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Influence of Different Nutrient Management Practices on Growth and Yield of Broccoli *(Brassica oleracea* L. var. *italica).*

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Abstract: ***The present investigation on "Influence of different nutrient management practices on growth, yield and quality of broccoli (Brassica oleracea var. italica)" was done during the Rabi season of 2021-2022 at Campus for Research and Advanced Studies, Dhablan, G.S.S.D.G.S. Khalsa College, Patiala. A field experiment was carried out in randomized block design (RBD) in which 12 treatments were applied in 3 replication. Growth and yield parameters were recorded highest in treatment T_9 (RDF 50 % + 5 t ha^{-1} FYM + 2 t ha^{-1} VC + Azotobactor). Maximum plant height (58.43 cm), plant spread (55.34 cm), no. of leaves plant^{-1} (21.06), leaf length (30.23 cm), leaf breadth (19.72 cm), days to curd initiation (61.01), days to 50 % curd maturity (72.37), days to 100 % curd maturity (95.45), curd diameter (16.15 cm), yield (16.23 kg plot^{-1}) and total yield (190.94 q ha^{-1}) respectively was observed. Whereas treatment T_{12} (RDF 75 % + 2 t ha^{-1} FYM + 1 t ha^{-1} VC + Azotobactor) was at par with this however lowest values were recorded in treatment T_1 (Control).***

Keywords: Broccoli, manures, fertilizers and biofertilizers

1. Introduction

Broccoli *(Brassica oleraca* L. var. *italica)* is a member of Brassicaceae family and chromosome no. is 2n= 18. Broccoli originated from coastal area of Mediterranean sea. It is rich source of proteins, vitamins, phytochemicals. Edible portion of broccoli is immature flower buds. Organic manures plays chief role in improving the soil structure, water holding capacity of soil, improve microbial activity in the soil. Inorganic fertilizers make nutrients readily available to plants. They provides NPK in adequate amount. Biofertilizers also plays major role in fixing umavailable form of atmospheric nitrogen to available form. (Sahai 2010). The application of manures, inorganic fertilizers and biofertilizers in conjugation helps in maintaining fertility of soil as well as improve physical, chemical and biological properties of soil (Kumar *et al.* 2011). Sustainable crop can be produced by use of inorganic, organic and biotic resources in integration that is good for various cropping system. For balanced use of plant nutrients there is urgent need of adopting nutrients in integration (Singh *et al.* 2021).

2. Material and Methods

The present examination was carried out at Campus for Research and Advanced Studies, Dhablan, G.S.S.D.G.S. Khalsa College, Patiala during *Rabi* season of 2021-2022. The experiment was laid out in Randomized Block Design in which 12 treatments were applied in 3 replication. Treatments includes T_1= (Control), T_2 = RDF 50 %, T_3 = RDF 75 %, T_4 = RDF 100 %, T_5 = FYM 20 t ha^{-1}, T_6 = VC 4 t ha^{-1}, T_7 = RDF 50 % + FYM 10 t ha^{-1}, T_8 = RDF 50 % + VC 3 t ha^{-1}, T_9 = RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*, T_{10} = RDF 75 % + FYM 15 t ha^{-1}, T_{11} = RDF 75 % + VC 2 t ha^{-1}, T_{12} = RDF 75 % + FYM 2 t ha^{-1} + VC 1 t ha^{-1} + *Azotobactor*. The observations to be recorded from the plants that were randomly selected included growth parameters i.e plant height (cm), plant spread (cm), plant length (cm), plant breadth (cm), number of leaves, days taken to curd initiation, days to 50 % maturity and days to 100 % maturity. The yield parameters included curd diameter (cm), yield (kg plot^{-1}) and total yield (q ha^{-1}).

3. Results and Discussion

Growth Parameters

The growth parameters that were observed are discussed as follows:

Plant height (cm)

The result findings showed that treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) exhibit the maximum plant height (58.43 cm). This is due to the adequate supply of nitrogen as nitrogen is main constituent of chlorophyll, amino acids, vitamins. Which leads to increase in photosynthetic activities thus plant height increases (Pawde *et al*. 2019 and Singh *et al*. 2021) Where as minimum plant spread was recorded in treatment T_1 (Control).

Plant spread (cm)

The maximum plant spread was observed in treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) (55.34 cm). This is as a result of combine application of organic manures, inorganic fertilizers and biofertilizers which helps in proper supply of macro nutrients and micro nutrients in available form. This leads to increase in plant spread Kumar and Biradar (2017) and Singh *et al*. (2020). While minimum plant spread was recorded in treatment T_1 (Control).

Treatments	Plant height (cm)	Plant spread (cm)	Number of leaves plant^{-1}	Leaf length (cm)	Leaf breadth (cm)
Control	44.12	44.63	10.64	17.88	9.95
RDF 50 %	47.84	50.20	13.21	21.51	12.36
RDF 75 %	48.30	51.48	16.33	23.47	13.15

RDF 100 %	51.86	52.94	17.33	25.18	15.63
FYM 20 t ha^{-1}	53.93	52.31	18.40	27.13	16.34
VC 4 t ha^{-1}	55.12	53.23	18.64	27.21	17.31
RDF 50 % + FYM 10 t ha^{-1}	50.47	50.34	14.88	26.39	16.47
RDF 50 % + VC 3 t ha^{-1}	51.13	50.49	15.61	27.65	17.35
RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*	58.43	55.34	21.06	30.23	19.72
RDF 75 % + FYM 15 t ha^{-1}	51.91	51.68	16.56	26.34	18.19
RDF 75 % + VC 2 t ha^{-1}	56.15	53.18	17.83	27.36	17.25
RDF 75 % + FYM 2 t ha^{-1} + VC 1 t ha^{-1} + *Azotobactor*	57.23	53.21	19.02	29.28	19.28
SE (m)±	**1.06**	**1.01**	**1.04**	**0.98**	**1.01**
CD 5 %	**2.20**	**2.10**	**2.17**	**2.05**	**2.09**

Number of leaves $plant^{-1}$

The highest number of leaves $plant^{-1}$ was recorded in treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) (21.06). This might be due to the use of different nutrients in integration. Organic manures helps in improving physical properties of soil. Inorganic fertilizers readily make available nutrients in available form. Biofertilizers also aids up in plant growth which leads to increase in number of leaves $plant^{-1}$ (Kumar and Biradar 2017 and Prasad *et al*. 2018). Where as lowest number of leaves were recorded in treatment T_1 (Control).

Leaf length (cm)

The result findings showed that maximum leaf length was observed in treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) (30.23 cm). Combine application of different nutrients results in adequate supply of nutrients in accessible form which leads to cell division, cell enlargement and cell elongtion that leads to increase in leaf length (Sharma *et al.* 2018 and Pawde *et al*. 2019). Where as minimum leaf length was recorded in treatment T_1 (Control).

Leaf breadth (cm)

Treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) showed the maximum leaf breadth (19.72 cm). This might be due to use of manures, fertilizers and biofertilizers in conjugation thus adequate supply of macro and micro nutrients takes place as a result of this metabolic activities increases which ultimately leads to increase in leaf breadth (Sharma *et al*. 2018 and Tiwari *et al.* 2021). Howerver minimum leaf breadth was recorded in treatment T_1 (Control).

	Treatments	Days taken to curd initiation	Days taken to 50 % curd maturity	Days taken to 100 % curd maturity
T_1	Control	70.86	90.83	110.44
T_2	RDF 50 %	68.12	84.80	102.08
T_3	RDF 75 %	66.05	82.84	100.85
T_4	RDF 100 %	64.01	80.77	99.57
T_5	FYM 20 t ha^{-1}	67.12	80.80	104.32
T_6	VC 4 t ha^{-1}	68.07	79.56	103.84
T_7	RDF 50 % + FYM 10 t ha^{-1}	68.19	83.03	102.77
T_8	RDF 50 % + VC 3 t ha^{-1}	67.90	82.40	101.67
T_9	RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*	61.01	72.37	95.45
T_{10}	RDF 75 % + FYM 15 t ha^{-1}	65.34	80.88	100.86
T_{11}	RDF 75 % + VC 2 t ha^{-1}	64.16	80.50	98.80
T_{12}	RDF 75 % + FYM 2 t ha^{-1} + VC 1 t ha^{-1} + *Azotobactor*	63.86	79.38	97.23
	SE (m)±	**1.23**	**1.26**	**1.69**
	CD 5 %	**2.56**	**2.62**	**3.51**

Days to curd initiation

The minimum days taken to curd initiation was observed in treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) (61.01) which was as a result of use of organic manures, inorganic fertilizers and biofertilizers in combinationwhich increase in photosynthetic activity that leads to increase in plant height, plant spread, leadf length and breadth thus early initiation takes place (Ekta *et al*. 2017, Kumar and Biradar 2017). While maximum days taken to curd initiation were recorded in treatment T_1 (Control).

Days to 50 % curd maturity

Treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) showed minimum days to 50 % curd maturity (72.37). This might be due to the unite application of manures, fertilizers and biofertilizers that makes soil most favorable for microbial activity thus adequate nutrients supply occurs (Singh *et al*. 2016 and Ekta *et al*. 2017). However maximum days taken were recorded in treatment T_1 (Control).

Days to 100 % curd maturity

The result findings showed that minimum days to 100 % curd maturity (95.45) was recorded in treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*). This was due to use of different nutrients in conjugation that leads to easy accessibility of macro and micro nutrients enhancing the vegetative as well as reproductive growth of plant thus curd maturity takes place (Pawar and Barkule 2017 in cauliflower and Ekta *et al*. 2017 in broccoli. Whereas maximum days taken were recorded in treatment T_1 (Control).

Yield Parameters

The observations related to yield parameters that were recorded discussed as follows:

Curd diameter (cm)

Treatments		Curd diameter (cm)	Yield (kg plot^{-1})	Total yield (q ha^{-1})
T_1	Control	10.00	7.06	83.05
T_2	RDF 50 %	12.26	10.30	121.17
T_3	RDF 75 %	13.53	11.91	140.11
T_4	RDF 100 %	14.06	12.12	142.58
T_5	FYM 20 t ha^{-1}	14.16	13.11	154.23
T_6	VC 4 t ha^{-1}	14.25	13.86	163.05
T_7	RDF 50 % + FYM 10 t ha^{-1}	13.97	10.98	129.14
T_8	RDF 50 % + VC 3 t ha^{-1}	15.03	11.20	131.72
T_9	RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*	16.15	16.23	190.94
T_{10}	RDF 75 % + FYM 15 t ha^{-1}	14.05	12.97	152.58
T_{11}	RDF 75 % + VC 2 t ha^{-1}	14.26	14.36	168.93
T_{12}	RDF 75 % + FYM 2 t ha^{-1} + VC 1 t ha^{-1} + *Azotobactor*	15.79	14.40	169.41
	SE (m)±	**0.89**	**0.96**	**11.30**
	CD 5 %	**1.86**	**2.00**	**23.43**

The maximum diameter of curd were recorded in the treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) (16.15 cm). This might be due to combine application of inorganic fertilizers, organic manures and biofertilizer which helps in maintaining the proper soil conditions thus microbial activity enhanced as a result of this more uptake of nutrients and more accumulation of food and water which ultimately leads to increase in curd diameter (Kumar and Biradar 2017, Sharma *et al*. 2018 and Singh *et* al. 2021). While minimum diameter of curd were recorded in the treatment T_1 (Control).

Yield (kg plot^{-1})

Treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*) gave highest values of yield (16.23 kg). This was due to use of organic manures which provides favourable conditions for the activity of microbes which is beneficial for plant metabolism. Inorganic fertilizers readily supply macro nutrient in available form. Biofertilizer fixes atmospheric nitrogen to available form which all aids up in proper growth and development of plant thus increases yield (Ekta *et al*. 2017, Meena *et al*. 2017, Lal *et al*. 2020 and Singh *et al.* 2021).

Total yield (q ha^{-1})

The result findings showed that maximum total yield (190.94 q) was recorded in treatment T_9 (RDF 50 % + FYM 5 t ha^{-1} + VC 2 t ha^{-1} + *Azotobactor*). This might be due to integrate application of various nutrients which helps in proper growth and development of plant thus appropriate vegetative and reproductive growth takes place thus total yield increases (Mal *et al*. 2015 and Kumar and Biradar 2017).

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