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Interaction Effect of Different Plant Spacing on Performance of Different Varieties with Respect to Yield and Economics of Broccoli (*Brassica oleracea* var. *italica* L.) under North Gujarat Conditions

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A B S T R A C T

Keeping in view the importance of vegetable crops in nutritional security and generating the income and employment to the farm population a study on economics of broccoli cultivation in north Gujarat was carried out at Horticulture Instructional Farm, CP College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *rabi* season 2015-16 to find out the "Interaction effect of different plant spacing on performance of different varieties with respect to yield and economics of broccoli (*Brassica oleracea* var. *italica.* L). The results revealed that among various treatments the treatment S_1V_2 [Plant spacing (30 cm × 30 cm) with variety Palam Vichitra] was found best for obtaining maximum yield per hectare (283.479 q/ha), gross realization of (Rs. 8,50,410 per hectare) as well as net realization (Rs. 7,52,415 per hectare) and the highest benefit cost ratio (1: 8.67).

Introduction

Indian subcontinent has been endowed by nature with vast diversity of land, soil and agro climate conditions which are found suitable to produce various types of vegetable crops. There is substantial increase in production and productivity of vegetables crops. The area and production of vegetables are increasing year after the green revolution, owing to growing of improved varieties and adoption of improved cultivation technologies. Further, the country has made quantum jump since independence scoring more than seven times increase in vegetables production. However, the production of different vegetables is comparatively low in comparison with that of other developed countries.

Broccoli (*Brassica oleracea* var. *italica* L.) is an important fancy and highly nutritive exotic vegetable. It is a member of cruciferous family having many important vegetables such as Cauliflower, Cabbage, Knol-khol, Brussels sprout, Kale and Chinese cabbage. It is also known as winter broccoli or heading broccoli or Italian broccoli. It is considered to be originated from wild cabbage, *Brassica oleracea* var. *oleracea* (syn. *Brassica oleracea*

var. *Sylvestris* L.), which is found growing wild along the Mediterranean Sea.

Broccoli is a rich source of sulphoraphane which is associated with reducing the risk of cancer (Guo *et al.,* 2001). The primary inflorescence was characterized by higher levels of dry matter, total nitrogen, vitamin-C, chlorophylls, β-carotene, carotenoids and by lower levels of nitrates. Nutritionally, it is rich in vitamin-A (2500 I.U.), vitamin-C (113 mg), protein (3.6 g), carbohydrates (5.9 g) and minerals like calcium (103 mg), iron (1.1 mg), phosphorous (78 mg), potassium (382 mg) and sodium (15 mg) per 100 gm of edible portion (Rana, 2008). After harvesting the head, its green leaves are also a good source of nutritious green fodder and serves in acute shortage in winter season (Kumar *et al.,* 2007).

In India, it is being used as a fresh vegetable, where as in USA and European countries it is used as fresh as well as frozen form. It is usually boiled or steamed but may be eaten raw as salad and is liked in soups. The anti-cancer benefits of broccoli are greatly reduced if the vegetable is boiled. However, other preparation method such as steaming, microwaving and frying had no significant effect on the constituent compounds (Jeffery, 2005). There are two types of broccoli, heading and sprouting. Most common broccoli is of the heading type which is closely related to cauliflower and forms a large central head. Sprouting or Italian broccoli form many florets or small heads but they do not produce a solid head. Its edible portion consists of immature, fully-differentiated flower buds and tender portions of the upper stem.

Broccoli is a crop which is grown as cool season vegetable which further offer great opportunity of income and employment generation to the community mainly involves in its cultivation. Since, prices of inputs like seeds, manures, fertilizer, chemical, irrigation and labour charges are increasing every year. Thus it is of utmost importance to study the economics of broccoli cultivation, in order to present the real scenario of economic broccoli cultivation. Keeping in view of these facts the study entitled "Interaction effect of different plant spacing on performance of different varieties with respect to yield and economics of broccoli (*Brassica oleracea* var. *italica* L.) under north Gujarat conditions" India. So, there is a research need to made a certain recommendations to generate research evidences with respect to suitability of certain spacing and suitable varieties in a specific season to benefit the growers of North Gujarat region.

Materials and Methods

The study was conducted at Horticulture Instructional Farm, CP College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat during *Rabi* season 2015-16. The experiment was laid out in a split plot design with three replications. The experimental area was divided into plots of 2.70 m x 1.80 m size. The experiment was carried out with three plant spacing (S_1 30cm × 30cm, S_2 45cm × 30cm, S3 45cm × 45cm) and four varieties [Palam Samridhi (V_1), Palam Vichitra (V_2), Pusa Broccoli KTS-1 (V_3) and Palam Haritika (V_4)].

To raise the crop recommended package of practices was followed. The date of seed sowing in nursery bed was on 23rd November 2015 and date of transplanting on 17th December 2015 during Rabi season. The interaction effect of different treatments of broccoli was studied and data recorded on yield and economics. The mean data were subjected to statistical analysis following analysis of variance technique (Panse and Sukhatme, 1985).

Results and Discussion

Yield

Yield of different treatments (Table 1) showed significant differences. The highest yield per hectare (283.479 q) was found with treatment S_1V_2 [Plant spacing (30 cm ×30 cm) with variety Palam Vichitra]. The treatment S_1V_1 [Plant spacing (30 cm ×30 cm) with variety Palam Samridhi] was found statistically at par with the treatment S_1V_2 [Plant spacing (30 cm ×30 cm) with variety Palam Vichitra] and the minimum yield per hectare (64.53 q) was obtained with treatment S_3V_4 [Plant spacing (45 cm ×45 cm) with variety Palam Haritika].

These significant differences with respect to yield per hectare among different treatments may be due to their own-genetic makeup and the suitability of varieties to the weather conditions of this zone.

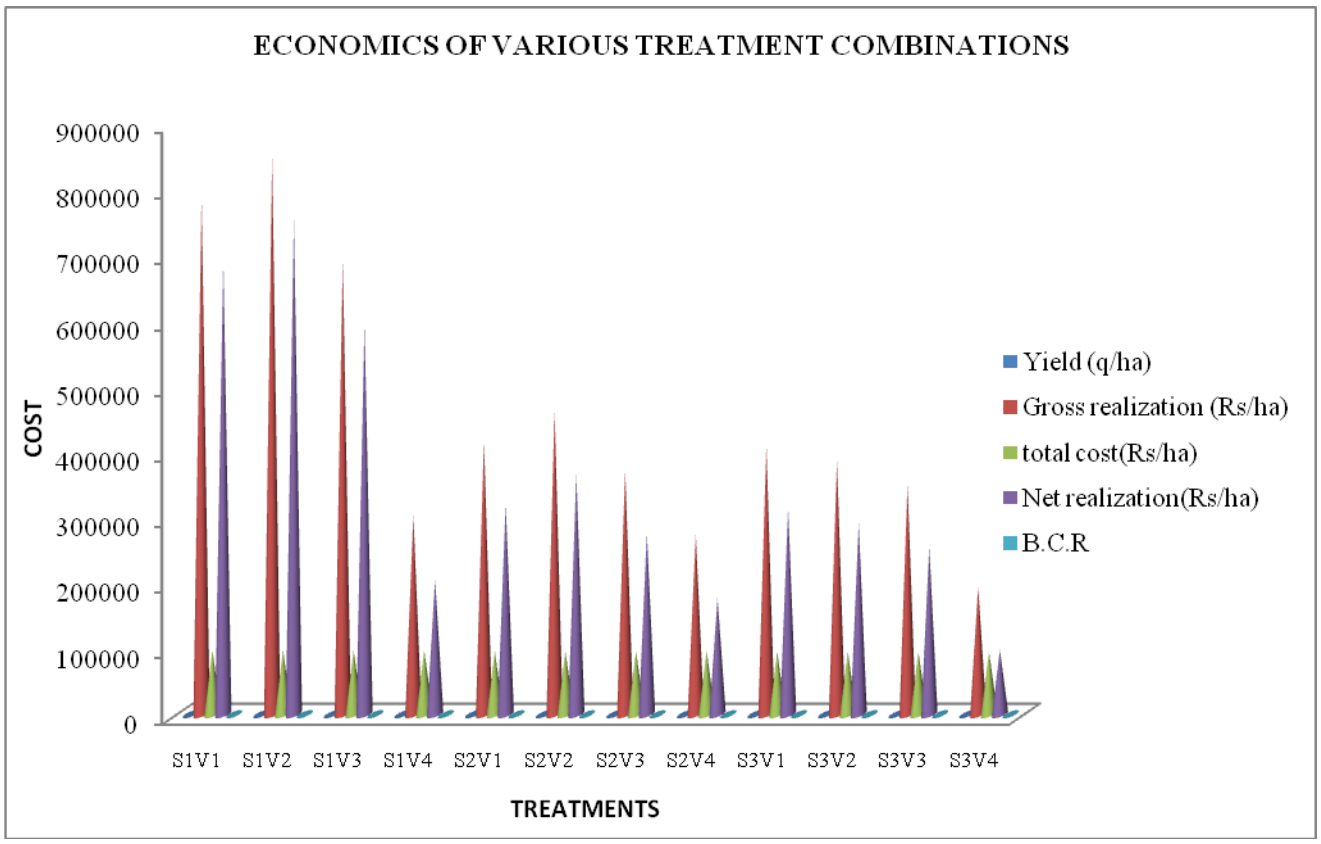
Treatment combinations

S. No	Treatment Notations	Treatment Combinations
1.	S_1V_1	Plant spacing (30 cm ×30 cm) with variety Palam Samridhi
2.	S_1V_2	Plant spacing (30 cm ×30 cm) with variety Palam Vichitra
3.	S_1V_3	Plant spacing (30 cm ×30 cm) with variety Pusa broccoli KTS-1
4.	S_1V_4	Plant spacing (30 cm ×30 cm) with variety Palam Haritika
5.	S_2V_1	Plant spacing (45 cm ×30 cm) with variety Palam Samridhi
6.	S_2V_2	Plant spacing (45 cm ×30 cm) with variety Palam Vichitra
7.	S_2V_3	Plant spacing (45 cm ×30 cm) with variety Pusa broccoli KTS-1
8.	S_2V_4	Plant spacing (45 cm ×30 cm) with variety Palam Haritika
9.	S_3V_1	Plant spacing (45 cm ×45 cm) with variety Palam Samridhi
10.	S_3V_2	Plant spacing (45 cm ×45 cm) with variety Palam Vichitra
11.	S_3V_3	Plant spacing (45 cm ×45 cm) with variety Pusa broccoli KTS-1
12.	S_3V_4	Plant spacing (45 cm ×45 cm) with variety Palam Haritika

Table.1 Economics as influenced by different treatment combinations

Treatments	Yield (q/ha)	Gross realization (₹) / ha	Total cost (₹) / ha	Net realization (₹) / ha	B.C.R
S_1V_1	261.859	785550	97835	687715	1:8.02
S_1V_2	283.479	850410	97995	752415	1:8.67
S_1V_3	231.179	693510	97795	595715	1:7.09
S_1V_4	100.949	302820	97835	204985	1:3.09
S_2V_1	138.899	416670	96600	320070	1:4.31
S_2V_2	153.889	461640	96700	364940	1:4.77
S_2V_3	124.079	372210	96570	275640	1:3.85
S_2V_4	91.299	273870	96600	177270	1:2.83
S_3V_1	136.219	408630	95415	313215	1:4.28
S_3V_2	128.899	386670	95485	291185	1:4.05
S_3V_3	116.739	350190	95395	254795	1:3.68
S_3V_4	64.539	193590	95415	98175	1:2.02

Selling price of Broccoli i.e. 3000 ₹ per q



Benefit cost ratio

The details of total cost of cultivation, gross realization, net realization and net BCR for different treatments have been calculated and presented in Table 1.

The results were calculated and the data summarized in Table 1 indicates that treatment S_1V_2 [Plant spacing (30 cm× 30 cm) with variety Palam Vichitra) recorded maximum gross return of ₹8,50,410 ha^{-1}, net return of ₹ 7,52,415ha^{-1} and Benefit Cost Ratio *i.e.* 1 : 8.67 whereas, treatment S_3V_4 [Plant spacing (45 cm× 45cm) with variety Palam Haritika) recorded minimum gross return of ₹ 1,93,590 ha^{-1}, net return of ₹98,175 ha^{-1} and Benefit Cost Ratio *i.e.* 1: 2.02.

Highest benefit cost ratio was obtained with treatment S_1V_2 [Plant spacing (30 cm× 30 cm) with variety Palam Vichitra] might be due to maximum head weight of variety Palam Vichitra (311.87g), yield per plot (4.67 kg) and yield per hectare (188.7 q/ha) and also might be due to more number of plants per unit area in closer plant spacing i.e. 54 plants in 30 cm× 30 cm plant spacing.

After close evaluation of treatments, it was found that the treatment S_1V_2 [Plant spacing (30 cm × 30 cm) with variety Palam Vichitra] emerged as most remunerative for cultivating under North Gujarat Agro Climatic region. Variation in these profit values was due to yield obtained from different treatment combinations which was accountable for maximum returns and benefit.

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