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Effect of NPK, vermicompost and spacing on growth, yield and quality of broccoli (*Brassica oleracea* L. var. *italica*)

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Abstract
The experiment was conducted during *winter* season of during 2016-17 and 2017-18 at the Horticulture farm of Udai Pratap, Autonomous College, Varanasi (U.P.), is situated in the South eastern part of Varanasi city was carried out during winter season. The experimental material used for the "Effect of NPK, Vermicompost and Spacing on Growth, Yield and Quality of Broccoli (*Brassica oleracea* L. var. *italica*)" The materials used, experimental procedures followed and techniques of experimentation were planted at a spacing of 45cm x 45cm and 45cm x 60cm per plot under open conditions. The experiment was laid out in RBD comprising of Sixteen treatments with three replication study F_3 (180:80:80 NPK kg ha^{-1}) and minimum in F_1 (140:40:40 NPK kg ha^{-1}) and at 45 and 60 DAP the minimum plant height was recorded with F_4 (200:100:100 kg ha^{-1}) and minimum with F_1 (200:100:100 kg ha^{-1}) and minimum with F_1 (140:40:40 NPK kg ha^{-1}) during both the years of study. In case of spacing S_1 (45 x 45 cm) recorded maximum and minimum in S_2 (45 x 60 cm) at all the stages during both the years of experimentation. (T_1)- 140:40:40 NPK kg/ha + 45x45cm. Spacing + 20kgVermicompost/ha, (T_2)-140:40:40 NPK kg/ha + 45x45cm. Spacing + 10 kg PSB/ha, (T_3) -140:40:40 NPK kg/ha + 45x60cm. Spacing + 20 kg Vermicompost /ha (T_4)-140:40:40 NPK kg/ha + 45x60cm. Spacing + 10kgPSB/ha (T_5)-160:60:60 NPK kg/ha + 45x45cm. Spacing + 20kgVermicompost/ha, (T_6)-160:60:60 NPK kg/ha + 45x45cm. Spacing +10kg PSB/ha, (T_7)-160:60:60 NPK kg/ha + 45x60cm. Spacing + 20kgVermicompost/ha, (T_8) - 160:60:60 NPK kg/ha + 45x60cm. Spacing + 10kg PSB/ha (T_9) - 180:80:80 NPK kg/ha + 45x45cm. Spacing + 20 kg Vermicompost /ha (T_{10}) - $V_1$80:80:80 NPK kg/ha + 45x45cm. Spacing + 10kg PSB/ha (T_{11}) - 180:80:80 NPK kg/ha + 45x60cm. Spacing +20kgVermicompost/ha (T_{12}) - 180:80:80 NPK kg/ha + 45x60cm. Spacing + 10kg PSB/ha (T_{13}) - 200:100:100 NPK kg/ha + 45x45cm. Spacing + 20kgVermicompost/ha (T_{14}) - 200:100:100 NPK kg/ha + 45x45cm spacing + 10kg PSB/ha (T_{15}) - 200:100:100 NPK kg/ha + 45x60cm. Spacing + 20kg Vermicopost/ha (T_{16}) - 200:100:100 NPK kg /ha + 45x60cm spacing + 10 kg PSB/ha. The highest yield q ha^{-1} was recorded in treatment F_4 (200:100:100 NPK kg ha^{-1}), while minimum in F_1 (140:40:40 NPK kg ha^{-1}). The biofertilizer such as PSB (B_2) @ 10 kg/ha which act positively with the above nitrogen dose which enhance significantly yield, weight of head, diameter of head, fresh weight of leaves and Vitamin C content in broccoli, non-significant but high performance of Vermicompost (B_1) @ 10 kg ha^{-1} was seen in important quality characters such as protein content and Vitamin C. The application of 180:80:80 NPK kg ha^{-1} + 45 x 45 cm. spacing + Phosphorus sulublizing bacteria @ 10 kg ha^{-1} in broccoli may be recommended in order to secure higher growth, yield and quality traits of broccoli.

Keywords: Vermicompost, broccoli, *Brassica oleracea* L

Introduction
Broccoli (*Brassica oleracea* var. *italica* L. sub var. *cymosa* cv. 'Premium crop') are belongs to family cruciferae, is a member of Cole group having 18 chromosomes (2n=18, x=9). The term 'Cole' originated from the word Colewort meaning wild cabbage. Application of vermicompost and poultry manure subsequently increase yield attributing characters and yield of broccoli (Sameera *et al*. 2005) [8]. Therefore, present investigation was carried out to find out the effect of organic manures on growth and yield of broccoli.

As per National Horticulture Database 2011, India is the largest producer of ginger and okra and ranks second in production of potato (10%), onion, cauliflower, brinjal and cabbage and is known as fruit and vegetable basket of the world. The overall growth rate of 2.08% in area, 1.64% in productivity and 3.72% in total production has been achieved during the last five years. Our demand of vegetables will be 225 million tonnes by 2020 and 350 million tonnes by 2030 (Singh, 2005) [9].

The present investigation was conducted at the Horticulture farm of Udai Pratap, Autonomous College, Varanasi (U.P.), is situated in the South eastern part of Varanasi city was carried out

during winter season of 2016-17 and 2017-18. The experiment conducted that on "Effect of NPK, Vermicompost and Spacing on Growth, Yield and Quality of Broccoli (*Brassica oleracea* L. var. *italica*)" The materials used, experimental procedures followed and techniques adopted during the course of experimentation have been described plants were planted at a spacing of 45cm x 45cm and 45cm x 60cm per plot under open conditions. All the plants were maintained under uniform cultural practices like irrigation, weeding, pinching, disbudding, etc. except treatments during the course of study (T_1)- 140:40:40 NPK kg/ha + 45x45cm. Spacing + 20kgVermicompost/ha, (T_2)-140:40:40 NPK kg/ha + 45x45cm. Spacing + 10kgPSB/ha, (T_3) -140:40:40 NPK kg/ha + 45x60cm. Spacing + 20kgVermicompost/ha (T_4)-140:40:40 NPK kg/ha + 45x60cm. Spacing + 10kgPSB/ha (T_5)-160:60:60 NPK kg/ha + 45x45cm. Spacing + 20kgVermicompost/ha, (T_6)-160:60:60 NPK kg/ha + 45x45cm. Spacing +10kgPSB/ha, (T_7)-160:60:60 NPK kg/ha + 45x60cm. Spacing + 20 kg Vermicompost/ha, (T_8) - 160:60:60 NPK kg/ha + 45x60cm. Spacing + 10 kg PSB/ha (T_9)- 180:80:80 NPK kg/ha + 45x45cm. Spacing + 20kgVermicompost/ha (T_{10}) - $V_1$80:80:80 NPK kg/ha + 45x45cm. Spacing + 10kg PSB/ha (T_{11}) - 180:80:80 NPK kg/ha + 45x60cm. Spacing +20kg Vermicompost/ha (T_{12}) - 180:80:80 NPK kg/ha + 45x60cm. Spacing + 10kgPSB/ha (T_{13}) - 200:100:100 NPK kg/ha + 45x45cm. Spacing + 20kg Vermicompost/ha (T_{14}) - 200:100:100 NPK kg/ha + 45x45cm. Spacing + 10kg PSB/ha (T_{15}) - 200:100:100 NPK kg/ha + 45x60cm. Spacing + 20kg Vermicopost/ha (T_{16}) - 200:100:100 NPK kg/ha + 45x60cm. Spacing+ 10kg PSB/ha times dilution with a total of 16 treatment combinations investigation was analyzed statistically Factorial with Control in Randomized Block Design (RBD) with three replications.

Result and Discussion

The data pertaining to length of leaves affected by different treatments have been presented to length of leaves at 45 DAP and harvest stage as affected by different treatments have been presented in table 1 and Fig. No.1 the perusal of data clearly indicated that the maximum length of leaves (29.81 and 30.98 cm) was recorded with the application of 180:80:80 NPK doses which was statistically at par with 200:100:100 NPK dose and significantly superior over rest of the treatments with The increase in growth characters by biofertilizer is not just related to the capacity to fix atmospheric nitrogen but also, due to the production of plant growth promoting substances. The abilities of Vermicompost have been postulated to be partially due to production of phytohormones, including gibberellins, cytokines like substances and auxins from tryptophan, ethylene and vitamins and partially due to nitrogen fixation, phosphate solubilization (Fulchieri *et al*., 1993) [3]. These phytohormones promote root growth of the plants, consequently increasing nutrients and water absorption areas, resulting improve growth. These findings are come in conformity the findings of Akbar *et al.* (2009) [1] in cabbage, Bashyal (2011) [2] and Islam *et al.* (2014) [4] in cauliflower.

The data pertaining to Diameter of Curd (cm) as influenced by fertilizer levels, spacing and biofertilizer on broccoli have been presented in table 2 Fig. No.2 the maximum Diameter of Curd (cm) (15.67 and 16.05cm) was observed with the application of 200:100:100 NPK doses which was statistically at par with 180:80:80 NPK dose and significantly superior to 160:60:60 NPK the maximum fresh weight of leaves (0.58 and 0.63 kg) was observed with the application of 200:100:100 NPK doses which was statistically at par with 180:80:80 NPK dose and significantly superior to 160:60:60 NPK Which was found significantly superior to the (0.51 and 0.58 kg) Yadav *et al.* (2012) [10] reported that application of biofertilizers significantly increased the yield of cabbage Kachari and Korla (2012) [5] also reported that application of biofertilizers significantly increased the yield of cauliflower. The findings of present experiment are closely related to the findings of Kumar *et al.* (2011) [7] and Khan *et al.* (2009) [6] in cauliflower.

The data with respect to protein content in broccoli as affected by fertility levels, spacing and biofertilizer treatments have been arranged in table 3 Fig. No.3 the maximum protein content in broccoli (3.31 and 3.41%) was observed with the application of 200:100:100 NPK dose which was statistically at par with 180:80:80 and 160:60:60 NPK dose and significantly superior to 140:40:40 NPK different plant spacing not affected the protein content significantly. The maximum protein content was recorded in wider plant spacing of 45 × 60 cm.

The data pertaining to vitamin C content have been given in table 3 the vitamin C content was markedly influenced by fertility level while spacing, biofertilizer and their interaction was found non-significant. The perusal of data clearly indicated that the maximum vitamin C content (134.16 and 136.48 mg) was observed with the application of 200:100:100 NPK doses which was statistically at par with 180:80:80 NPK dose and significantly superior to rest of the treatment. The different plant spacing not affected the vitamin C content significantly maximum vitamin C content was recorded in wider plant spacing of 45 × 60cm. Maximum vitamin C content was (132.17 and 134.50 mg) Maximum protein content (3.37 and 3.32%) and vitamin C (135.16 and 132.83) content was recorded with the treatment B_1 (vermicompost) which were found with B_2 (PSB) significantly superior during both the years of study. The treatment B_2 (PSB) produces highest vitamin C Bashyal (2011) [2] observed that application of biofertilizers increased the vit. C content of cauliflower. The findings of present study were also close agreement with the findings of Islam (2014) [4] in cauliflower.

Table 1: Effect of inorganic fertilizer and bio-fertilizer levels and spacing on length of leaves of broccoli at different growth stages

Treatments	45 DAP		At harvest stage	
	2016-17	2017-18	2016-17	2017-18
Levels of Fertilizers				
F_1	20.66	21.89	25.19	26.58
F_2	22.09	23.24	26.92	28.23
F_3	24.46	25.5	29.81	30.98
F_4	23.99	25.05	29.24	30.43
SEm+	0.41	1.81	0.50	2.15
CD at 5%	1.23	2.70	1.41	3.17
Plant Spacing (cm)				
S_1	21.85	23.02	26.63	27.96
S_2	23.75	24.82	28.95	30.15
SEm+	0.59	1.67	0.68	1.99
CD at 5%	1.38	2.30	1.01	2.71
Levels of organic fertilizers				
B_1	23.99	25.05	29.24	30.43
B_2	23.28	24.37	28.37	29.6
SEm+	0.51	1.75	0.59	2.08
CD at 5%	1.66	2.89	1.17	6.58

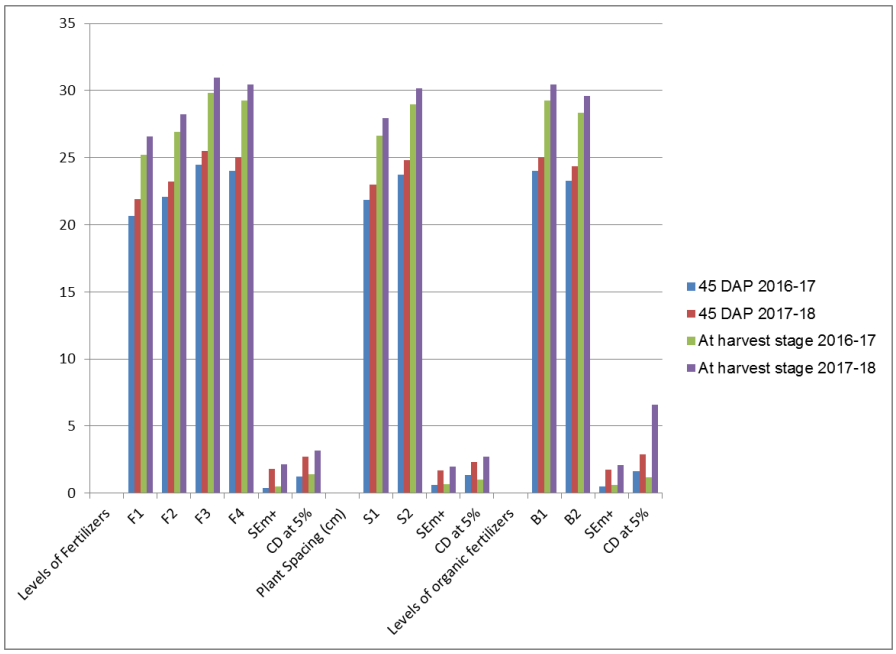


Table 2: Effect of inorganic fertilizer and bio-fertilizer levels and spacing on diameter of curd and fresh weight of leaf of broccoli

Treatments	Diameter of Curd (cm)		Fresh weight of leaf (g)	
	2016-17	2017-18	2016-17	2017-18
Levels of Fertilizers				
F_1	15.65	16.03	0.57	0.63
F_2	15.42	15.81	0.62	0.64
F_3	15.65	16.03	0.65	0.71
F_4	15.67	16.05	0.69	0.73
SEm+	0.10	1.01	0.015	0.016
CD at 5%	0.30	2.68	0.045	0.049
Plant Spacing (cm)				
S_1	16.14	16.50	0.59	0.64
S_2	15.05	15.46	0.67	0.70
SEm+	0.22	0.90	0.01	0.01
CD at 5%	0.63	2.65	0.03	0.03
Levels of organic fertilizers				
B_1	15.39	15.79	0.60	0.63
B_2	16.03	16.39	0.67	0.70
SEm+	0.16	0.97	0.01	0.01
CD at 5%	0.54	1.55	0.04	0.04

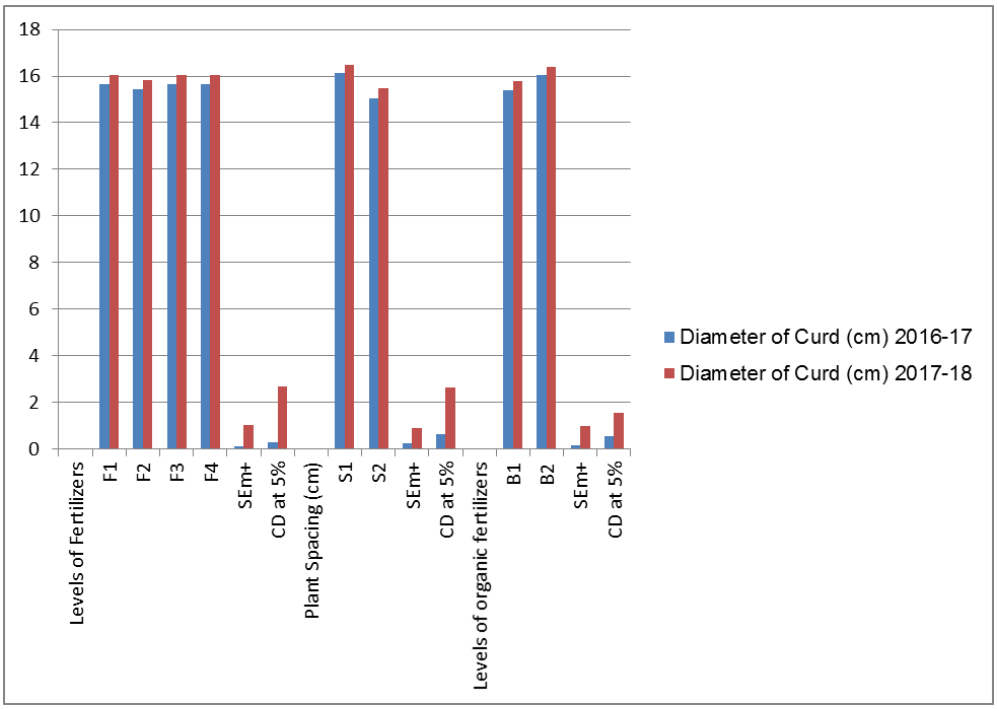
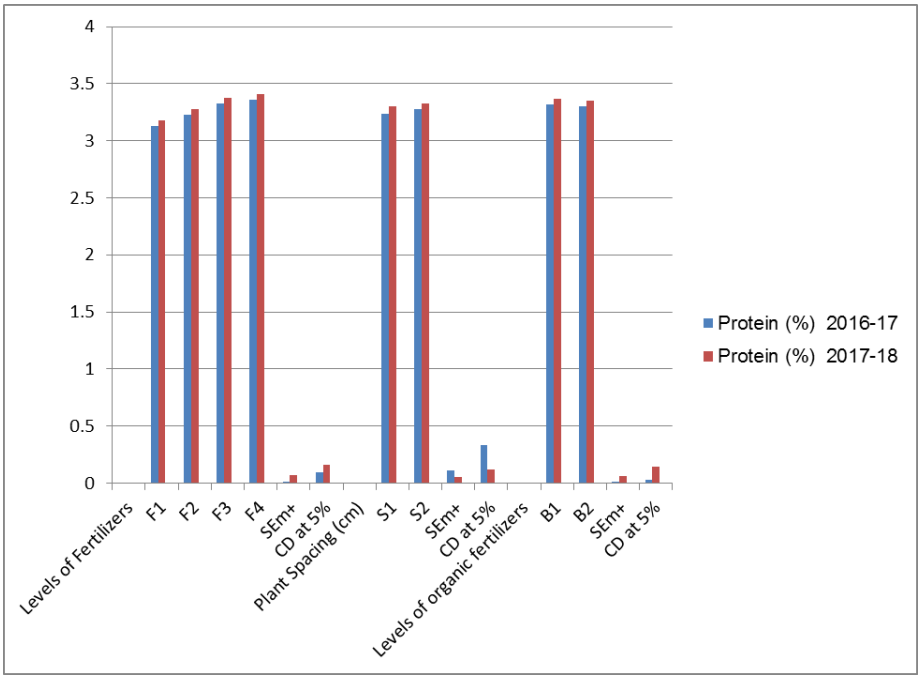
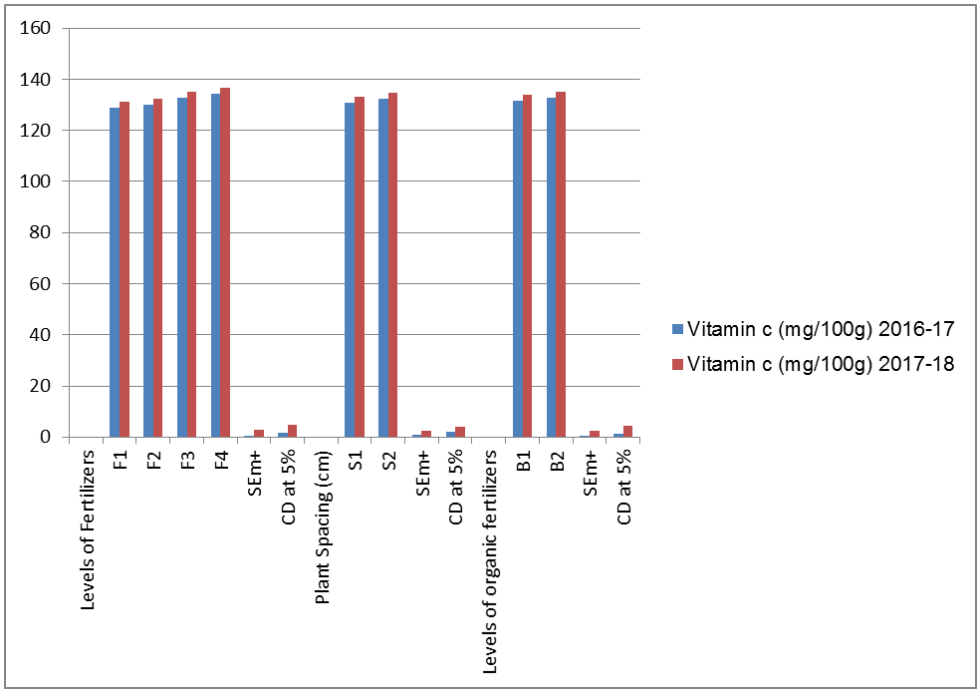


Table 3: Effect of inorganic fertilizer and bio-fertilizer levels and spacing protein (%) and vitamin c (mg/100g) of leaf of broccoli

Treatments	Protein (%)		Vitamin c (mg/100g)	
	2016-17	2017-18	2016-17	2017-18
Levels of Fertilizers				
F_1	3.13	3.18	128.84	131.19
F_2	3.23	3.28	130.17	132.51
F_3	3.33	3.38	132.83	135.16
F_4	3.36	3.41	134.16	136.48
SEm+	0.001	0.07	0.42	2.67
CD at 5%	0.094	0.16	1.55	4.83
Plant Spacing (cm)				
S_1	3.24	3.30	130.84	133.17
S_2	3.28	3.33	132.17	134.50
SEm+	0.11	0.05	0.74	2.32
CD at 5%	0.33	0.12	1.98	3.85
Levels of organic fertilizers				
B_1	3.32	3.37	131.5	133.84
B_2	3.3	3.35	132.83	135.16
SEm+	0.01	0.06	0.57	2.51
CD at 5%	0.03	0.14	1.14	4.38





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