

GROWTH AND YIELD OF SPROUTING BROCCOLI (*BRASSICA OLERACEA L. VAR. ITALICA*) VARIETIES UNDER OPEN FIELD AND NATURALLY VENTILATED POLYHOUSE CONDITION

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ABSTRACT

An experiment was conducted to study the performance of six varieties (Palam Haritika, Palam Kanchan, Palam Samridhi, Palam Vichitra, MSB-12 and Ganesh) of broccoli with two environmental conditions (open field and naturally ventilated polyhouse) during Rabi season 2014-15 at College of Horticulture, RVSKVV, Mandsaur (M.P.). The experiment was laid out in Factorial Randomized Block Design with three replications. The E_2 environmental condition has maximum curd yield of 256.82q/ha. Among the varieties maximum dry weight of plant at curd stage (161.92g) and harvesting stage (279.33g), SPAD value (67.10) and curd yield (375.41q/ha) were found in Palam Kanchan whereas plant spread (10852.40cm²) in Palam Vichitra. Highest stem diameter was recorded in case of Palam Haritika at curd initiation (3.33cm) and harvesting stage (3.79cm). Interaction effect of varieties with environmental conditions was significant for all the characters except curd yield. Treatment combination E_2V_2 showed superior performance for curd yield. Therefore, it may be concluded that the performance of varieties is better in polyhouse than the open field.

INTRODUCTION

Sprouting broccoli (*Brassica oleracea var. italica L.*) is a native of eastern Mediterranean region, derived from ancient forms of *Brassica oleracea*. Italy is a centre of diversification (Singh and Nath, 2012). Broccoli is an Italian word originated from Latin 'Brachium' meaning an arm or branch (Thamburaj and Singh, 2013). It is known for its taste, flavor, nutritive and medicinal properties. Broccoli and other cole crop like cauliflower contain the compound namely, glucoraphanin, which can be processed into an anti-cancer compound sulphoraphane (Shiwani *et al.*, 2016). The curd of broccoli contains following nutrients per 100 g of edible portion; moisture 89.9 g, carbohydrates 5.5g, fat 0.2g, protein 3.3g, vitamin A 3500 IU, thiamine 0.05 mg, riboflavin 0.12 mg, phosphorous 79 mg, calcium 80 mg, iron 0.8 mg, ascorbic acid 137 mg and calories 37g (Singh and Nath, 2012).

Protected cultivation is a most existing approach to produce high value vegetables. Controlled Environment Agriculture (CEA) is highly productive, conservative of water, fertilizers and land and also protective of the environment like the temperature, humidity, light. By adopting protected cultivation technology, the growers can look forward to a better and additional remuneration for high quality produce (Ughade *et al.*, 2016).

In recent years sprouting broccoli cultivation has gained momentum in India, because of its high nutritive values and

popularity among tourist. Sprouting broccoli is a cool season crop and very sensitive to high temperature which causes the heads to be distorted and unevenly-sized flower buds on inflorescence, making it a high-risk crop (Bjorkman and Pearson, 1998). The environmental factor like temperature has great influence on yield and yield attributing characters (Kumar *et al.* 2013). Different cultivars have different growth and yield parameters varying with growing conditions (Thapa *et al.* 2013). Open field cultivation is often affected with sudden adverse changes in weather conditions. Whereas natural ventilated polyhouses provides protection from such conditions. Therefore, present study was conducted to evaluate the growth and yield of sprouting broccoli varieties under open field and naturally ventilated polyhouse condition.

MATERIALS AND METHODS

The investigation was carried out at the Research Field of the Department of Vegetable Science, College of Horticulture, Mandsaur, (M.P), during 2014-15. The experiment was laid out in a Factorial Randomized Block Design having two environmental conditions viz, Open field (E_1) and naturally ventilated polyhouse (E_2) with six varieties i.e. Palam Haritika (V_1), Palam Kanchan (V_2), Palam Samridhi (V_3), Palam Vichitra (V_4), MSB-12 (V_5) and Ganesh (V_6) with three replications. The seeds were sown in raised beds on 4th Sep 2014. One month old seedlings were transplanted at spacing of 50cm × 45 cm. Fertilizer was applied at the rate of 100 kg N, 80 kg P₂O₅ and

60 kg K₂O/ha. Optimum soil moisture was maintained in the open field and naturally ventilated polyhouse through drip irrigation system. Regular cultural practices, crop protection measures were adopted as per the requirement of crops in both environmental conditions.

The data were recorded on 5 randomly selected plants in each plot and their mean values were worked out. Observations were taken on growth parameters, SPAD value and yield parameters. The plant spread at curd initiation stage was recorded as product of average of distance between two outer most leaves in both direction (N to S and E to W) (Srivastava *et al.*, 2001). The data were analysed statistically as per the procedure described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The results (Table 1) indicated that the plants grown in the polyhouse were more superior to open filed condition. In determining the photosynthetic efficiency of the leaves, the surface area of the leaves is an important factor. Larger leaves accompanied with spreading nature lead to maximum plant

spread in case of variety Palam Vichitra. Minimum plant spread was observed in case of variety Ganesh which was significantly lower than all other varieties. Similar results have been found by Prasad *et al.* (2010) and Thapa and Prasad (2013). Environmental condition had exerted significant effect on plant spread. Favourable environmental conditions for plant growth resulted in highest plant spread under polyhouse. These results have parity with findings obtained by Srivastava *et al.* (2002) in cauliflower, Agrawal *et al.* (2003) in cauliflower, cabbage and knolkhol and Thapa *et al.* (2013) in broccoli. Combined effect of varieties and environmental condition (Table 2) showed significant effect on plant spread. Growth promoting environment coupled with superior genetic potential enabled treatment combination E₂V₄ to achieve highest plant spread which was significantly superior over all the treatment combinations.

Maximum stem diameter was recorded with Palam Haritika in both curd initiation and harvesting stage whereas the minimum stem diameter was measured in case of Ganesh at both stages. This variation among the varieties in stem diameter may be attributed to the variability in their genetic configuration. These

Table 1: Effect of varieties and environmental conditions on growth and yield of sprouting broccoli

Treatment Varieties (V)	Plant spread (cm ²)	Stem diameter (cm)		Dry weight of plant (g)		SPAD value			Curd yield (q/ha)
		Curd initiation stage	Harvesting stage	Curd initiation stage	Harvesting stage	30 DAT	45 DAT	60 DAT	
V ₁	9104.80	3.33	3.79	139.42	204.17	52.71	59.25	63.87	235.43
V ₂	10026.17	2.73	3.01	161.92	279.33	57.27	61.68	67.10	375.41
V ₃	5889.50	3.04	3.26	37.92	84.83	52.31	56.92	60.14	166.02
V ₄	10852.40	2.67	2.91	151.25	210.00	52.82	60.37	64.13	348.67
V ₅	6353.03	2.38	2.52	49.17	51.58	52.61	57.47	62.42	216.92
V ₆	4484.03	2.31	2.47	19.17	46.33	50.45	55.90	59.48	89.21
S _{Em} ±	160.18	0.07	0.08	5.31	7.30	0.44	0.50	0.53	11.50
CD(P=0.05)	443.98	0.19	0.22	14.73	20.24	1.22	1.40	1.48	31.88
Environmental condition (E)									
E ₁	7429.68	2.61	2.81	77.67	131.75	50.41	55.88	61.64	202.40
E ₂	8140.30	2.88	3.18	108.61	160.33	55.65	61.32	64.08	256.82
S _{Em} ±	92.48	0.04	0.05	3.07	4.22	0.25	0.29	0.31	6.64
CD(P=0.05)	265.33	0.11	0.13	8.50	11.68	0.70	0.81	0.86	18.40

Table 2: Combined effect of varieties and environmental condition on growth and yield of sprouting broccoli

Treatment	Plant spread (cm ²)	Stem diameter (cm)		Dry weight of plant (g)		SPAD value			Curd yield (q/ha)
		Curd initiation stage	Harvesting stage	Curd initiation stage	Harvesting stage	30 DAT	45 DAT	60 DAT	
E ₁ V ₁	8477.40	3.14	3.60	112.50	186.83	49.93	57.02	63.47	216.92
E ₁ V ₂	9556.27	2.37	2.56	145.83	245.17	53.85	58.37	66.07	361.43
E ₁ V ₃	5777.13	3.03	3.17	32.33	66.67	48.87	55.77	59.66	143.54
E ₁ V ₄	10180.27	2.49	2.64	129.33	198.00	50.97	57.27	63.28	311.53
E ₁ V ₅	6233.27	2.33	2.46	30.83	50.00	49.91	54.76	59.05	200.77
E ₁ V ₆	4353.73	2.27	2.42	15.17	43.83	48.93	52.09	58.30	88.24
E ₂ V ₁	9732.20	3.51	3.98	166.33	221.50	55.49	61.48	64.27	253.93
E ₂ V ₂	10496.07	3.08	3.47	178.00	313.50	60.70	64.99	68.13	389.40
E ₂ V ₃	6001.87	3.06	3.36	43.50	103.00	55.75	58.07	60.63	188.50
E ₂ V ₄	11524.53	2.85	3.17	173.17	222.00	54.67	63.48	64.98	385.81
E ₂ V ₅	6472.80	2.43	2.57	67.50	53.17	55.31	60.17	65.80	233.07
E ₂ V ₆	4614.33	2.36	2.51	23.17	48.83	51.98	59.72	60.66	90.18
S _{Em} ±	226.52	0.10	0.11	7.52	10.33	0.62	0.71	0.76	16.26
CD(P=0.05)	627.88	0.27	0.31	20.83	28.62	1.72	1.97	2.09	NS

findings are corroborated with those of Prasad *et al.* (2010) and Thapa and Rai (2012). Highest stem diameter was found under polyhouse at both curd initiation and harvesting stage. It was significantly superior over open field condition at both stages of growth under study because polyhouse provided favourable environmental conditions. These findings are in agreement with Solunke *et al.* (2011) and Thapa *et al.* (2013). Highest stem diameter was found with E_2V_1 . Treatment combination E_1V_6 has recorded lowest stem diameter at both curd initiation and harvesting stage.

Variety Palam Kanchan recorded maximum dry weight of plant at both curd initiation and harvesting stages. Minimum dry weight of plant was observed in case of Ganesh at both curd initiation and harvesting stages. These results are in agreement with Srivastava *et al.* (2011) in cauliflower and Abou El-Magd (2013) in broccoli, they reported that superiority of plants vegetative growth might be owing to its potential heredity. In addition, higher photosynthetic activity and higher potentiality for condensation of metabolites which in turn reflects higher vegetative growth rate. Maximum dry weight of plant was recorded in polyhouse condition at both curd initiation and harvesting stage. Open field had lowest dry weight of plant. These results are in line with those obtained by Abou El-Magd (2013). Combined effect of varieties and environmental condition revealed significant influence on dry weight of plant at all stages of growth. Among the treatment combinations, E_2V_2 had highest dry weight of plant while E_1V_6 had recorded lowest dry weight of plant at both curd initiation and harvesting stage. Genetic potential coupled with favourable environmental condition might be responsible for such results. Similar findings have been reported by Abou El-Magd (2013).

SPAD value in leaves was determined at 30, 45 and 60 days after transplanting. Maximum SPAD value was found in case of Palam Kanchan. Lowest SPAD value was observed under Ganesh at all the stages. Difference in SPAD value could be attributed to their genetic makeup. Polyhouse condition recorded maximum SPAD value which was significantly higher than open field at all the stages of crop under study. Such results reflect the favourable condition for SPAD value under E_2 . Treatment combination E_2V_2 had highest SPAD value among the combinations at all the stages.

Variety Palam Kanchan recorded maximum curd yield. Minimum curd yield was observed in case of variety Ganesh. Such variability in curd yield of broccoli is also in conformity with the earlier findings reported by Thapa and Prasad (2013), Thapa *et al.* (2013), Abou El Magd (2013), Uniyal *et al.* (2013) and Ngullie and Biswas (2014) in broccoli, reporting that variety superior in its vegetative growth and leaf area allows plant to receive more light energy and consequently more photosynthesis and photosynthetic metabolites which translocated and stored in main yield. Highest curd yield was found under polyhouse condition. Favourable effect of polyhouse condition enhanced the growth and yield attributes which ultimately resulted in highest curd yield. These findings are corroborated with those obtained by Srivastava *et al.* (2002), Pradeepkumar *et al.* (2002) in cauliflower, Saleem *et al.* (2014) in cabbage, Agrawal *et al.* (2003) in cauliflower, knolkhol and cabbage and Thapa *et al.* (2013) in broccoli, they reported that yield of all these vegetable crops were found

encouraging because utilization of high rate of carbon dioxide inside the protected cultivation.

From the findings of the present investigation it may be inferred that naturally ventilated polyhouse was superior as compared to open field for growth and yield attributes in sprouting broccoli. Among the varieties maximum dry weight of plant at curd stage and harvesting stage, SPAD value and curd yield were found with Palam Kanchan. Whereas maximum plant spread and stem diameter was recorded with Palam Vichitra and Palam Haritika, respectively. Interaction effect of varieties with environmental conditions was significant for all the parameters except curd yield.

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