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Effect of Macronutrients, Bio- fertilizers and Micronutrients on Yield and Yield Attributing Characters of Broccoli (*Brassica oleracea var. italica* L.)

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A B S T R A C T

Field experiment was conducted during Rabi, 2019 to study the "Effect of macronutrients, bio- fertilizers and micronutrients on yield and yield attributing characters of broccoli (*Brassica oleracea var. italica* L.)" with the sole purpose of studying the effect of inorganic fertilizers, bio-fertilizers and micronutrients on yield of broccoli and to find out the most appropriate combinations of the inputs for broccoli crop required under Bhubaneswar agroclimatic condition. The experiment was conducted at Instructional Farm – II, Agricultural Research Station Binjhagiri, Chatabar, Siksha "O" Anusandhan Deemed to be University, Bhubaneswar. The test crop broccoli (var.Shishir) received 10 different treatments namely; absolute control (T_1), N 100% + PK full (RDF)+ bio-fertilizers (T_2), N 75% + PK Full (RDF) +bio-fertilizers (T_3), N 50%+ PK Full (RDF)+ bio-fertilizers (T_4), N 100% + PK Full (RDF)+ micronutrients (T_5), N 75% + PK Full (RDF)+ micronutrients (T_6), N 50% + PK Full (RDF) + micronutrients (T_7), N 100% + PK Full (RDF) + bio-fertilizers + micronutrients (T_8), N 75% + PK Full (RDF) + bio-fertilizers + micronutrients (T_9) and N 50% + PK Full (RDF) + bio-fertilizers + micronutrients (T_{10}). Each treatment was replicated three times and imposed over a statistically laid out field in randomized block design. The 100% soil test based recommended dose of fertilizer for broccoli was (150:60:100) kg N P K/ha. Shisir variety of broccoli was transplanted at a spacing of (60×50) cm Application of different levels of N, P, K in combination with micronutrients and bio-fertilizers increase the curd yield per plot and thereby increasing the yield per hectare. The results revealed that the treatment T_8 (N 100% + PK Full (RDF) + bio-fertilizers + micronutrients) recorded maximum values for curd length(14.11cm), curd diameter (25.27cm), curd circumference (46.37cm), curd yield plot^{-1} (13.95 kg) and curd yield q ha^{-1} (118.01 q^{-1}) which was followed by the treatment T_5 (N 100% + PK Full (RDF)+ micronutrients) and T_2 (N 100% + PK full (RDF)+ bio-fertilizer) respectively. From the present investigation it may be concluded that soil test based recommended dose of fertilizer (100%) combined with biofertilizers and micronutrients was the best treatment for getting higher yield from broccoli.

Introduction

Broccoli (*Brassica oleracea* var. italica L.) is a fast growing annual plant in the brassicaceae family whose large flowering head is consumed as a vegetable. It is originated from the Mediterranean region (Thamburj and Singh, 2001). Sprouting broccoli was cultivated in Italy in the ancient Roman times. It was introduced to England and America in the 1700s.The 1st commercial crop broccoli grown in the U.S. Broccoli the word comes from Italian plural of broccolo, which means "the flowering crest of a cabbage" and is the tiny form of brocco, that means "small nail" or "sprout".

In India cultivation of broccoli increasing popularity among the cultivars for the last few years due to high demand in cities and awareness of its rich nutritive values for healthy lifestyle. Their economic importance becomes so popular only since the thirties of the century when the vegetable become popular in the U.S.A. Commonly broccoli known as "Harigobi" in India. Broccoli is cultivated in hilly areas of Himachal Pradesh, Utter Pradesh, Jammu and Kashmir and Northern plains of India. Jitendra Ladkat a farmer of India brought the 1st few seed of broccoli all the way from Kenya during the gulf war around 1990. Then he started cultivating in his field in pune, Maharastra.

Biofertilizers improve the quality and fertility of soil. It offers ecologically sound route and economically attractive for augmenting nutrient supply that enable to plant growth and development of fruits and vegetables (Joseph *et al.,* 2015). Biofertilizers are living organisms that enrich the nutrient quality of soil. it refers to the use of microbes instead of chemicals to enhance the nutrition of soil. Biofertilizers protect the environment from pollutants since they are natural fertilizers. Biofertilizers such as Rhizobium, Azotobacter, Azospirillium, Blue green algae (BGA) and Phosphorus solubilizing bacteria (PSB) have been in use a long time. Effect of Azospirillium and in combination with other biofertilizers on the yield of leafy vegetables and perusal of data trial indicate that biofertilizers treatment gave significantly high amount of yield in the leafy vegetables (Kolhe *et al.,* 1988).

Micronutrients are crucial for plant growth and an imp for balancing crop nutrition. These are required in very small amount. The deficiencies of micronutrient have become major constraints to stability, productivity and sustainability of soils. Availability of micronutrients is influenced by physico-chemical properties in soil and their distribution in soil. Soil with high organic matter and finer properties can generally provide a greater reserve of these elements where as coarse textured soil such as, sand have fewer reserves and tend to get depleted rather quickly (Bhanwaria *et al.,* 2011).

Materials and Methods

The present research entitled "Effect of macronutrients, bio- fertilizers and micronutrients on yield and yield attributing characters of broccoli (Brassica oleracea var. italica L.)" was carried out during Rabi Season, 2019-2020 at Research Farm, Chhatabara, Bhubaneswar. The experiment was carried out to study the effect of bio-fertilizers and micronutrients at different levels of fertilizer on yield and yield attributing characters of Broccoli. Variety Sishir was selected. Ten treatments using different recommended dose of fertilizer (NPK: 150:60:100), FYM (15ton ha^{-1}), bio-fertilizers (Azotobacter, Azospirillum and PSB were used in 1:1:1 ratio @ 1 kg $plot^{-1}$) and micronutrients (Planofix @ 200 ppm) were applied in different treatments. The sowing was done in rabi season using RBD.

The sowing spacing of 60cm x 50cm in 3m x 3m with gross area of 359 sqm for each treatment is done. From each plot five observation plants were selected from each treatment to record the curd length, curd diameter, curd circumference, curd yield plot^{-1} and curd yield q ha^{-1}. The details of the treatments applied in this experiment are given in Table 1.

Results and Discussion

The curd length of broccoli was measured treatment wise and the data after statistical analysis are presented table 2 and fig. 1. The ANOVA is given in Appendix. The curd length was influenced significantly under the various treatments. It was ranged from 14.11 to 7.95 cm. It is apparent from the data the curd length was found maximum (14.11cm) from T8, closely followed by T5(12.82cm) and T2(10.89cm). All the values were found statistically identical. There after the curd length was found to decrease under T1 (9.16cm), T9 (9.58cm) and T6(9.8cm). The curd length was continued decreased further (7.95 cm to 10.89cm). The lowest curd length (7.95cm) was recorded in T4 treatment. These findings are also in close agreement with the findings of Singh *et al.*, (2014), Singh *et al.*, (2015) in broccoli. The mean data of curd diameter of broccoli under different treatments are highlighted in table 2, fig 2. and graphical presentation is shown. The analysis variance is given in appendix section. The curd diameter was also influenced significantly due to applied treatment and ranging from 19.89 to 23.73. Among the treatment, T8 recorded maximum curd diameter (25.27cm), closely followed by T5 (23.73cm) and T2 (23.01cm). The curd diameter was continued decreased further (19.89cm to 22.56cm). The lowest curd diameter (19.89cm) was recorded in T7 treatment. These findings are also in close agreement with the findings of Singh *et al.*, (2014), Singh *et al.*, (2015), Islam *et al.*, (2015), Amit kumar and khare (2015) and Thapa *et al.*, (2016). Ouda and Mahadeen (2008) found that the head diameter was higher when a combination of organic and inorganic fertilizers was applied compared with their individual application. Similarly Das *et al.*, (2013) also showed that the combined use of recommended dose of nitrogen by inorganic fertilizers + vermicompost + recommended dose of phosphorus and potassium recorded the highest head diameter.

Table.1 The experiment comprised of the following treatments

Treatments	Treatments details
T_1	N100% +PK full (RDF)(Control)
T_2	N100% + PK full (RDF)+Biofertilizer
T_3	N75%+ PK Full (RDF)+Biofertilizer
T_4	N50%+ PK Full (RDF)+Biofertilizer
T_5	N100%+PK Full (RDF)+ Micronutrient
T_6	N75%+ PK Full (RDF)+ Micronutrient
T_7	N50%+ PK Full (RDF) + Micronutrient
T_8	N100%+ PK Full (RDF) + Biofertilizer + Micronutrient
T_9	N75%+ PK Full (RDF) + Biofertilizer + Micronutrient
T_{10}	N50%+ PK Full (RDF) + Biofertilizer + Micronutrient

Table.2 Effect of macronutrients, bio- fertilizers and micronutrients on yield and yield attributing characters of broccoli (*Brassica oleracea* var. italica L.) var. Sishir

Treatment	Treatment detail	Curd length	Curd Diameter	Curd circumference	Curd yield/plot in (kg)	Curd yield(q/ha)
T_1	N100% +PK full (RDF)(Control)	9.16	21.62	43.8	9.16	105.27
T_2	N100% + PK full (RDF)+Biofertilizer	10.89	23.01	44.4	10.02	111.28
T_3	N75%+ PK Full (RDF)+Biofertilizer	9.22	22.31	42.92	9.22	102.57
T_4	N50%+ PK Full (RDF)+Biofertilizer	7.95	22.37	43.51	7.95	88.77
T_5	N100%+PK Full (RDF)+ Micronutrient	12.82	23.73	45.44	10.38	113.86
T_6	N75%+ PK Full (RDF)+ Micronutrient	9.8	21.87	43.00	9.8	109.11
T_7	N50%+ PK Full (RDF) + Micronutrient	8.65	19.89	39.96	8.65	98.51
T_8	N100%+ PK Full (RDF) + Biofertilizer + Micronutrient	14.11	25.27	46.37	13.95	118.01
T_9	N75%+ PK Full (RDF) + Biofertilizer + Micronutrient	9.58	22.56	44.22	9.58	106.58
T_{10}	N50%+ PK Full (RDF) + Biofertilizer + Micronutrient	8.14	21.35	41.75	9.68	90.52
	S.Em±	0.28	0.27	0.19	0.22	0.25
	C.D.(5%)	0.83	0.82	0.57	0.67	0.76

Fig.1 Effect of bio-fertilizers and micronutrients on curd length of broccoli var. Shishir

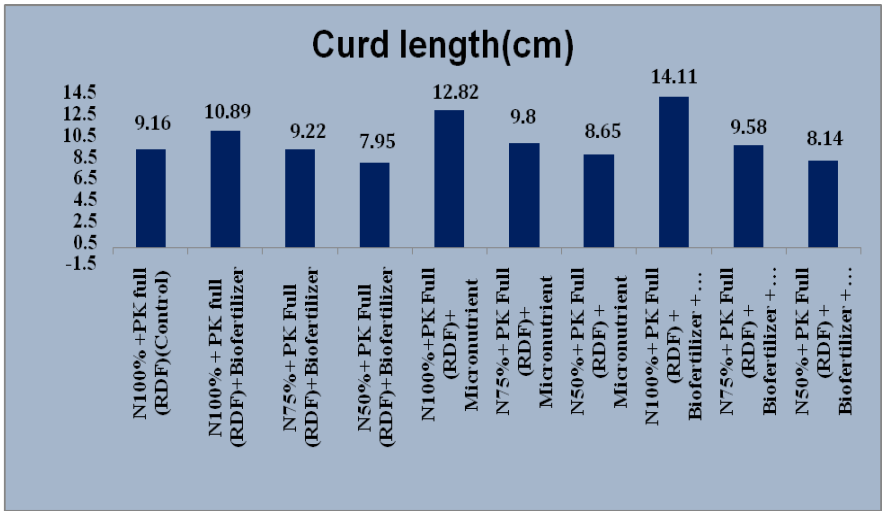


Fig.2 Effect of bio-fertilizers and micronutrients on curd diameter of broccoli var. shishir

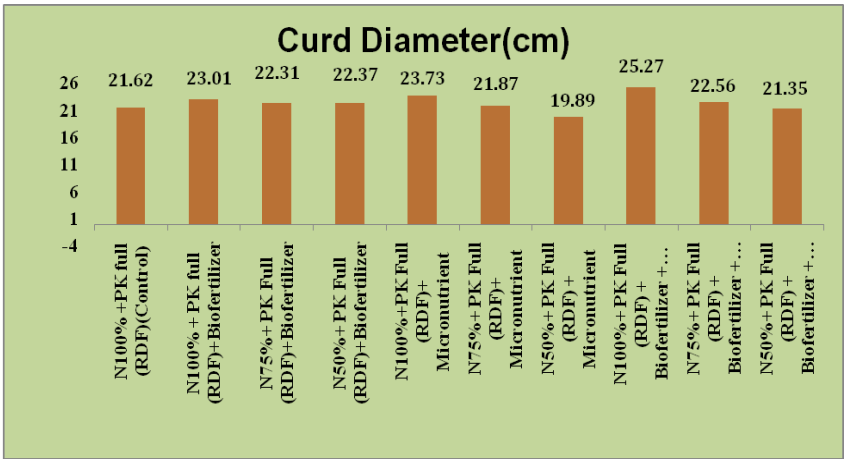


Fig.3 Effect of bio-fertilizers and micronutrients on curd circumference of broccoli var. shishir

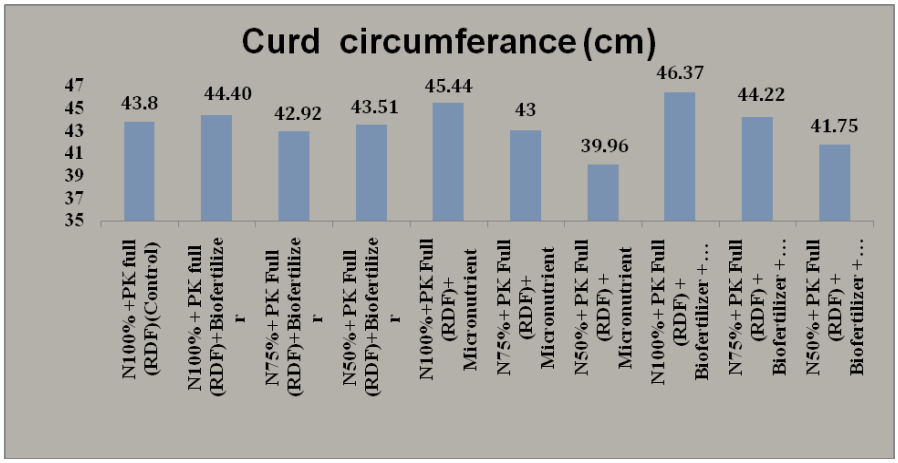


Fig.4 Effect of bio-fertilizers and micronutrients on curd yield/plot in kg of broccoli var. shishir

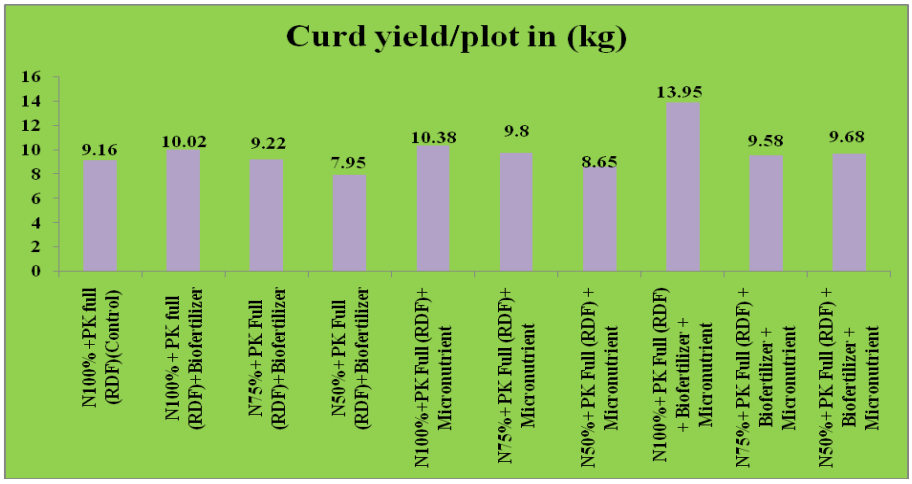
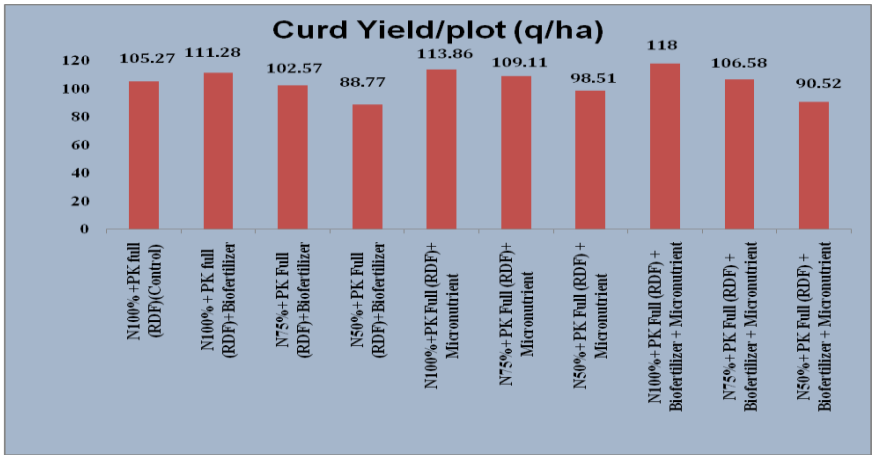


Fig.5 Effect of bio-fertilizers and micronutrients on curd yield /plot of broccoli var. Shishir



The data with respect to different treatment for curd circumference are summarized in Table 2 and fig. 3. The ANOVA is shown in appendix section. The curd circumference of broccoli was significantly influenced due to biofertilizer and micronutrient. T8(46.37cm) has given maximum curd circumference, closely followed by T5(45.44cm) and T2 (44.40cm). The minimum no of curd circumference was recorded in T9 (44.22cm), T4 (43.51cm) and T6 (43cm). The lowest value of curd circumference was recorded in T7 (39.96cm). It was ranging from 39.96 to 46.37cm, which was confirmation with findings of Singh *et al.*, (2015), Islam *et al.*, (2015), Amit Kumar and Khare (2015) and Thapa *et al.*, (2016). Kodithuwakku *et al.*, 2009) revealed the possibility of increasing N recommendation for obtaining large curd.

The data in the table 2 and fig. 4 clearly signifies that awide variation in total curd yield per plot can be obtained by altering the levels of N fertilizer along with the application of bio-fertilizers and micronutrients. Highest yield per plot (13.95 kg) was obtained from treatment T8 followed by 10.38 kg in T5 and 10.02 kg in T2. Lowest yield per plot (9.16 kg) was recorded in treatment T1 (control). It was found that the various doses of nutrients produced significant variation in total curd yield per plot. These findings are also in confirmatory with the findings of Moniruzzaman *et al.*, (2008), Sanchita *et al.*, (2010) and Dubey (2013).

The yield of any crop is the final index of the experiment which indicates the success or failure of any treatment. With this view point, from table 2 and fig. 5 the curd yield of broccoli was recorded. The data for the yield per plot under different treatments were recorded and converted into curd yield q per hectare. The data so obtained were statistically computed and the analysis of variance is given in Appendix section. From the Table 2 and Fig. 5, it can clearly be revealed that curd yield was recorded significantly higher in T8 (118.01q/ha) treatment which statistically significantly superior to all the treatment tried in the experiment, second best treatment was found in T5 (113.86q/ha) and third best treatment was at higher rates T2 (111.28q/ha). Amongst the treatment biofertilizer and micronutrient resulted in significantly higher curd yield as against to other treatments. The mean of curd yield was ranges from 90.52 q/ha to 118.01 q/ha. So far the curd yield is concerned different treatment followed in order of T8 >T5>T2>T6>T9>T1> T3>T10>T4. These

findings are also in agreement with the findings of Moniruzzaman *et al.*, (2008), who reported that application of S, B, Zn and Mo increased head yield of broccoli. Sanchita *et al.*, (2010) studied on the effect of recommended dose of nitrogen through fertigation was found to be significantly superior in terms of growth, yield and economics of broccoli. Dubey (2013) found that micronutrient recorded maximum curd yield.

In conclusion the salient findings of the present study, entitled "Effect of macronutrients, bio- fertilizers and micronutrients on yield and yield attributing characters of broccoli (*Brassica oleracea var. italica* L.)" clearly indicates that significant variation having maximum number of curd length (14.11cm), was recorded in the treatment receiving 100 % RDF (150:60:100 NPK kg ha $^{-1}$) in combination with bio-fertilizers treatment and micronutrients spray. Also, significantly curd diameter (25.27cm), curd circumference (46.37cm), curd yield plot-1 (13.95 kg) and curd yield q ha-1 (118.01 q) was also observed in the above treatment, which all were significantly superior to rest other treatments. Increase the yield and yield attributing characters in above treatment T_8 might be due to the combined effect of bio-fertilizers (1 kg/plot) and micronutrients @200 ppm with different levels of N:P: K kg ha^{-1}(150:60:100) which in turn expressed better yield and other yield attributing characters in Broccoli.

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