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Assessment of producing quality sprouting broccoli (*Brassica oleracea* var. *italica*) under cover and open condition

Umesh Thapa*, Rashmi Rai, Yvonne Angel Lyngdoh, Sankhendu Bikash Chattopadhyay and Param Hans Prasad

Department of Vegetable Crops, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia - 741252 (W.B.) India.

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The present study evaluates Poly House and Open field production of quality Sprouting broccoli. Sprouting broccoli is an exotic vegetable which is gaining popularity among Indian growers due to its high nutritive value and market potential in the recent years. Experiment was conducted to determine the growth, yield and quality of sprouting broccoli under polyhouse and open field condition at Horticultural Research Station, Mondouri, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal (India) during the months of October to March (2010 to 2012). The experiment consisted of two growing conditions (viz, Polyhouse and Open field) with four hybrid varieties (viz, Early You, Princess, Fiesta and Nokguk). Results indicated that the plants grown in the polyhouse were superior than those grown in the field. Quality attributes like, Chlorophyll a, chlorophyll b, total chlorophyll, reducing sugar , non-reducing sugar and total sugar were also found significantly increased in polyhouse grown crops. Marketable curd yield of 'Early you' were highest in poly house condition. Plants grown in poly house gave the highest production in all the four varieties as compared to the plants grown in open field. Significant trends were found in all the quality attributes with increasing tendency in all the four varieties of sprouting broccoli in polyhouse. Study amongst the four varieties that for highest production with good quality, polyhouse condition was found to be effective for successful cultivation of Sprouting broccoli in the gangetic plains of West Bengal.

Key words: Sprouting broccoli, polyhouse, open field.

INTRODUCTION

India is the second largest producer of vegetable crops in the world. However, its vegetable production is much less than the requirement if balanced diet is provided to every individual. There are different ways and means to achieve this target, e.g., bringing additional area under vegetable crops using hybrid seeds, use of improved agro-techniques. Another potential approach is perfection and promotion of protected cultivation of vegetables (Singh, 1998; Singh et al., 1999). In hilly areas parts of the country especially in Northern plains, the soils are highly fertile but extremes of temperature ranging from (0 to 48°C) during the year, it does not allow year round outdoor vegetable cultivation. Similarly, in several parts of the country biotic stresses mainly during rainy and post rainy season do not allow successful production of vegetables like tomato, chilli, okra, cauliflower, etc., in the

*Corresponding author. E-mail: drumesh.thapa@gmail.com. Tel: +919830234577, +913473-222659.

fields. In upper reaches of Himalayas, cool desert conditions period where the temperature is extremely low (-5 to -30°C) during winter season and most of the region remain cut off from rest of the country from November to March due to very heavy snowfall therefore it is very difficult to grow vegetables in such climate.

However, considerable attention is being given on the proper and protected production technology of vegetables which are rich in nutrient content and have a high yield potential. Growing plants continuously, without crop rotation or interruption in production as in open field production during winters, can lead to an excessive build up of soil pathogens. Hence, the greenhouse has evolved into more than a plant protector. The greenhouses of today can best be seen as plant or vegetable factories for value added vegetables like brussel sprouts, lettuce, chinese cabbage, sprouting broccoli, parsley, pakchoi, etc. because year round production can be achieved through controlled environmental condition whereas, in the open field crop production is only seasonal.

Cultivation of these value added vegetables have opened up new opportunities for vegetable growers of West Bengal for diversification and off-season production for high market in metropolis throughout the year. Sprouting broccoli mainly grown in temperate and sub-tropical climate. It is grown during winter months (October to February) in Northern India (Sharma et al., 2004). It requires cool and humid climate for growth and production. Hot weather during harvesting period results in an undesirable leafiness in the heads, the heads develop so rapidly that it is difficult to harvest at proper time. The plant is hardy and will withstand fairly heavy frost without any appreciable damage.

Realizing the tremendous potential of sprouting broccoli in domestic and foreign market, the cauliflowers growers of terai zone of West Bengal, India are gradually adopting the broccoli cultivation (Saha et al., 2006). To popularize this new introduced vegetable with advanced production technology (Greenhouse), proper research was being carried out in the department of vegetable crops of Bidhan Krishi Viswavidyalaya at West Bengal, India. The objective was to evaluate the production technology of sprouting broccoli (*Brassica oleracea* var. *italica*) under cover and open condition.

MATERIALS AND METHODS

The experiment was conducted during October to March (2010 to 2012) at Horticultural Research Station (HRS), Mondouri, B.C.K.V., Nadia, West Bengal, India. The Research Station is located 23.5°N latitude and 80°E longitude and an latitude of 9.75 m above sea. The experiment was laid out in a Factorial Randomized Block Design having two growing conditions (viz, Poly –house and Open field) with four hybrid varieties (viz, Early You, Princess, Fiesta and Nokguk), replicated thrice. The transplanting of seedlings was accomplished with the spacing of (60 x 45 cm) having plot area (2 × 2 m) in both growing conditions (viz, Polyhouse and Open field).

Applied fertilizer doses are in NPK ratio of (100:80:100) kg per hectare. Regular cultural practices, crop protection measures were adopted as per the requirements of crops in both growing conditions. Observations were taken under physical and quality attributing parameters. The average of five plants was computed to get the mean value and this mean value of randomized data were used for standard statistical analysis (Panse and Sukhatme, 1985). Most of the quality attributes was analysed by the methods of Ranganna (1997).

RESULTS AND DISCUSSION

The results indicated that the plants grown in the poly house were more superior than open field condition. Significant trends were found in all the quantity and quality attributes with increasing tendency in all the four varieties grown under polyhouse.

The four varieties of Broccoli differed significantly in both growing conditions (Table 1). The plant height varied from 67.78 to 38.88 cm. Maximum plant height was observed in *Princess* variety grown under polycover and minimum plant height in variety *Fiesta*, that is, in open field condition. The lower plant height observed in other varieties might be possibly due to their inherent genotypic characteristics or for the variations in agro-climatic condition. The number of leaves per plant is an important character that might influence the yield. The cultivars included in the study produced an average variation of 17 to 29 leaves per plant. The maximum number of leaves per plant was recorded in Early you, followed by Nokguk and Princess grown under polyhouse. The lowest number of leaves was noticed in the variety Fiesta in open field. Reduced number of leaves in open field condition was probably due to slow rate in leaf initiation which would be due to lack of photosynthetic efficient climate for vegetative growth of cultivars as because only these cultivars performing fairly well under polyhouse climate. This is in agreement with previous investigation in which some of the cultivars were included (Vanparys, 1998; Rooster et al., 1998; McCall et al., 1996).

In determining the photosynthetic efficiency of the leaves, the surface area of the leaves is an important factor. In this investigation, plant spreads were recorded from both open field and polyhouse grown cultivars were found significantly variable from each other. The range of plant spread was 3462.5 to 5853.2 cm^2. Maximum plant spread was obtained with variety Early you grown in polyhouse and minimum plant spread with Fiesta in open field. These findings were also in parity with the results obtained by (Mourão and Hadley, 1998).

The highest stem diameter occurred in polyhouse, that is, Nokguk followed by Early you. In the polyhouse there were significant differences among varieties. Varieties grown in open field also differ significantly from those grown in polyhouse. The lowest diameter of stem was obtained with variety Princess. Yield and yield attributes differed due to different varieties grown and edapho-climatic condition. In respect of curd initiation and days required to first harvesting, cultivars under

Table 1. Varietal evaluation of Sprouting Broccoli under poly house and open field condition in the plains of West Bengal.

Variety	Plant height (cm)	Leaf Area (cm^2)	Plant spread (cm^2)	No. of leaves	Stock length (cm)	Stem diameter (cm)	Curd weight (g)	Curd diameter (cm)	Curd yield (kg/ plot)	Curd yield (q/ha)	Curd initiation (days)	First harvest (days)	Number of sprouts	Sprouts weight (g)	Sprout yield g/plant
Open field condition															
V1	41.51	564.94	4659.07	20.19	30.34	2.89	294.44	21.18	4.71	94.27	76.13	87.04	5.16	35.18	181.60
V2	40.06	501.23	3740.69	18.89	30.04	2.69	240.39	20.10	3.85	76.93	73.24	81.88	4.22	40.81	172.38
V3	38.88	494.64	3462.50	17.62	28.19	2.87	255.20	22.12	4.08	81.67	75.19	87.22	4.51	31.22	140.81
V4	39.28	779.35	4498.79	18.46	29.53	3.04	259.06	21.77	4.14	82.87	73.42	82.37	2.25	41.93	94.41
SEm (±)	0.949	13.019	124.165	0.567	0.405	0.029	9.320	0.361	0.150	2.995	0.409	0.271	0.079	0.985	5.367
CDat 5%	3.28	45.047	429.628	1.963	1.401	0.101	32.248	1 .251	0.518	10.363	1.414	0.938	0.275	3.408	18.571
Poly house condition															
V1	50.03	1084.97	5853.29	29.60	32.27	3.40	371.84	23.02	5.95	119.00	57.32	70.45	6.72	55.31	371.65
V2	67.78	856.52	4324.59	24.12	57.05	3.16	340.47	21.69	5.45	108.93	55.17	67.12	5.80	51.39	298.29
V3	63.50	869.01	5392.16	19.48	37.64	3.17	316.25	23.26	5.06	101.13	62.1	72.07	5.41	50.51	273.16
V4	58.14	1206.13	5443.17	24.37	42.94	3.74	336.47	25.23	5.38	107.60	57.84	67.12	3.09	64.63	199.69
SEm (±)	1.066	15.089	23.274	0.726	0.202	0.045	4.658	0.303	0.074	1.481	0.470	0.252	0.090	0.907	6.409
CDat 5%	3.687	52.209	80.528	2.513	0.699	0.157	16.117	1.052	0.256	5.123	1.624	0.0892	0.310	3.139	22.175

Note: V1- Early You; V2- Princess; V3- Fiesta; V4- Nokguk.

polyhouse study were found significant. Curd formation is dependent on the temperature and soil pH factor. Low temperature and high soil alkalinity can boost the yield and quality of sprouting broccoli under polyhouse which confirms the findings of Nath and Mohan (1993), who reported that low soil pH of 4.5 causes poor yield and curd quality. The average number of days to curd initiation varied from 55 to 76. All the cultivars grown under polyhouse climate found earlier and open field grown one found very late in respect to curd initiation. The average period of days to harvesting varied from 67 to 87. Almost all the varieties harvested earlier in polyhouse treatment. The highest curd diameter was recorded in polyhouse with cultivar Nokguk followed by Fiesta.

Significant increase in curd weight was observed in response to different varieties grown in polyhouse. The maximum head weight was found with Early *you* under polycover. The varieties grown under polyhouse produced comparatively more curd weight than those in field. The highest curd weight might be due to the highest head diameter of the respective varieties and suitability of physical climate. The minimum curd weight was obtained with field grown Princess Variety. Early you had the highest head yield (q/ha) and Princess and Nokguk had similar yields (108.93 q/ha, 107.60 q/ha), respectively. Greatest number of sprout (spears) were also recorded from polyhouse grown variety Early you followed by Princess. The lowest numbers of sprout were observed from Nokguk variety grown in field. The differences in number of sprout among varieties may be due to their own genetic characters as well as the temperature receptivity. These were significant differences in the sprout weight among the varieties (Table 1). The highest sprout weight was obtained from Nokguk followed by Early you.

The data clearly indicated that the variety Early you grown under polyhouse condition superseded in giving the maximum sprouts yield/plant and the minimum was found in variety Nokguk grown in open field condition. Quality attributes like, Chlorophyll-a, Chlorophyll-b, total Chlorophyll, reducing sugar, non-reducing sugar and total sugar were significantly higher in plants grown in polyhouse (Table 2). Significant trends were found in most of the quality attributes with increasing

Table 2. Quality evaluation of sprouting broccoli under poly-house and open field condition in the gangetic plains of West Bengal.

Parameter	Total chlorophyll (mg/g)	Chlorophyll-a (mg/g)	Chlorophyll-b (mg/g)	Total sugar (%)	Reducing sugar (%)	Non-reducing sugar (%)
Open field condition						
V1	5.42	2.79	6.07	1.47	1.13	0.34
V2	4.25	2.24	5.20	1.99	1.86	0.14
V3	4.91	2.81	5.33	2.47	1.96	0.51
V4	4.04	2.10	4.92	1.89	1.78	0.11
SEm (±)	0.072	0.070	0.155	0.036	0.054	0.056
CDat5%	0.249	0.241	0.535	0.124	0.186	0.192
Polyhouse condition						
V1	7.51	3.70	8.58	1.52	1.11	0.42
V2	5.30	2.75	6.13	1.75	1.43	0.32
V3	5.95	3.08	6.86	1.97	1.74	0.23
V4	4.92	2.72	6.31	1.77	1.55	0.23
SEm (±)	0.125	0.069	0.110	0.046	0.053	0.041
CDat5%	0.433	0.239	0.383	0.160	0.184	0.142

trend in all four varieties of sprouting broccoli in poly-house. These findings are also corraborated with the results of Hidaka et al. (1992). Amongst the four varieties for highest production with good quality, polyhouse production was found to be effective for successful cultivation of Sprouting broccoli in the gangetic plains of West Bengal.

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