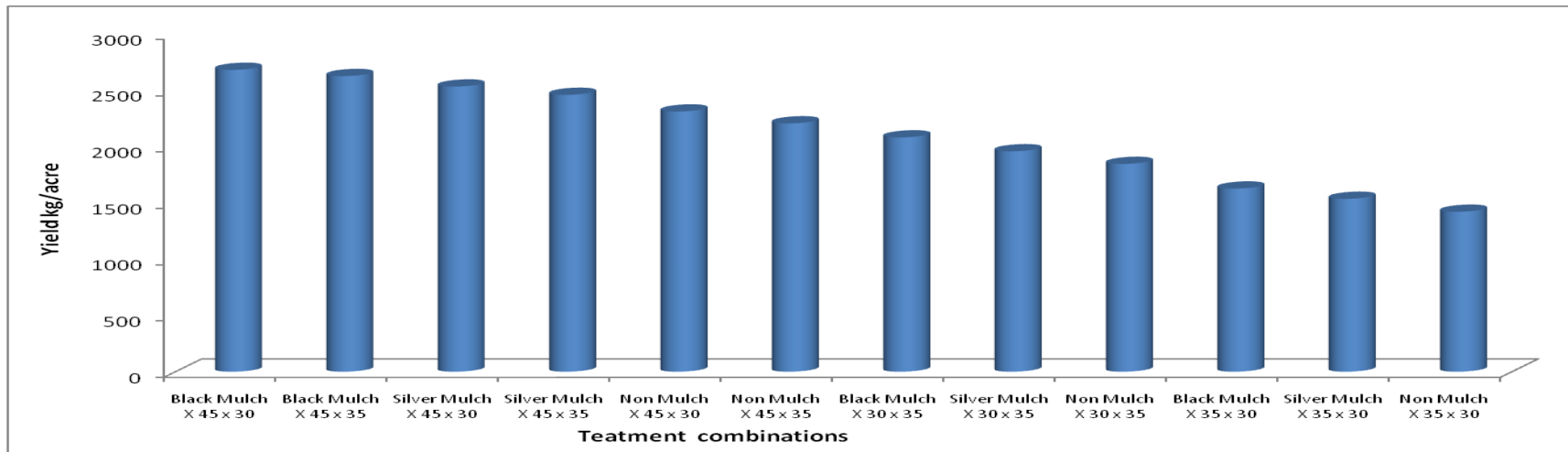
At conducted research the content of dry matter in Tender stem broccoli ranged from 7.69% to 10.75% (Grabowska *et al.*, 2009).

Table.1 Effect of different colour plastic mulch and plant spacing on Tender stem broccoli

Treatment	Height (cm)	No. of leaves	Days taken to first harvest	No. of curds harvested/plant	No. of curds/acre	Avg. wt. (g) of the curd	Yield/acre (kg)	CoC (Rs.)	Gross returns (Rs.)	Net Return (Rs.)
Mulch										
None	69.5	42	65	13.5	29123	6.8	4129	74483	123870	49387
Silver plastic	73.7	45	65	13.8	29576	7.4	4310	74745	129300	54555
Black plastic	76.2	47	65	14.0	30175	7.6	4475	76580	134250	57670
S. Ed. (±)	1.76	0.62	0.09	0.10	209	0.71	64	-	-	-
C. D. (0.05)	3.36	1.28	NS	0.25	443	1.45	135	-	-	-
Plant spacing										
35 X 30 cm	70.0	41	65	13.1	27190	7.0	4050	73558	121500	47942
45 X 30 cm	78.6	48	65	14.8	30670	7.9	4549	71554	136470	64916
35 X 35 cm	75.0	46	65	14.0	29165	7.5	4254	72125	127620	55495
30 X 35 cm	74.1	43	65	13.5	28853	7.2	4187	74320	125610	51290
S. Ed. (±)	1.40	0.83	0.07	0.37	196	0.50	76	-	-	-
C. D. (0.05)	2.87	1.56	NS	0.78	395	0.98	148	-	-	-

*Mean separation in columns by Duncan's multiple range test, 5% level. NS Not significant

Fig.1 Combined effect of colour plastic mulch and plant spacing on yield of Tender stem broccoli



Effect of plant spacing

The more plant spacing showed most effective in comparison to less plant spacing. The highest height of the plant was achieved as 78.6 cm in 45 X 30 cm spacing followed by 35 X 35 (75.0 cm), 30 X 35 cm (74.1 cm) and lowest 70.0 cm plant height was noticed in plant spacing 35 X 30 cm. In case of number of leaves also 45 X 35 cm plant spacing was found most effective with maximum number of leaves 48/plant and followed by 46 cm, 43 cm and 41 cm in respective plant spacing 45 X 30 cm, 35 x 35 cm and 30 X 35 cm). In case of days taken to first harvest no significant difference recorded with 65 day first harvest taken in all treatments. In all the spacing of mulching and un-mulching plot, it has been noted that harvesting started on the similar day i.e. number of days taken for first harvest was same in case of all spacing in both and un-mulch conditions. Number of curds harvested/plant was ranged in 13 to 15 numbers in all spacing of mulch and un-mulch conditions. The more plant spacing showed superiority with maximum number of curd/plant in comparison to less plant spacing. In 45 X 35 plant spacing, maximum 14.8 curd/plant was recorded after that 14.0 curd/plant, 13.5 curd /plant and 13.1 curd /plant were recorded by in respective plant spacing 45 X 30 cm, 35 x 35 cm and 30 X 35 cm 70 cm. It clearly indicated that mulching technique and more plant spacing have showed significant impact on vegetative growth of the TSB crop as seen in the experiment. Number of curds per acre was also varied significantly as per plant spacing plots. Highest number of curds harvested in plant spacing 45 X 30 cm (30670 numbers) and followed by plant spacing 35 X 35 cm (29165 numbers), 30 X 35 cm and (28853 numbers of curd). This figure was significantly higher than the other plant spacing condition number of curds harvested

was recorded as 27190 numbers of curds. If comparison is done among all spacing of mulching and un-mulching plot, it has been observed that number of curds were higher in maximum plant spacing in mulching plot than the un-mulching plot. In case of average weight per curd, also plant spacing 45 X 35 cm was found most effective with highest weight 7.9g in comparison to other plant spacing and lowest curd weight 7.0g was noticed plant spacing 35 X 30 cm. Maximum Tender stem broccoli yield 2549 kg/ acre was recorded by plant spacing 45 X 35 along with highest 56.8 % recovery of produce followed by 35 X 35 cm 2254 kg yield/acre with 54.2 % recovery and minimum yield 2050 kg/acre was noticed in plant spacing 35 X 30 with 50.0 % recovery. If comparison is done among all spacing of mulching and un-mulching plot, it has been observed that number of curds were higher in all spacing in mulching plot than the un-mulching plot. However, the main head yield of Tender stem broccoli was significantly different from one treatment to another. 60cm x 40cm plant spacing produced the highest main head yield and 60cm x 60cm plant spacing produced the lowest main head yield. Similar results had got by Pornsuriya *et al.*, (1997). Main head yield and total yield of Tender stem broccoli followed the same trend in response to plant spacing. Increasing the plant number per plot decreased the head size but increased the yield (Nassar *et al.*, 1972). Solunke *et al.*, (2011) reported that the Tender stem broccoli transplanted on the 1st date of planting *i.e.* 15th September reported significantly maximum yield (122.14 q ha⁻¹) over the other dates of planting, while spacing 60 x 60 cm showed significantly maximum growth for height, number of leaves, stem diameter and leaf area. Interaction between dates of planting and spacing was significant in respect of curd yield/ hectare. Hossain *et al.*, (2011) reported that 1 October sowing produced the highest yield (21.39 t/ha) and 30

October sowing produced the lowest yield (13.6t/ha) of Tender stem broccoli. On the other hand, closer spacing (60 x 40cm) produced the highest yield (18.8t/ha) which was statistically similar to 60 x 50cm (17.6t/ha) and lowest yield (16t/ha) was obtained from 60 x 60 cm spacing. Gagoi *et al.*, (2016) reported the most of the growth parameters were not influenced by planting distances except for canopy spread, days to heading and days to flowering.

Combined effect of colour plastic mulch and plant spacing on Tender stem broccoli production

Treatment combination of colour plastic mulch and plant spacing had significant effect on yield and yield contributing characters of Tender stem broccoli production (Fig. 1). Combination of black colour plastic mulch and 45cm x 30cm plant spacing required the minimum days to first harvest of tender stem Tender stem broccoli. Without mulch and 35 cm x 30cm plant spacing required the maximum days to first harvest. Maximum length and diameter of Tender stem broccoli head was measured from the treatment combination of black colour plastic mulch and 45 cm x 30 cm plant spacing. Black colour mulch and 45 x 30cm plant spacing combination produced the highest yield (2680 kg/ acre) which was statistically similar to Black colour mulch sowing and 35 x 35cm plant spacing (2625 kg/acre) and the lowest yield (1420 kg/acre) was produced from without mulch and 35 x 30cm plant spacing combination.

Results of the present study revealed that black colour plastic mulch and plant spacing of 45 cm x 30 cm is the preeminent for broccoli production. Maximum crop growth, curd weight and yield were found maximum in said treatment. The maximum return was also found in black plastic mulch with a plant

spacing of 45 cm x 30 cm in Northern plains of India.

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