Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-6: 78-86

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-6 pp. 78-86**
Journal homepage: http://www.ijcmas.com

Original Research Article

Studies on Effect of Planting Dates on Growth, Yield and Quality of Broccoli (*Brassica oleracea* L. var. *italica*) cv. Green Magic

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Keywords

Planting date, Yield and quality of broccoli

A B S T R A C T

The investigation entitled, "Studies on effect of planting dates on growth, yield and quality of broccoli (*Brassica oleracea* L. var. *italica*) cv. Green magic" was designed and conducted at Department of Horticulture, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani and Dist-Parbhani during *rabi* season of 2016-17. The experiment was laid out in randomized block design with three replications and eight treatments viz., date of sowing D_1 (October 11th), D_2 (October 18th), D_3 (October 25th), D_4 (November 1st), D_5 (November 8th), D_6 (November 15th), D_7 (November 22nd) and D_8 (November 29th) to study crop growth under different dates of sowing in broccoli. Among the different treatments the treatment D_4 (November 1st) noted the highest plant growth and yield in respect to, height of plant (59.82 cm), girth of main stem (21.00 cm), weight of central head per plant (638.84 g), diameter of central head (20.88 cm), height of central head (21.00), volume of central head (762.96 cm^3), days for curd initiation (45.30), days for harvesting (55.00), number of leaves per plant (23.00), length of leaf (48.78 cm), leaf width (22.00), leaf area of plant (724.00 cm^2), total yield per plant (1202.80 g), total yield per plot (30.07 kg), total yield per hector (445.49 q), benefit cost ratio (3.36) and quality parameters like total chlorophyll (0.31 mg/g) and ascorbic acid (125.50 mg/100g). Therefore, amongst all the treatments D_4 planted at November 1st can be considered as most beneficial in terms of yield, vegetative and reproductive growth.

Introduction

Broccoli (*Brassica oleracea*) belongs to the genus *Brassica*, and family *Brassicaceae* which includes a wide range of crop plants derived from the Mediterranean Sea cabbage and modified over the years by selection and breeding (Decoteau, 2000). Broccoli is one of the most important and popular vegetable crops in many countries of the world because of its good organoleptic properties and high nutritive value (Dhillon *et al.*, 2005). Broccoli is a rich source of folic acid, vitamin-C, vitamin-A and a compound, Sulphoraphane which is associated with reducing the risk of cancer (Guo *et al.*, 2001). Broccoli soup is a delicacy in big hotels and resorts which is more nutritious than other coles, such as cabbage, cauliflower (Salaria and Salaria, 2011). The vegetable is often boiled or steamed but may be eaten raw. Its commercial cultivation was started around 1923 (Ouda and Mahadeen, 2008). Broccoli like other cole crops prefers a cool moist climatic condition which helps in the developing quality heads. It is more

sensitive to temperatures. When the plants are small and tender, they are susceptible to cold injury. Warm weather is disadvantageous, since the bad clusters grow loose quickly (Fellows, 1997).

Proper sowing time and transplanting time played an important role in achieving good yield for broccoli (Yoldas and Esiyok, 2004). Keeping in view the above facts, the present investigation was carried out to standardize optimum time of planting for head production of broccoli.

Materials and Methods

The experiment was conducted during *rabi* season of 2016-17. The experiment was laid out in randomized block design with three replications and eight treatments. Broccoli was planted at seven days interval to study crop growth under different dates of sowing. The variety selected for experiment was "Green Magic" which is of mid to early maturity class. The treatment details are given below.

The growth, yield and quality observations like height of plant, girth of main stem, weight of central head per plant, diameter of central head, volume of central head, days required for curd initiation, days for harvesting, number of leaves per plant, length of leaf, width of leaf, leaf area, yield per plant, yield per plot, yield per hectare, chlorophyll, ascorbic acid, benefit cost ratio were recorded.

Results and Discussion

Treatment D_4 planted at November 1st produced maximum height of plant (59.82 cm) which was significantly superior over all other treatments and followed by treatments D_3 and D_5 planted at October 25th and November 8th (58.65 cm and 58.63 cm) at all growth stages. This might be due to conducive climatic conditions prevailed during the crop period. Similar results were obtained by Saikia *et al.,* (2010) and Sighal *et al.,* (2009) in broccoli. Girth of main stem was found to be maximum in D_4 (21.00 cm) planted at November 1st which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (19.97 and 19.92 cm) at all growth stages. The minimum girth of main stem might be due to lower day and night average temperatures prevailed during the vegetative growth period when compared to earlier dates of planting. Seasonal influences on stalk stem diameter were also reported in broccoli by Sighal *et al.,* (2009) and Khan *et al.,* (1991). Maximum average weight of central head (638.84 g) was recorded in treatment D_4 which was planted at November 1st which was significantly superior over rest of the treatments under study and followed by treatments D_3 and D_5 (599.31 g and 599.12 g) planted at November 25th and October 8th. Reduction in weight of central head in late planting November 29th (D_8) (347.00 g) might be due to gradual increase in temperatures during curd development stage. Such influence of climate factors on curd weight were reported by Hossain *et al.,* (2011), Sharma *et al.,* (1995), Singh *et al.,* (1999) in broccoli and Ara *et al.,* (2009) in cauliflower. Among the dates of planting, the treatment D_4 planted at November 1st possessed significantly maximum diameter of central head (20.88 cm) which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (19.39 cm and 19.32 cm) respectively might due to optimum favorable low temperatures prevailing during curd initiation and curd development period. Such influence of temperature on curd quality was also reported by Magd (2013), Hossain *et al.,* (2011), Saikia *et al.,* (2010), Sermenli *et al.,* (2011) and Sighal *et al.,* (2009) in broccoli

and Ara *et al.,* (2009) in cauliflower. The maximum height of central head (21.00 cm) was recorded in treatment D_4 planted at November 1st the treatment D_4 planted at November 1st possessed significantly maximum volume of central head (762.96 cm^2) which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (642.29 cm^3 and 636.42 cm^3). Broccoli planted on November 29th i.e. treatment D_8 (71.01), took significantly more number of days to flower bud initiation than all other treatments and which was followed by treatments D_1 and D_7 planted at October 11th and November 22nd (66.89 and 66.81). Delay in curd initiation due to late planting was reported by Thapa *et al.,* (2002) in cauliflower, Saikia *et al.,* (2010), Magd (2013) and Nooprom *et al.,* (2013) in broccoli. Broccoli planted on November 29th i.e. treatment D_8, took significantly more number of days to harvesting (80.92) than all other treatments and which was followed by treatments D_1 and D_7 planted at October 11th and November 22nd (75.34 and 75.28) (Table 1). Sharma (1998) in cabbage, Saikia *et al.,* (2010) in broccoli and Ara *et al.,* (2009) in cauliflower also reported the reduced maturity period of head due to high temperature in late plantings. Treatment D_4 planted at November 1st produced highest number of leaves (23.00) which was followed by treatments D_3 and D_5 planted on October 25th and November 8th (22.68 and 22.42) respectively. Higher production of leaves per plant at ambient temperatures was reported by Saikia *et al.,* (2010) in broccoli. Maximum leaf length was found in D_4 planted at November 1st (48.78 cm) which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (47.24 cm and 47.10 cm) respectively. Decreasing plant growth with decrease in temperatures during vegetative growth was reported by Kumar *et al.,* (2007) in broccoli and Srivastava *et al.,* (2002) in cauliflower. Maximum leaf width was found in D_4 planted at November 1st (22.00 cm) which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (21.10 cm and 21.04 cm) respectively. Decreasing plant growth with decrease in temperatures during vegetative growth was reported by Kumar *et al.,* (2007) in broccoli and Srivastava *et al.,* (2002) in cauliflower. Treatment D_8 planted at November 1st recorded maximum leaf area (724.00 cm^2) than all other treatments and which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (702.14 and 700.00 cm^2). Decreasing plant growth with decrease in temperatures during vegetative growth was reported by Kumar *et al.,* (2007) in broccoli and Srivastava *et al.,* (2002) in cauliflower.

Treatment D_4 planted at November 1st gave highest total yield per plant (1202.80 g) followed by treatment D_5 (1081.40 g) planted at November 8th. The maximum plant yield may be due to favorable climatic conditions that prevailed at the time of vegetative growth and curd development period resulted increase in number and size of the leaves which could contributed towards more yield in early transplants. Such influences of temperature on curd yield were reported by Sharma *et al.,* (1995) in broccoli and Ara *et al.,* (2009) in cauliflower. The treatment D_4 planted at November 1st produced significantly highest total yield (30.07 kg) than all treatments which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (27.03 kg and 27.03 kg). The maximum plot yield may be due to favorable climatic conditions that prevailed at the time of vegetative growth and curd development period resulted increase in number and size of the leaves which could contributed towards more yield in early transplants. Such influences of temperature on curd yield

were reported by Sharma *et al.,* (1995) in broccoli and Ara *et al.,* (2009) in cauliflower. The treatment D_4 planted at November 1st produced significantly highest total yield (445.49 q) than all treatments which was at par with treatments D_5 and D_3 planted at November 8th and October 25th (400.46 q and 400.40 q) respectively. Moderate temperatures during crop growth allow better photosynthesis and translocation of metabolites reflecting increases in vegetative growth and consequently curd yield. Similar results were quoted by Sighal *et al.,* (2009), Saikia *et al.,* (2010) and Sharma *et al.,* (1995) in broccoli, Prabhakar and Srinivas (1993) in cabbage and Ara *et al.,* (2009) in cauliflower. The lower yields were recorded in delayed planting on November 29th indicates that transplanting time assumes a major significance, as delayed transplanting adversely affects the yield by arresting the plant growth and production blinds due to insect-pest attack in the prevailing high temperature during curd development period. These results were in agreement with the findings of Sharma (1998) in cabbage, Ara *et al.,* (2009) in cauliflower, Nooprom *et al.,* (2013) in broccoli. November 1st (D_4) planting had maximum chlorophyll content (0.31 mg per g) in curd which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (0.26 mg per g and 0.26 mg per g). Plants set out on November 1st (D_4) significantly maximum ascorbic acid (125.50 mg per 100 g) content in curds which was followed by treatments D_3 and D_5 planted at October 25th and November 8th (119.00 mg and 118.96 mg per 100 g) respectively. Plants from later plantings had less of ascorbic acid. It was probably caused by lower sunlight intensity. Positive relationship between light and ascorbic acid level in the plants was also stated by Lee and Kader (2000) and Acikgoz (2012). Treatment D_4 planted at November 1st recorded maximum benefit cost ratio (3.36) which was followed by treatments D_5 and D_3 planted at November 8th and October 25th (2.87 and 2.86) respectively. Similar results were obtained by Saikia *et al.,* (2010) in broccoli.

Table.1 Effect of planting dates on growth, yield and quality of broccoli cv. Green Magic

Treatments	Plant height (cm)			
	15 DAP	**30 DAP**	**45 DAP**	**60 DAP**
D_1	12.52	27.40	45.29	56.13
D_2	13.40	31.00	45.57	57.99
D_3	14.81	33.54	46.92	58.65
D_4	15.90	34.96	48.02	59.82
D_5	14.73	34.44	46.88	58.63
D_6	13.07	30.92	45.26	57.97
D_7	12.27	27.38	44.89	56.82
D_8	10.09	24.92	43.21	55.00
SE	0.57	0.94	0.50	0.62
CD at 5% level	1.72	2.85	1.53	1.88

Contd....

Treatments	Girth of main stem (cm)			
	15 DAP	30 DAP	45 DAP	60 DAP
D_1	4.19	8.90	13.95	17.38
D_2	4.98	9.12	14.78	18.12
D_3	5.72	9.64	15.54	19.97
D_4	6.33	10.92	16.92	21.00
D_5	5.70	9.62	15.50	19.92
D_6	4.92	9.04	14.72	18.06
D_7	4.14	8.82	13.91	17.32
D_8	3.70	8.02	12.98	16.14
SE	0.22	0.29	0.43	0.63
CD at 5% level	0.67	0.87	1.30	1.90

Contd....

Treatments	Weight of central head (g)	Diameter of central head (cm)	Height of central head (cm)	Volume of central head (cm^3)
D_1	404.43	17.59	19.54	503.73
D_2	540.78	18.71	19.56	580.53
D_3	599.31	19.39	20.50	642.29
D_4	638.84	20.88	21.00	762.96
D_5	599.12	19.32	20.46	636.42
D_6	540.72	18.47	19.84	564.02
D_7	404.02	17.85	19.48	517.23
D_8	347.00	15.45	19.02	378.35
SE	16.13	0.90	0.61	14.37
CD at 5% level	48.85	2.73	1.85	43.52

Contd....

Treatments	Days for curd initiation	Days for harvest	Leaf area at harvest (cm^2)
D_1	66.89	75.34	588.36
D_2	61.04	69.69	634.92
D_3	52.08	63.25	702.14
D_4	45.30	55.00	724.00
D_5	52.00	63.22	700.00
D_6	60.98	69.94	634.81
D_7	66.81	75.28	588.32
D_8	71.01	80.92	502.00
SE	2.08	2.43	21.78
CD at 5% level	6.29	7.36	65.97

Contd....

Treatments	Number of leaves			
	15 DAP	30 DAP	45 DAP	60 DAP
D_1	6.98	10.56	15.90	20.86
D_2	7.44	11.00	16.52	21.84
D_3	7.90	11.68	17.66	22.68
D_4	8.27	12.00	17.88	23.00
D_5	7.80	11.60	17.42	22.42
D_6	7.28	11.02	16.34	21.80
D_7	6.92	10.52	15.82	20.78
D_8	6.20	9.40	15.08	19.90
SE	0.26	0.31	0.34	0.36
CD at 5% level	0.78	0.95	1.04	1.09

Contd....

Treatments	Length of leaf (cm)			
	15 DAP	30 DAP	45 DAP	60 DAP
D_1	19.82	28.98	36.48	45.00
D_2	21.76	29.48	37.64	46.92
D_3	22.84	30.30	38.92	47.24
D_4	23.30	31.00	40.00	48.78
D_5	22.72	30.30	38.84	47.10
D_6	21.00	29.22	37.58	46.75
D_7	19.40	28.94	36.36	44.82
D_8	17.82	27.18	35.62	43.55
SE	1.03	0.58	0.53	0.77
CD at 5% level	3.12	1.76	1.60	2.35

Contd....

Treatments	Leaf width (cm)			
	15 DAP	30 DAP	45 DAP	60 DAP
D_1	9.96	13.40	15.79	19.24
D_2	10.36	13.68	16.08	19.75
D_3	10.48	13.79	16.64	21.10
D_4	10.96	14.00	17.00	22.00
D_5	10.44	13.72	16.50	21.04
D_6	10.26	13.62	16.00	19.64
D_7	9.92	13.31	15.74	19.17
D_8	9.04	13.00	15.34	18.43
SE	0.48	0.13	0.29	0.57
CD at 5% level	1.45	0.39	0.87	1.71

Contd....

Treatments	Total yield per plant (g)
D_1	746.41
D_2	950.78
D_3	1081.30
D_4	1202.80
D_5	1081.40
D_6	950.50
D_7	744.70
D_8	623.00
SE	16.48
CD at 5% level	54.42

Contd....

Treatments	Yield plot^{-1} (kg)		
	Marketable yield (kg)	Unmarketable yield (kg)	Total yield per plot (kg)
D_1	14.18	4.48	18.66
D_2	18.28	5.49	23.77
D_3	21.32	5.71	27.03
D_4	24.06	6.01	30.07
D_5	21.35	5.68	27.03
D_6	18.30	5.46	23.76
D_7	14.15	4.47	18.62
D_8	11.68	3.90	15.55
SE	1.04	0.25	1.11
CD at 5% level	3.15	0.76	3.37

Contd....

Treatments	Yield ha^{-1}		
	Marketable yield (q/ha)	Unmarketable yield (q/ha)	Total yield (q/ha)
D_1	210.07	66.37	276.44
D_2	270.86	81.29	352.15
D_3	315.90	84.54	400.40
D_4	356.40	89.09	445.49
D_5	316.35	84.10	400.46
D_6	271.11	80.89	352.00
D_7	209.63	66.22	275.85
D_8	173.09	57.73	230.82
SE	10.23	2.81	19.44
CD at 5% level	30.98	8.51	58.89

Contd....

Treatments	Chlorophyll (mg/g)	Ascorbic acid (mg/100g)	B:C ratio (ha)
D_1	0.21	102.18	1.57
D_2	0.23	112.00	2.31
D_3	0.26	119.00	2.86
D_4	0.31	125.50	3.36
D_5	0.26	118.96	2.87
D_6	0.22	111.30	2.31
D_7	0.20	102.12	1.56
D_8	0.15	97.22	1.11
SE	0.01	5.30	0.17
CD at 5% level	0.04	16.03	0.53

Treatment details

Sr. No.	Treatments	Planting Dates
1	D_1	11.10.2016
2	D_2	18.10.2016
3	D_3	25.10.2016
4	D_4	01.11.2016
5	D_5	08.11.2016
6	D_6	15.11.2016
7	D_7	22.11.2016
8	D_8	29.11.2016

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