

Effect of different growing methods and integrated nutrient management systems on yield and yield contributing traits of broccoli [*Brassica oleracea* (L.) var. *italica*]

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Abstract

Field experiment was conducted in two consecutive summer seasons of year 2016 and 2017 to evaluate effect of different growing methods and integrated nutrient management systems on yield and yield contributing traits of broccoli (*Brassica oleracea* var. *italica*). Studies employed two growing methods (flat bed & ridges), three biofertilizers levels (No biofertilizers application, *Azospirillum* spp. & *Pseudomonas fluorescense*) and three level of recommended doses of NPK (50%, 75 % & 100 %). Results revealed that ridge method of cultivation, seedling treatment of *Azospirillum* spp and 100 % recommended dose of NPK has significant direct positive effect on number of leaves, diameter of head, weight of head and yield per ha Interaction effect revealed that ridge method of cultivation, seedling treatment of *Azospirillum* spp. and 100 % recommended dose of NPK was also statistically at par with the highest treatment combinations for head weight and yield per ha during year 2016 and 2017.

Key words: Broccoli, biofertilizers, higher hills, HP, INM

Introduction

Broccoli [*Brassica oleracea* (L.) var. *italica* Plenck] is an economically important member of family Brassicaceae. It is one of the popular cole crops in Europe, USA and Australia. It is becoming popular among rich people in India because of its low-fat content, high vitamin C and good source of vitamin A, B2 and Calcium Sanwal and Yadav (2005). It also contains Indole 3 carbinol, a chemical which boost DNA repair in cells and appear to block the growth of cancer cells. Due to climatic similarities with European countries, its cultivation is done successfully in the

higher hills of tribal districts of Himachal Pradesh. It is cultivated either during main growing season i.e. May to July or after harvesting of Peas during second growing season i.e July to September. Farmers earn remunerative price through contract farming due to its high demand in big cities, luxury hotels and tourist resorts. Flood irrigation is common practice of irrigation in the region. Flat bed method of cultivation results water lodging condition in the field due to flood irrigation. On the other hand, ridge method of cultivation facilitates easy irrigation through furrow channels. Consistent and indiscriminate use of chemical fertilizers had caused serious damage to soil and ecology. Soil microorganisms play a significant role in regulating the dynamics of organic matter decomposition and the availability of plants nutrient. It is well recognized that microbial inoculants constitute an important component of Integrated Nutrient Management. Biofertilizers are the carrier-based preparations containing beneficial microorganisms in viable state intended for seed, seedling or soil applications. These microbes help to fix atmospheric nitrogen, solubilize and mobilize phosphorus, translocate minor elements like Zinc, copper etc. to the plants, produce plant growth promoting hormones, vitamins and amino acids and control plant pathogenic fungi, thus helping to improve the soil health and increase crop production. Therefore, comparative effect of flat and ridge method of cultivation along with integrated nutrient management was planned to find out its effect on yield and yield contributing traits in broccoli.

Materials and Methods

The present experiment entitled “Effect of different growing methods and integrated nutrient management systems on yield and yield contributing traits of Broccoli (*Brassica oleracea* (L.) var. *italica*)” was carried out at experimental farm of Dr Y S Parmar University of Horticulture and Forestry Krishi Vigyan Kendra Lahaul

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& Spiti-II H.P. during the Year 2016 and 2017. The experiment was laid out in Factorial Randomised Block Design with 18 treatment combinations replicated thrice. The individual plot size was 3 X 1 m having a spacing of 45 X 45 cm. Pusa KTS-1 variety of Broccoli was taken for the trial. Treatment combination comprises of two levels of growing method (flat bed and ridge method), three levels of biofertilizers (No use of biofertilizers, *Azospirillum*, *Pseudomonas fluorescens*) and three levels of chemical fertilizers (100 % RDF, 75 % RDF and 50 % RDF). The detail of treatment combination is given in Table 1. Seedling dip method of biofertilizers was given at the time of transplanting. Observation were recorded on parameters days taken to head initiation, days taken to marketable maturity, plant height (cm), number of leaves, diameter of head (cm), weight of head (g) and Yield per ha (qt). The data regarding above mentioned characters were averaged and subjected to analysis of variance prescribed by Fisher and Yates (1963).

Results and Discussion

Direct Effect: Data presented in Table 2 reveal that plant height (cm), number of non-wrapper leaves, diameter of head (cm), weight of head (g) and yield per ha (q) decreased with decrease in fertilizer dose. 100 % recommended dose of NPK recorded maximum values of plant height (47.02 & 45.22 cm), number of leaves (17.57 & 17.50), diameter of head (16.13 & 14.56 cm), weight of head (286.55 & 229.07 g) and yield per ha (141.51 & 113.12 q) during both the years. The probable reason of maximum plant height, maximum number of non-wrapper leaves and yield parameters with highest dose of fertilizer may be due to higher uptake of nitrogen and increased nutrient transport from root to aerial parts and increased rate of photosynthesis and transport of photosynthates. Similar finding of maximum plant height, maximum number of non-wrapper leaves, head diameter, head weight and head yield were observed in cabbage with 100 % recommended doses of fertilizers by Verma et.al. (2014). Among biofertilizers application, significant direct effect was found on all the parameters. Days taken to head initiation (79.42 & 77.48 days) and days to marketable maturity (96.47 & 95.64 days) was earliest with the application of biofertilizer *Pseudomonas fluorescens* during both the years. However, application of biofertilizer *Azospirillum* spp. recorded maximum values for plant height (47.32 & 45.47 cm), number of non-wrapper leaves (17.96 & 17.74), diameter of head (16.21 & 14.79 cm), weight of head (292.14 & 246.47 g) and yield per ha (144.26 & 121.71 q) during both the years. The microbial inoculants might have accelerated to complete the vegetative growth earlier due to certain

Table 1: Treatment combinations of fertilizer doses, biofertilizers application and growing method

Treatment combinations	Detail of treatment combinations
F1B0GM1	100% Recommended Dose of NPK + No biofertilizers + Flat Beds
F1B1GM1	100% Recommended Dose of NPK + <i>Azospirillum</i> + Flat Beds
F1B2GM1	100% Recommended Dose of NPK + <i>Pseudomonas fluorescens</i> + Flat Beds
F1B0GM2	100% Recommended Dose of NPK + No biofertilizers + Ridges
F1B1GM2	100% Recommended Dose of NPK + <i>Azospirillum</i> + Ridges
F1B2GM2	100% Recommended Dose of NPK + <i>Pseudomonas fluorescens</i> + Ridges
F2B0GM1	75% Recommended Dose of NPK + No biofertilizers + Flat Beds
F2B1GM1	75% Recommended Dose of NPK + <i>Azospirillum</i> + Flat Beds
F2B2GM1	75% Recommended Dose of NPK + <i>Pseudomonas fluorescens</i> + Flat Beds
F2B0GM2	75% Recommended Dose of NPK + No biofertilizers + Ridges
F2B1GM2	75% Recommended Dose of NPK + <i>Azospirillum</i> + Ridges
F2B2GM2	75% Recommended Dose of NPK + <i>Pseudomonas fluorescens</i> + Ridges
F3B0GM1	50% Recommended Dose of NPK + No biofertilizers + Flat Beds
F3B1GM1	50% Recommended Dose of NPK + <i>Azospirillum</i> + Flat Beds
F3B2GM1	50% Recommended Dose of NPK + <i>Pseudomonas fluorescens</i> + Flat Beds
F3B0GM2	50% Recommended Dose of NPK + No biofertilizers + Ridges
F3B1GM2	50% Recommended Dose of NPK + <i>Azospirillum</i> + Ridges
F3B2GM2	50% Recommended Dose of NPK + <i>Pseudomonas fluorescens</i> + Ridges

growth promoting substances secreted by the microbial inoculants, which in turn, might have to be better root development, better transportation of water, uptake and deposition of nutrients. These results are in close agreement with the findings of Kumari et al. (2015). Growing method has significant effect on days to marketable maturity and number of leaves during both the years. However, its direct significant effect was found on days taken to head initiation during year 2016 and on diameter of head (cm), weight of head (g) and yield (q) during year 2017. Days taken to marketable maturity were earliest (97.10 & 96.20 days) in ridge method of cultivation. Ridge method of cultivation also recorded maximum number of non-wrapper leaves (17.57 & 17.35) during both the years. Same cultivation method was earliest to days taken to head initiation (80.07) during year 2016 and recorded maximum value of diameter of Head (14.30 cm), weight of head (221.05 g) and yield (109.16 q) during year 2017.

Table 2: Direct effect of different growing methods, biofertilizers and doses of chemical fertilizers on yield contributing traits in broccoli var. KTS-1 (2016 & 2017)

Treatment	Days taken to head initiation		Days taken to marketable maturity		Plant height (cm)		No of leaves		Diameter of head (cm)		Weight of head (g)		Yield per ha (q)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Fertilizer Doses														
F1	81.01	79.41	97.91	96.99	47.02	45.22	17.57	17.50	16.13	14.56	286.55	229.07	141.51	113.12
F2	80.94	78.51	97.94	97.01	45.76	44.09	16.28	16.97	14.76	13.72	241.14	212.45	119.08	104.91
F3	80.11	78.61	97.17	96.41	45.92	43.81	17.08	15.82	14.04	12.42	228.65	177.25	112.91	87.53
CD _(0.05)	NS	NS	NS	NS	0.94	0.95	0.89	0.93	0.93	0.91	29.94	23.68	14.78	11.70
Biofertilizers														
B0	82.25	80.43	99.15	98.22	45.43	43.64	16.36	16.14	14.11	12.71	229.68	179.41	113.42	88.60
B1	80.39	78.62	97.39	96.55	47.32	45.47	17.96	17.74	16.21	14.79	292.14	246.47	144.26	121.71
B2	79.42	77.48	96.47	95.64	45.96	43.99	16.63	16.41	14.63	13.19	234.52	192.89	115.81	95.25
CD _(0.05)	1.18	1.30	1.15	1.14	0.94	0.95	0.89	0.93	0.93	0.91	29.94	23.68	14.78	11.70
Growing Method														
GM1	81.30	79.37	98.24	97.40	45.89	44.49	16.40	16.18	14.63	12.83	240.51	191.46	118.77	94.55
GM2	80.07	78.32	97.10	96.20	46.58	44.25	17.57	17.35	15.33	14.30	263.71	221.05	130.23	109.16
CD _(0.05)	0.96	NS	0.94	0.93	NS	NS	0.73	0.76	NS	0.75	NS	19.34	NS	9.55

F1= 100% Recommended Dose of NPK F2= 75% Recommended Dose of NPK F3=50% Recommended Dose of NPK; B0= No biofertilizers B1= *Azospirillum* spp. B2= *Pseudomonas fluorescense*; GM1= Growing Method 1 Flat Beds GM2= Growing Method 2 Ridges

Table 3: Interaction effect of different growing method, biofertilizers and doses of chemical fertilizers on yield and yield contributing traits in broccoli var. KTS-1 (2016 & 2017)

Treatment combination	Days taken to head initiation		Days taken to marketable maturity		Plant height (cm)		No of leaves		Diameter of head (cm)		Weight of head (g)		Yield per ha (q)	
	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
F1B0GM1	83.27	81.23	99.67	98.83	45.50	45.73	16.84	16.76	14.50	12.47	231.91	190.86	114.52	94.25
F1B1GM1	79.33	77.43	96.33	95.44	48.00	45.33	17.24	17.10	17.67	15.47	319.73	255.77	157.89	126.30
F1B2GM1	79.50	77.57	96.50	95.61	47.17	46.00	17.43	17.40	16.17	14.03	284.19	232.05	140.34	114.59
F1B0GM2	82.60	81.53	99.60	98.50	46.80	43.40	19.29	19.26	15.80	14.90	304.72	231.97	150.48	114.55
F1B1GM2	81.67	80.33	98.67	97.78	47.00	46.33	18.78	18.64	16.00	14.87	306.15	246.35	151.18	121.65
F1B2GM2	79.67	78.33	96.67	95.78	47.67	44.50	15.87	15.81	16.67	15.60	272.61	217.42	134.62	107.37
F2B0GM1	83.63	81.50	100.63	99.44	42.00	42.73	12.82	16.40	11.00	9.93	158.67	128.70	78.36	63.55
F2B1GM1	83.33	81.27	100.33	99.39	47.33	45.00	17.64	17.79	16.33	15.27	294.70	258.82	145.53	127.81
F2B2GM1	82.33	79.33	99.33	98.44	44.67	42.47	14.69	16.46	13.67	12.73	184.69	179.51	91.21	88.65
F2B0GM2	82.33	79.67	99.33	98.56	48.00	44.00	16.61	15.91	17.00	15.93	293.72	239.28	145.05	118.16
F2B1GM2	78.00	75.67	95.00	94.11	48.23	44.33	18.32	17.71	17.23	16.17	301.12	272.24	148.70	134.44
F2B2GM2	76.00	73.67	93.00	92.11	44.33	46.00	17.63	17.55	13.33	12.27	213.94	196.12	105.65	96.85
F3B0GM1	78.67	77.33	95.67	94.89	45.33	45.67	16.50	12.66	13.33	10.73	205.19	129.44	101.33	63.92
F3B1GM1	81.00	79.67	98.00	97.44	45.67	45.83	17.87	17.00	13.67	14.27	231.91	231.64	114.52	114.39
F3B2GM1	80.67	79.00	97.67	97.12	47.33	41.67	16.54	14.02	15.33	10.53	253.61	116.33	125.24	57.44
F3B0GM2	83.00	81.33	100.00	99.11	44.93	40.33	16.08	15.85	13.00	12.27	183.88	156.22	90.81	77.15
F3B1GM2	79.00	77.33	96.00	95.11	47.67	46.00	17.89	18.18	16.33	12.73	299.23	213.97	147.76	105.66
F3B2GM2	78.33	77.00	95.67	94.78	44.60	43.33	17.62	17.19	12.60	14.00	198.05	215.89	97.80	106.61
CD _(0.05)	2.89	NS	2.93	2.78	2.30	2.33	2.18	NS	2.28	2.24	73.33	58.01	36.21	28.65

F1= 100% Recommended Dose of NPK F2= 75% Recommended Dose of NPK F3=50% Recommended Dose of NPK; B0= No biofertilizers B1= *Azospirillum* spp. B2= *Pseudomonas fluorescense*; GM1= Growing Method 1 Flat Beds GM2= Growing Method 2 Ridges

Indirect Effect: Data presented in Table 3 reveal that treatment combination has significant effect on all the parameters except days taken to head initiation and number of non-wrapper leaves during year 2017. Days taken to head initiation during year 2016 and market maturity during year 2016 and 2017 was earliest with

the treatment combination 75% recommended doses fertilizer + *Pseudomonas fluorescense* application + Ridge method of cultivation. The maximum number of days taken head initiation during year 2016 and marketable maturity was observed with 75% recommended doses fertilizer + No use of biofertilizers + Flat method of

cultivation. Early head initiation and marketable maturity may be achieved due to cumulative effect of balanced use of fertilizers with bioinoculants and ridge method of cultivation. Plant height was recorded highest in treatment combination (F2B1GM2) and (F1B1GM2) during year 2016 and 2017 respectively. Both treatment combinations were statistically at par with each other during both the years indicating the assimilative effect of optimum dose of fertilizers with bioinoculants and ridge method of cultivation on plant height. Diameter of head (cm), weight of head (g), yield per ha (q) were recorded highest in treatment combination (F1B1GM1) and (F2B1GM2) during year 2016 and 2017 respectively. Treatment combinations were found statistically at par with treatment combination (F1B1GM2) during both the years. Based on the direct and indirect effect, treatment combination of 100 % RDF along with seedling treatment with *Azospirillum* spp. and ridge method of cultivation was found most effective on yield and yield contributing characters. Thus, the study concludes that judicious combination of biofertilizers with recommended doses of fertilizers and ridge method of cultivation may be helpful in increasing the broccoli productivity.

सारांश

ब्रोकली में उपज तथा उपज घटकों पर विभिन्न उगाने के तरीके का प्रभाव तथा एकीकृत पोषक तत्व प्रबंधन पर वर्ष 2016 तथा 2017 में प्रक्षेत्र प्रयोग किया गया। प्रक्षेत्र प्रयोग में दो तरह के उगाने के तरीके

(समतल बिस्तर तथा नाली-बरहा रिज), तीन जैव उर्वरक स्तर (बिना जैव उर्वरक के एजोस्पाइरिलम स्पीशीज तथा स्यूडोमोनास फ्लुओरेसेंस) तथा अनुमोदित नत्रजन, फॉस्फोरस तथा पोटाश के तीन स्तर (50 प्रतिशत, 75 प्रतिशत तथा 100 प्रतिशत) के उपचार संयोजकों का प्रयोग किया गया। परिणाम से स्पष्ट है कि नाली-बरहा विधि से उगाने, पनीरी का एजोस्पाइरिलम स्पीशील से उपचार तथा 100 प्रतिशत अनुमोदित नत्रजन फॉस्फोरस तथा पोटाश का पत्तियों की संख्या, ब्रोकली के ग्रीव का व्यास, शीर्ष का वजन तथा पैदावार प्रति हेक्टेयर पर सीधा व महत्वपूर्ण सकारात्मक प्रभाव पड़ा। पारस्परिक प्रभाव में भी ब्रोकली के शीर्ष का वजन तथा पैदावार प्रति हेक्टेयर के लिए वर्ष 2016 तथा 2017 में नाली-बरहा विधि से उगाने, पनीरी का एजोस्पाइरिलम स्पीशीज से उपचार तथा 100 प्रतिशत अनुमोदित नत्रजन, फॉस्फोरस तथा पोटाश का उपचार संयोजक अधिकतम मूल्य वाले उपचार संयोजक के बराबर पाया गया।

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