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EFFICACY OF ORGANIC MANURES AND BIO-FERTILIZERS ON GROWTH, YIELD AND QUALITY OF BROCCOLI *(BRASSICA OLERACEA* L.VAR. *ITALICA* PLENCK)

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Abstract

The present experiment was conducted during rabi season of 2016-17 with an aim to study the efficacy of organic manures and bio-fertilizers on growth, yield and quality of broccoli (*Brassica oleracea* L. var. *italic* Plenck). The experiment was carried out in a Randomized Block Design with eleven treatments T_0-control, T_1- Recommended Dose of Fertilizers (R. D. F.) 100%, T_2-(Vermi-compost 100%), T_3- (Azotobacter 100%), T_4- (FYM 100%), T_5- (50% RDF + 50% Vermi-compost), T_6- (50% RDF + 50% Azotobacter), T_7- (50% RDF + 50% FYM), T_8-(50% Vermi-compost + 50% Azotobacter), T_9- (50% Vermi-compost + 50% FYM) and T_{10}-(50% Azotobacter + 50% FYM) by three replication. Observations were recorded for growth parameters like height of the plant (cm), stem diameter (cm), plant spreading (cm), number of leaves per plant, leaf length (cm) and width of leaves (cm), weight of curd with guard leaf (g), weight of curd without guard leaf (g), yield (kg/plot), yield (q/ha), quality parameters *viz.* vitamin-c (mg/100g), T.S.S. (Total Soluble Solids) (^{0}Brix), total sugars (%), reducing sugar (%) and non-reducing sugar (%). The experimental result revealed that the use of organic manure improved the production of broccoli in general as compared to untreated control. Among the treatments, application of (50%NPK+ 50% FYM) can be suggested to broccoli growers for obtaining better growth, yield and quality improvement of broccoli cv. Palam Samridhi under Lucknow subtropical condition.

Key words : organic manures, bio-fertilizer, broccoli, growth, quality and yield.

Introduction

Among the major contributing vegetables, broccoli (Brassica oleracea L. var. *italica* Plenck) is an important member of Cruciferae family such as cauliflower, cabbage, kale, chinese kale etc. which are commonly known as Cole crops (Sermenli, 2011). It is used as a vegetable in curries, soups and for pickles etc. It is a significant source of phenolics such as sinapic acid (Vallejo *et al*., 2003). It is originated in Mediterranean region. Parent of the species of genus Brassica contain glucosinolates which in crushed broken down by myrosinase enzyme to give bitter taste and goitrogenic substance. Apart from other nutritional antioxidants, broccoli is also a significant source of calcium, folic acid, carotenoids, ascorbic acid and known to reduce risk of breast and prostate cancer (Beecher, 1994 and Williamson *et al.,* (1998). It is not a new crop, was cultivated in Italy from ancient time started in England in 1720. However, commercial cultivation started in 1920. In India it is mostly cultivated in hilly areas of Himachal Pradesh, Uttar Pradesh, Jammu and Kashmir, Nilgiri Hills and Northern plains of India and known as harigobhi in Hindi. 100 gram broccoli contains Carbohydrate 7g (2%), Fat-0.4g, Sodium-33 mg (1%), Potassium-316 mg (9%), Dietary fiber-2.6g (10%), Sugar-1.7g, Protein-2.8 g, Vitamin A-12%, Vitamin C–148%, Calcium-4%, Iron-3%, Vitamin B_6-10%, Magnesium-5%, Phosphorus 79mg (Annonymus-2015). Thus, broccoli market value is very high especially in super market, big hotels and restaurant etc. Eating a few portions of broccoli each week may help to reduce the risk of cancer. The cancer- fighting properties of broccoli are not new and previous studies have related these benefits to the high levels of active plant chemicals called glucosinolates (Zhao *et al.,* 2007).

Broccoli is heavy feeder and it requires large amount of nutrients like nitrogen, phosphorus and potassium for

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better development of curd and quality in addition to checking the various disease and physiological disorders. The present forming system totally depends on use of chemical fertilizers, pesticides and growth regulators for enhancing crop productivity. To obtain maximum yield in broccoli, farmers are repeatedly using chemical fertilizers. Farmers are facing the problem of soil deterioration, affecting soil flora and fauna and ultimately yield and quality of broccoli. There is a growing concern throughout the world on adverse effect of indiscriminate use of inorganic fertilizer, pesticide, herbicide etc. Therefore, a combination strategy of using judicious chemical fertilizer, organic manures and bio-fertilizers may be helpful in increasing production with fewer hazards. Such efforts will be effective not only in supplementing a part of chemical fertilizers requirement of the crops and yield, but also influence quality attributes in several vegetable, besides, considerable saving of inorganic fertilizers.

Organic farming is a production system which avoids largely use of chemical fertilizer, pesticides and growth regulators. They pointed that organic matter plays an important role in the chemical behavior of several metals in soils throughout its active groups (Flavonic and humic acids) which have the ability to retain the metals in complex and chelate forms. Organic agriculture cannot be adopted uniformly under under all farming situations, the technology as a role to play in the cultivation of high value crops *i.e.* fruits, vegetables, spices, and condiments, medicinal and aromatic plants. The organically cultivated food crops have a greater export potential, growing at 10-15 percent per year. The sustainable agriculture practice can effectively prevent the entry of pesticide and toxicants in the food chain and prevent soil and water pollution vis-à-vis health hazards, if adopted with a blend of ecologically safe modern technologies, organic culture, though not in its orthodox version has the potential to be accepted by the farmers.

Materials and Methods

The field experiment was conducted at Horticultural Research Farm of the Department of Applied Plant Science (Horticulture), Babasaheb Bhimrao Ambedkar University, (A Central University), Vidya- Vihar, Rae Bareli Road, Lucknow - 226025 (U.P.), India during rabi season of 2016-17. Geographically, Lucknow is situated at 260 50´ N latitude, 800 52´ E longitude and altitude of 123 meter above mean sea level (MSL). Lucknow has humid subtropical climate with an average annual rainfall of about 110 cm and relative humidity 60-90%. The winter is severe and summer is dry and hot. The maximum temperature generally goes up to (43^{0}C) in summers and average minimum up to 2^{0}C in winter. Monsoon generally sets in during the third week of June and recedes by the end of September with heavy rainfall during monsoon season. The weather parameters which prevailed during the course of investigation were recorded at the meteorological observatory of the IISR (Indian Institute of Sugarcane Research), Lucknow. The soil of experimental field is sandy loam and slightly alkaline in nature with the soil pH 8.2. The seeds were treated with thiram and bavistin mixed in 2:1 ratio @ 3.0 g per kg of seeds before sowing in the soil solarised nursery bed area. Seeds were sown on 7th Oct.2016. Seed was covered with dry mulch (grass) and irrigated lightly just after sowing. After a week the mulch was removed on the emergence of seedlings. Organic mulches like- grass was made over the seed bed with adequate provision for ventilation to protect the seedling from rains and direct sunlight Proper aftercare in respect of irrigation, weeding and plant protection measures (like drenching with Bavistin and Redomil) were undertaken till seedlings were ready for transplanting. The field was prepared by deep ploughing, harrowing and levelling, these operations were done by Tractor drawn implements fertilizers were also applied one day prior to sowing as per treatment at the rate of 150 Kg N, 60 Kg P_2O_5 and 60 Kg K_2O per hectare through Urea, Single Super Phosphate and Murate of Potash. All these fertilizers were applied uniformly and were mixed with the help of spade in each bed. Remaining 50 percent of Nitrogen in the form of urea was applied as top dressing after 30 days of transplanting as band placement. Transplanting was done when the seedling was 30 days old and it transplanted on date 6th Nov 2016. A spacing of 45×30 cm was adopted for transplanting. Seedlings of uniform size were selected from the nursery for this purpose. The Observations on height of the plant (cm), stem diameter (cm), plant spreading (cm), number of leaves per plant, leaf length (cm) and width of leaves (cm), taken as vegetative growth parameters. Weight of curd with guard leaf (g), Weight of curd without guard leaf (g), Yield (Kg/plot) and Yield (q/ha) taken as yield parameters. quality parammeters *viz*. Vitamin-C (mg/100g), T.S.S. (Total Soluble Solids)(^{0}Brix), Total sugars (%), Reducing sugar (%), Non reducing sugar (%)were estimated in departmental laboratory, following the standard method (AOAC, 2000). The experiment was laid out in Randomized Block Design with eleven treatments and three replications. The treatments were T_0-control, T_1-Recommended Dose of Fertilizers (R. D. F.) 100%, T_2-(Vermi-compost 100%), T_3-(Azotobacter 100%), T_4-(FYM 100%), T_5-(50% RDF + 50% Vermi-compost), T_6-(50% RDF + 50%

Table 1: Effect of Organic manures and Bio-fertilizers on vegetative growth, yield and quality characters of broccoli.

Treatments	Plant height (cm)		Stem diameter (cm)		No. of leaves /plant		Plant spreading(cm)				Length of leaf		Width of leaf					Weight of curd (g)		Yield		Quality Characters				
	30 DAT	60 DAT	30 DAT	60 DAT	30 DAT	60 DAT	East-West	North-South	East-West	North-South	30 DAT	60 DAT	30 DAT	60 DAT	Curd nitia-tion days	Days taken to curd harv-est	Curd diam-eter (g)	Weight of curd with guard leaves	Weight of curd without guard leaves	Yield (Kg/ Plot)	Yield (Q/ha)	Vitamin C (mg/ 100g)	T.S.S. (°Brix)	Total sugar (%)	Redu-cing sugar	Non-redu-cing sugar
T_0	21.38	39.66	1.18	2.53	6.71	11.67	26.83	31.03	38.90	43.89	21.71	34.03	10.74	20.96	62.24	19.03	11.62	425.56	358.56	5.70	263.88	80.37	6.37	2.97	2.32	0.35
T_1	24.76	39.26	1.70	3.11	6.91	12.89	29.28	34.87	42.70	44.47	24.62	35.81	12.11	23.04	64.79	18.56	14.28	494.25	425.96	6.80	314.81	82.41	7.03	3.16	2.76	0.50
T_2	23.24	39.00	1.70	3.51	7.26	13.33	29.94	32.28	41.42	44.67	23.28	37.17	11.80	24.19	63.44	16.82	13.48	432.11	365.28	5.84	270.37	85.47	7.10	3.34	2.70	0.67
T_3	25.90	42.56	1.59	3.13	7.08	13.00	30.68	33.35	41.61	45.28	22.50	35.55	11.62	24.79	63.68	18.39	13.05	430.50	363.46	5.81	268.98	84.25	6.73	3.23	2.79	0.51
T_4	27.54	42.78	1.35	3.14	6.92	12.89	28.94	31.45	42.49	46.15	23.17	36.96	12.51	25.10	62.65	17.50	13.87	489.99	421.60	6.73	311.57	86.34	7.20	2.86	2.81	0.40
T_5	28.97	44.33	1.54	3.03	7.51	12.11	29.93	32.15	40.15	44.38	23.73	36.62	12.22	25.17	63.28	17.24	13.52	440.67	375.17	6.00	277.77	84.98	7.20	3.16	2.68	0.52
T_6	29.26	45.50	1.74	3.72	7.33	12.33	31.61	36.21	39.70	46.82	25.44	36.54	12.19	24.96	61.79	16.82	13.33	428.93	362.27	5.79	268.05	86.61	7.97	2.94	2.45	0.68
T_7	29.73	46.67	2.06	4.19	7.39	13.77	32.27	38.42	44.79	48.12	27.21	39.14	13.10	25.73	60.66	15.91	15.48	513.62	440.09	7.04	325.92	90.37	8.10	3.62	2.80	0.89
T_8	28.85	45.00	1.76	3.63	7.66	13.33	31.79	35.84	43.57	47.93	24.10	37.03	12.43	25.14	62.03	16.22	14.48	506.83	438.17	7.01	324.92	86.41	6.57	3.43	2.62	0.69
T_9	24.33	40.56	1.49	3.50	7.10	12.89	29.82	33.69	41.32	45.19	24.27	36.59	12.11	23.66	62.96	16.83	13.73	452.83	377.85	6.04	279.62	84.32	7.20	3.06	2.62	0.68
T_{10}	25.26	42.14	1.85	3.55	7.19	13.00	30.21	34.18	42.18	46.27	24.60	36.40	12.31	24.48	61.44	16.56	11.62	488.69	413.03	6.60	305.55	88.70	8.07	3.30	3.06	0.84
CD	4.631	5.231	0.311	0.520	1.056	1.060	2.190	1.584	2.111	1.425	2.044	2.212	1.060	1.525	0.979	1.168	0.911	33.819	40.201	0.57	41.05	3.430	1.032	0.514	0.288	0.203
SE(m)	1.561	3.456	0.105	0.192	0.528	0.530	0.740	0.533	0.711	0.480	1.022	1.106	0.430	0.513	0.329	0.393	0.307	11.384	13.532	0.19	13.71	1.155	0.416	0.257	0.097	0.068

Azotobacter), T_7-(50% RDF + 50% FYM), T_8-(50% Vermi-compost + 50% Azotobacter), T_9-(50% Vermi-compost + 50% FYM) and T_{10}-(50% Azotobacter + 50% FYM). Bio-fertilizer *viz.* Azotobacter@ 10g / liter of water was mixed and required quantity of solution was prepared. The roots of uprooted broccoli seedlings were dipped in this solution for (at least) 20 minutes before transplantation. Fertilizers were also applied one day prior to sowing as per treatment *i.e.* at the rate of 150 Kg N, 60 Kg P_2O_5 and 60 Kg K_2O per hectare. Different organic manures *viz.* FYM @ 20t per hectare, Vermi-compost@ 8t hectare were applied before transplanting as per the treatment and mixed thoroughly in the soil. The recorded data on vegetative growth, yield and curd quality parameters were statistically analyzed using ANOVA at 5% level of significance following the standard method as suggested by Sahu and Das (2014).

Discussion

Experimental results presented in the Table- 1 clearly showed that at 30 and 60 days after transplanting (DAT). Maximum plant height (29.73 cm and 46.67 cm respectively) was under the treatment T_7 (50% NPK + 50% FYM) followed by T_6(50% NPK + 50% Azotobacter). The minimum plant height of 21.38cm and 39.66 cm was noted at 30 and 60 DAT, respectively under the treatment T_0 (control). The recommended dose of nitrogen combined with Azotobacter produced as good results as 75 per cent of recommended dose of Azotobacter with regard to growth parameters. Moreover, both these treatments were significantly more advantageous than others Bhardwaj *et al*., (2007). The study revealed that number of leaves per plant, number of branches per plant were significantly more in treatment (50%NPK+ 50% FYM). Similar observation in length of leaves and width of leaves was also recorded maximum under T_7 (50% NPK+ 50% FYM). Whereas, the minimum value was observed in the treatment T_0 lower even from control. The stem diameter were maximum

(2.06cm) at the 30DAT under treatment T_7 (50% NPK + 50% FYM) followed by T_8 (50% Vermi-compost + 50% Azotobacter) and minimum leaves were recorded treatment T_0 [Control]. At 60 DAT the stem diameter was maximum (4.19 cm) under the treatment T_7 (50% NPK + 50% FYM) followed by treatment T_6 (50% NPK + 50% Azotobacter). Minimum data was found in treatment T_0 (Control).

Plant canopy spreading the plant spreading east-west direction was maximum (32.27cm) at the 30DAT under treatment T_7 (50% NPK + 50% FYM) followed by (31.79cm) T_8 (50% Vermi-compost + 50% Azotobacter) and minimum plant spreading was recorded (26.83) under treatment T_0 [Control]. At 60 DAT was maximum plant spreading (47.57cm) under treatment T_8 (50% Vermi-compost+ 50% Azotobacter) followed by observation (44.79 cm) under treatment T_7 (50% NPK+ 50% FYM). Minimum data was found in this case was (38.90 cm) under treatment T_0 (Control).

The plant spreading north-south direction was maximum (38.42cm) at the 30DAT under treatment T_7(50% NPK + 50% FYM) followed by (36.21cm) T_6(50% NPK + 50% Azotobacter) and minimum plant spreading was recorded (31.03cm) under treatment T_0 [Control]. At 60 DAT was maximum plant spreading (48.12cm) under treatment T_7 (50% NPK + 50% FYM) followed by observation (47.93 cm) under treatment T_8(50% Vermi-compost + 50% Azotobacter). Minimum data was found in this case was (43.89 cm) under treatment T_0 (Control). Vegetative growth characters data show in Table 1.

Yield and yield attributing characters like curd initiation day was recorded that minimum days (60.66days) under treatment T_7 (50% NPK + 50% FYM) and days taken to curd harvest after curd initiation was recorded that minimum (15.91days) under treatment T_7 (50% NPK+50% FYM) followed by (16.22 days) T_8 (50% Vermi-compost+ 50% Azotobacter). The Maximum observation of days taken to curd harvest after curd initiation (19.03) was recorded in the treatment T_0 (Control). Curd diameter it was recorded that maximum (15.48cm) under treatment T_7 (50% NPK + 50% FYM) followed by (14.48cm) under treatment T_8 (50% Vermi-compost + 50% Azotobacter). The Minimum observation (11.62cm) was recorded in the treatment T_0 (Control). Weight of curd with guard leaves were taken after harvesting the crop maximum (513.00 g) under treatment T_7 (50% NPK + 50% FYM) followed by (506.00g) under treatment T_8 (50% Vermi-compost + 50% Azotobacter). The minimum observation (425.56 g) was recorded under treatment T_0 (Control). Weight of curd without guard leaf, it was obtained maximum (440.09gm) under treatment T_7 (50% NPK + 50% FYM) followed by (438.17gm) under treatment T_8 (50% Vermi-compost + 50% Azotobacter). The minimum observation (358.56gm) was recorded under treatment T_0 (Control). The yield per plot of broccoli which is recorded maximum (7.04Kg) under the treatment T7 (50% NPK + 50% FYM) followed by (7.01kg) under treatment T8 (50% Vermi-compost + 50% Azotobacter). The minimum observation (5.7 Kg) was found in the treatment T0 (control) and the yield per ha of broccoli which is recorded maximum (325.92q/ha) under the treatment T7 (50% NPK + 50% FYM) followed by (324.92q/ha) under treatment T8 (50% Vermi-compost + 50% Azotobacter). The minimum observation (263.88q/ha) was found in the treatment T_0 (control). Kumar *et al.,* (2013) conducted an experiment on cauliflower to studied the eleven treatments, T_1 - Recommended dose of NPK/ha (120 kg:80 kg:60 kg), T_2 -Half dose of NPK/ha + FYM @ 15 tonnes/ ha, T_3 -Half dose of NPK/ha + Azospirillum @ 5 kg/ha, T_4 - Half dose of NPK/ha + FYM @ 15 tonnes/ha + Azospirillum @ 5 kg/ ha, T_5- Half dose of NPK/ha + VAM @ 5 kg/ ha, T_6-Half dose of NPK/ha + FYM @ 15 tonnes/ ha + VAM @ 5 kg/ha, T_7- Half dose of NPK/ ha + FYM @ 15 tonnes/ ha + Azospirillum @ 5 kg/ha + VAM @ 5 kg/ ha, T_8- Half dose of NPK/ha + Vermicompost @ 2.5 tonnes/ ha, T_9-Half dose of NPK/ha + vermicompost @ 2.5 tonnes/ ha + Azospirillum @ 5 kg/ha, T_{10}-Half dose of NPK/ha + vermi-compost @ 2.5 tonnes/ ha + VAM @ 5 kg/ha, T_{11}-Half dose of NPK/ha + vermi-compost @ 2.5 tonnes/ ha + Azospirillum @ 5 kg/ha + VAM @ 5 kg/ha were evaluated in Randomized Block Design with the three replication. Yield and yield attributing characters data in (Table 1).

In the case of Vitamin-C, it was obtained maximum (90.37 mg) under treatment T_7 (50% NPK + 50% FYM) followed by (88.70 mg) under treatment T_{10} (50% Vermi-compost + 50% FYM). The minimum observation (80.37 mg) was recorded under treatment T_0 (Control) and T.S.S was maximum (8.10^0Brix) under the treatment T_7 (50% NPK + 50% FYM) followed by ($8.07\ ^0$Brix) under treatment T_{10} (50% Vermi-compost + 50% FYM). The minimum observation (6.37^0Brix) was found in the treatment T_0 (Control). Total sugar was recorded maximum (3.62%) under treatment T_7 (50% NPK + 50% FYM) followed by (3.43%) under treatment T_8 (50% Vermi-compost + 50% Azotobacter). The minimum observation (2.97%) was recorded in the treatment T_0 (Control), reducing sugar was recorded maximum (3.06%) under treatment T_{10} (50% Vermi-compost + 50% FYM) followed by (2.81%) under treatment T_4

(Azotobacter 100%). The minimum observation (2.32%) was recorded in the treatment T_0 (Control) and non-reducing sugar was recorded maximum (0.89%) under treatment T_7 (50% NPK + 50% FYM) followed (0.84%) T_{10} (50% Vermi-compost+ 50% FYM) under treatment. The minimum observation (0.35%) was recorded in the treatment T_0 (Control).

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