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Effect of Different Fertilizer Levels and Method of *jeevamrut* Application on Growth of Broccoli (*Brassica oleracea* var. *italica*) cv. Palam Samridhi

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ABSTRACT: Unscientific use of chemicals in agriculture leads to several health hazards and environmental problems. To protect our crops and the environment, we must follow sustainable and ecological agriculture that minimizes the use of harmful chemical inputs and embraces the use of biofertilizers. With this in mind, an experiment titled "Effect of different fertilizer levels and method of *jeevamrut* application on growth of broccoli (*Brassica oleracea* var. *italica*) cv. Palam Samridhi" was conducted during *rabi* season 2020-21 and 2021-22 at College Farm, College of Horticulture, S.D.A.U., Jagudan, Mehsana, Gujarat. The experiment was arranged in Randomized Block Design with factorial concept (FRBD) with three replications containing twenty seven treatment combinations of fertilizer levels and method of *jeevamrut* application. The observed parameters were plant height (cm), number of leaves per plant, plant spread (cm), days required for head initiation, days required for head harvest. The findings showed that increased growth of broccoli can be achieved through 80% of the recommended rates of nitrogen, phosphorus and potash, along with soil application of *jeevamrut* @ 500 l/ha at the time of transplanting and 30 days after transplanting, in conjunction with foliar application @ 4% at 25 and 50 days after transplantation.

Keywords: Broccoli, Palam Samridhi, NPK, *Jeevamrut.*

INTRODUCTION

India is blessed with a wide range of tropical, subtropical and temperate climates that allow almost all vegetable crops to be grown. However, there are still some vegetables that are less known or rare to most of our growers and consumers. Among them, broccoli (*Brassica oleracea* var. *italica* L.) is an important ornamental and highly nutritious exotic vegetable from the cruciferous family. In India, broccoli became a commercial crop only recently and its cultivation is negligible, but now with the increasing popularity among Indian growers in the last few years due to its high nutritional value and increased tourist arrivals, the area under broccoli is gaining momentum. In India, cauliflower and broccoli are grown in an area of 4,58,000 hectares with an annual production of 88,40,000 tons and a productivity of 19.30 t ha^{-1} (FAO, 2020). Broccoli is a rich source of sulforaphane, which has been associated with reducing the risk of cancer (Guo *et al.*, 2001). Nutritionally, it is rich in vitamin 'A' (2500 I.U.), vitamin 'C' (113 mg), protein (3.6 g), carbohydrates (5.9 g) and minerals such as calcium (103 mg), iron (1.1 mg), phosphorus (78 mg), potassium (382 mg) and sodium (15 mg) per 100 g of edible portion (Rana, 2008).

The plant requires food in the form of correct doses of NPK for growth and development. The addition of nitrogen enhances vegetative growth and its deficiency leads to stunted growth with small yellow leaves and low production. Phosphorus is an indispensable component of nucleic acid, phospholipids and several enzymes. It is also required for energy transfer in the plant system and has a beneficial effect on early root development, plant growth and production quality. Potash also plays a vital role in crop productivity. It confers increased vitality and disease resistance to plants and functions as an activator of a number of enzymes such as pyruvate kinase, cytoplasmic enzymes, etc. It is responsible for a pervasive effect on the metabolic processes of the plant system. *Jeevamrut* is a liquid organic manure that is an excellent source of natural carbon and biomass that contains macro and micro nutrients required by crops. Compared to other forms of manure, *jeevamrut* has proven to be more effective and can be used along with other fertilizers. The organic liquid fertilizer product is designed for a fermentation process that forms an effective live soil microorganism that improves plant growth, productivity and supplies sufficient nutrients. Such fertilizers are cost-effective and environmentally friendly bio-

inoculants that have great potential to increase agricultural production in a sustainable manner.

It can reduce the excessive use of chemical fertilizers in the soil that cause low soil fertility. Therefore, *jeevamrut* is the best alternative to chemical fertilizer (Kumar *et al.*, 2021). Therefore, in view of the above facts, this investigation was conducted in North Gujarat condition.

MATERIALS AND METHOD

The research was conducted at College Farm, College of Horticulture, Sardarkrushinagar Dantiwada Agricultural University, Jagudan, District: Mehsana, Gujarat during rabi season 2020-21 and 2021-22. The experimental area was 426.06 m^2, each plot was 4.86 m^2 (2.70 m × 1.80 m). 36 plants measuring 45 cm x 30 cm were placed in each plot. The present investigation consists of three factors *i.e.* three levels of nitrogen *i.e.* 40% of recommended nitrogen dose (n_1), 60% of recommended nitrogen dose (n_2) and 80% of recommended nitrogen dose (n_3), three levels of phosphorus and potash *viz.* , 40% recommended dose of phosphorus and potash (p_1), 60% recommended dose of phosphorus and potash (p_2) and 80% recommended dose of phosphorus and potash (p_3) and three methods of *jeevamrut* application *i.e.* soil application (m_1), foliar application (m_2) and application to soil + foliar (m_3). Thus, there were total 27 treatment combinations under study. The experiment was laid out in Randomized Block Design with factorial concept with three replications.

Common dose of FYM @ 15 t/ha was given in all the treatments at the time of land preparation. NPK/ha Half dose of nitrogen (through urea) and full dose of phosphorous (through single super phosphate) and potash (through murate of potash) was given as a basal dose and remaining half dose of nitrogen was applied as a top dressing at 30 DAT as per treatments. *Jeevamrut* was given in soil through drenching @ 500 l/ha at the time of sowing and 30 DAT as per treatments. *Jeevamrut* was sprayed @ 4 % at 25 and 50 DAT as per treatments. Common spray of micronutrients @ 30 g/ 15 liter (500 l/ha) was given at 30 and 45 DAT.

Ten plants from each net plot were randomly selected and labeled. These tagged plants were used for recording growth parameters during the period of study and their average value was taken for statistical analysis and interpretations. Data analysis for different growth parameters has been recorded such as plant height, number of leaves per plant, plant spread, days taken for head initiation and days taken for head harvesting.

RESULTS AND DISCUSSION

The data presented in Table 1 and 2 showed the effect of chemical fertilizers along with *jeevamrut* application on growth and growth attributing parameters.

The effect of different nitrogen levels was found to be significant on growth parameters (Table 1), *i.e.* plant height (cm) and plant spread (cm). Maximum plant height at harvest (55.89, 53.34 and 54.61 cm) and plant spread at harvest (70.84, 68.65 and 69.75 cm) were recorded at 80% of the recommended nitrogen rate (n3) during 2020-21, 2021-22 and in the pooled analysis. This may be due to the fact that nitrogen, which is an important component of chlorophyll, imparts green color to plants and improves photosynthesis, leading to more photosynthate production and ultimately increasing plant height (Kaur *et al.*, 2020). Similar results were observed by Babik and Elkner (2002), Moniruzzaman *et al.* (2007); Giri *et al.* (2013); Neethu *et al.* (2015); Singh *et al.* (2015); Chand and Singh (2017); Kaur and Sharma (2020) in broccoli; Jana and Mukhopadhyay (2001); El-Saady and Omar (2018); Kaur *et al.* (2020) in cauliflower; Lavanya *et al.* (2015); Akand *et al.* (2015) in cabbage; Kavalgi *et al.* (2020) in red cabbage and Biswas *et al.* (2015) in tomato.

Significantly maximum plant height at harvest (54.18, 51.66 and 52.92 cm), plant spread at harvest (66.59, 64.37 and 65.48 cm) were recorded when applying 80% of the recommended dose of phosphorus and potash (p_3) during 2020-21, 2021-22 and in the pooled analysis. The use of increased levels of phosphorus can be attributed to its role in photosynthesis, energy storage, cell division and enlargement (Singh *et al.*, 2015). Similar results were reported by Islam *et al.* (2010); Hassan *et al.* (2013), Neethu *et al.* (2015), Singh *et al.* (2015), Zaki *et al.* (2015), Chand and Singh (2017), Hashem *et al.* (2018); Sonal *et al.* (2020) in broccoli; Elahi *et al.* (2015); Sharma *et al.* (2016); Sharma *et al.* (2017); El-Saady and Omar (2018); Sahito *et al.* (2018) in cauliflower.

Maximum plant height (53.24, 50.55 and 51.90 cm) and maximum plant spread (63.13, 60.81 and 61.97 cm) during 2020-21, 2021-22 and in the pooled analysis were recorded with soil + foliar application of *jeevamrut* (m_3). *Jeevamrut* could contribute to increase in growth parameters and enhancement of biological efficiency of the plants. Ample supply of nutrients through these organics increases the protoplasmic constituents and promotes the process of cell division and elongation. Integration of these liquid manures with chemical fertilizers might have improved growth and yield contributing characters (Gore and Sreenivasa 2011). This finding is supported by Gore and Sreenivasa (2011) in tomato and Hameedi *et al.* (2018) in bell pepper.

The result presented in Table 3 and 4 shows that interaction between different combination of treatments (n × m, p × m and n × p × m) exhibits non significant effect on different growth parameters, except plant height and plant spread. It was observed that maximum plant height at harvest (58.80, 56.20 and 57.50 cm) and maximum plant spread at harvest (77.36, 74.42 and 75.89 cm) recorded in treatment combination of n_3p_3 *i.e.*, (80% recommended dose of nitrogen × 80% recommended dose of phosphorous and potash) during year 2020-21, 2021-22 and also in pooled analysis. This may be due to higher availability of nutrients that promoted vegetative growth in plants that received higher doses of NPK (Sharma *et al.*, 2017). Similar findings have been recorded by Neethu *et al.* (2015); Singh *et al.* (2015); Zaki *et al.* (2015); Chand and Singh (2017); Chand *et al.* (2017); Sonal *et al.* (2020) in broccoli; Naher *et al.* (2014) in cabbage; Elahi *et al.*

(2015); Sharma *et al*. (2016); Metwaly (2017); Sharma *et al.* (2017); El-Saady and Omar (2018) in cauliflower. The results in Table 1 and 2 show that different fertilizer levels and method of *jeevamrut* application had no significant effect on the number of leaves per plant, days required for head initiation and days for head harvest.

Table 1: Effect of nitrogen levels, levels of phosphorous and potash and method of *jeevamrut* application on plant height (cm), number of leaves per plant and plant spread (cm) at harvest.

Treatment	Plant height (cm) at harvest			Number of leaves per plant			Plant spread (cm) at harvest		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Nitrogen levels (N)									
n_1	47.09	44.59	45.84	19.25	18.87	19.06	49.60	46.91	48.26
n_2	51.24	48.67	49.95	19.55	19.16	19.35	59.55	57.49	58.52
n_3	55.89	53.34	54.61	19.86	19.52	19.69	70.84	68..65	69.75
S.Em. ±	0.73	0.73	0.73	0.29	0.24	0.29	0.85	1.18	0.85
C.D. at 5%	2.07	2.06	1.46	NS	NS	NS	2.40	3.34	2.08
Phosphorous and potash levels (P)									
p_1	47.87	45.36	46.61	19.21	18.85	19.03	51.42	49.08	50.25
p_2	52.16	48.88	50.87	19.62	19.33	19.44	62.00	58.37	60.80
p_3	54.18	51.66	52.92	19.82	19.44	19.63	66.59	64.37	65.48
S.Em. ±	0.73	0.73	0.52	0.29	0.24	0.19	0.85	1.18	0.74
C.D. at 5%	2.07	2.06	1.46	NS	NS	NS	2.40	3.34	2.08
Method of *jeevamrut* application (M)									
m_1	50.84	48.39	49.61	19.46	19.14	19.30	5936	56.80	58.08
m_2	50.14	47.65	48.89	19.32	18.89	19.10	57.51	55.44	56.48
m_3	53.24	50.55	51.90	19.87	19.53	19.70	63.13	60.81	61.97
S.Em. ±	0.73	0.73	0.52	0.29	0.24	0.19	0.85	1.18	0.74
C.D. at 5%	2.07	2.06	1.46	NS	NS	NS	2.40	3.34	2.08
C.V. %	**7.37**	**7.73**	**7.63**	**7.77**	**6.50**	**7.25**	**7.32**	**10.60**	**9.24**
Interaction effect									
n × p	3.58	3.57	2.53	NS	NS	NS	4.16	5.78	3.60
n × m	NS	NS	NS	NS	NS	NS	NS	NS	NS
p × m	NS	NS	NS	NS	NS	NS	NS	NS	NS
n x px m	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: Effect of nitrogen levels, levels of phosphorous and potash and method of *jeevamrut* application on days taken for head initiation and days taken for head harvesting.

Treatment	Days taken for head initiation			Days taken for head harvesting		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Nitrogen levels (N)						
n_1	5.26	51.63	50.94	66.19	66.04	66.12
n_2	49.20	50.73	49.96	64.68	65.14	64.91
n_3	48.16	49.55	48.85	64.24	64.40	64.32
S.Em. ±	0.93	0.83	0.93	1.18	1.06	1.18
C.D. at 5%	NS	NS	NS	NS	NS	NS
Phosphorous and potash levels (P)						
p_1	50.31	51.80	51.05	65.05	65.50	65.28
p_2	48.99	50.39	49.68	66.01	65.73	65.86
p_3	48.31	49.74	49.03	64.04	64.38	64.21
S.Em. ±	0.93	0.83	0.63	1.18	1.06	0.79
C.D. at 5%	NS	NS	NS	NS	NS	NS
Method of *jeevamrut* application (M)						
m_1	49.39	50.85	50.12	65.01	65.19	65.10
m_2	49.70	51.15	50.43	65.45	65.69	65.57
m_3	48.52	49.90	49.21	64.65	64.70	64.67
S.Em. ±	0.93	0.83	0.63	1.18	1.06	0.79
C.D. at 5%	NS	NS	NS	NS	NS	NS
C.V. %	**9.81**	**8.50**	**9.23**	**9.40**	**8.44**	**8.95**
Interaction effect						
n × p	NS	NS	NS	NS	NS	NS
n × m	NS	NS	NS	NS	NS	NS
p × m	NS	NS	NS	NS	NS	NS
n x px m	NS	NS	NS	NS	NS	NS

Table 3: Interaction effect of nitrogen levels and levels of phosphorous and potash on plant height at harvest (cm).

	Year – 2020-21				Year – 2021-22				Pooled			
n/p	**n_1**	**n_2**	**n_3**	**Mean**	**n_1**	**n_2**	**n_3**	**Mean**	**n_1**	**n_2**	**n_3**	**Mean**
p_1	45.66	44.94	53.01	47.87	43.12	42.41	50.54	45.36	44.39	43.67	51.78	46.61
p_2	46.71	53.94	55.84	52.16	44.09	51.35	53.28	49.57	45.5	52.65	54.56	50.87
p_3	48.9	54.84	58.8	54.18	46.56	52.23	56.2	51.66	47.73	53.54	57.5	52.92
Mean	47.09	51.24	55.89	51.41	44.59	48.67	53.34	48.86	45.84	49.95	54.61	50.13
	n	**p**	**n × p**	**CV %**	**n**	**p**	**n × p**	**CV %**	**n**	**p**	**n × p**	**CV %**
S.Em. ±	0.73	0.73	1.26	**7.37**	0.73	0.73	1.26	**7.73**	0.52	0.52	0.9	**7.63**
C.D. 5%	2.07	2.07	3.58		2.06	2.06	3.57		1.46	1.46	2.53	

Table 4: Interaction effect of nitrogen levels and levels of phosphorous and potash on plant spread at harvest (cm).

	Year – 2020-21				Year – 2021-22				Pooled			
n/p	**n_1**	**n_2**	**n_3**	**Mean**	**n_1**	**n_2**	**n_3**	**Mean**	**n_1**	**n_2**	**n_3**	**Mean**
p_1	43.61	48.02	62.62	51.42	41.55	44.67	61.03	49.08	42.58	46.34	61.82	50.25
p_2	50.3	63.13	72.56	62	46.81	61.48	70.49	59.6	48.56	62.31	71.53	60.8
p_3	54.9	67.5	77.36	66.59	52.38	66.31	74.42	64.37	53.64	66.9	75.89	65.48
Mean	49.6	59.55	70.84	60	46.91	57.49	68.65	57.68	48.26	58.52	69.75	58.84
	n	**p**	**n × p**	**CV %**	**n**	**p**	**n × p**	**CV %**	**n**	**p**	**n × p**	**CV %**
S.Em. ±	0.85	0.85	1.46	**7.32**	1.18	1.18	2.04	**10.6**	0.74	0.74	1.28	**9.24**
C.D. 5%	2.4	2.4	4.16		3.34	3.34	5.78		2.08	2.08	3.6	

CONCLUSIONS

On the basis of experimental evidence, combined application of 80% recommended dose of nitrogen, phosphorous and potash with the soil application of *jeevamrut* @ 500 l/ha drenching at the time of transplanting and 30 days after transplanting and foliar application @ 4% at an interval of 25 and 50 days after transplanting results in higher growth from broccoli cultivation.

FUTURE SCOPE

In agricultural research, the success of the experiment opens avenues for further research into optimizing the use of biofertilizer, understanding its long-term effects on soil health, and investigating other crops that could benefit from similar practices. This research contributes to ongoing efforts to develop and promote sustainable agricultural practices for future generations.

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Conflict of Interest. None.

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