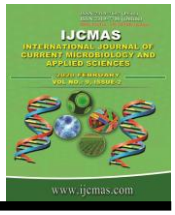
Int.J.Curr.Microbiol.App.Sci (2020) *9*(2): 1127-1136

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 2 (2020)**
Journal homepage: http://www.ijcmas.com



Original Research Article https://doi.org/10.20546/ijcmas.2020.902.132

Application of Organic Manures and their Influence on Broccoli Growth and Yield Parameters

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Keywords

Broccoli Growth and Yield Parameters, Organic Manures

Article Info

Accepted:
08 January 2020
Available Online:
10 February 2020

A B S T R A C T

A study was conducted at Organic Farming Research Centre of SKUAST - Jammu to find out the impact of organic manures and their influence on Broccoli growth and yield parameters. In this two year experiment, all broccoli growth parameters showed a significant impact on broccoli growth and yield parameters which were size of curd, plant height, curd weight and curd diameter. Maximum and minimum value in size of curd identified was 5.86 cm and 5.13 cm in T_8 and T_1. Maximum and minimum value in plant height identified was 63.83 cm and 55.20 cm in T_8 and T_1.As per tukey's post hoc analysis non-significant effect of treatments was observed on number of leaves as maximum and minimum value identified was 12.66 and 10.33 in T_{10} and T_1.Maximum and minimum value in curd weight identified was 314.33 g and 275.66 g in T_8 and T_1.Maximum and minimum value in curd diameter identified was 11.73 cm and 10.33 cm in T_8 and T_1. The additive effect of organic manures continuously improvised the growth and yield in comparison to time.

Introduction

Continuous and massive application of fertilizers during early seventies helped in improving the soil fertility and also the replenishment of nutrients lost due to abiotic factors or consumed by the plants and ushered an era of green revolution. After 50 years of green revolution, the continuous trend of application of fertilizers in imbalanced way because of some govt. policies like subsidy on urea led to the emergence of problem of soil and water bodies' pollution by nitrate. As a result, economic efficiency of fertilizers use as well as quality of crop products deteriorated. History is the witness that organic manure based agro-production systems continues to support the agriculture growth both quantitatively as well as qualitatively. Researchers concluded that

Organic Nutrient Management in agriculture as a way tends to be more promising and reliable to take on all the issues pertaining soil, climate and crop productivity sustainably (Sudha and Chandini 2003). Broccoli (*Brassica oleraceaL.*var. *italica*) belongs to family Brassicaceae. It is a fast growing vegetable crop andmostly requires high nitrogen input for proper growth and development. It is highly nutritious with essential vitamins and minerals (Michaud *et. al*., 2002).

Materials and Methods

Geographically the experimental site is located at 32°39'35.5"N latitude and 74°47'35.0"E longitude at an elevation of 332 meters above the mean sea level in site the Shivalik foothill plains of North-Western Himalayas.

Surface soil sampling from 0-15 cm depth was done randomly from four spots of the field prior to start of experiment. The soil samples collection were mixed together to form respective composite sample.

Experimental details

The experiment consisted of 10 treatments given in Table A.

*Blanket application of FYM @10 tonneha^{-1} was done

**Dhaincha was incorporated as a source of green manure

Crop and site detail

Total treatments :- 10
Total replications:- 3
Total no. of plots:- 30
Design: RCBD

Okra

Spacing:- 45cms (Row) X 30cms (Plant)
Variety:- Seli Special
Seed rate:- 20-25 kg ha^{-1}
N:P:K requirement:- 100:60:60

Broccoli

Spacing:- 60cms (Row) X 45cms (Plant)
Variety:- Early Green
Seed rate:- 300-400g ha^{-1}
N:P:K requirement:- 120:60:60

Dhaincha

Dhaincha seed was broadcasted in the experimental field @ 50 kg ha^{-1} and green matter was incorporated 45 DAS.

Experimental site

Organic Farming Research Centre of SKUAST -Jammu

Vegetative growth characteristics were measured on a random sample of ten plants, taken from each experimental bed and the data was recorded.

All broccoli heads of each plot were harvested at marketable stage.

Statistical analysis

The data on various characters studied during the course of investigation were statistically analyzed by using Tukey's test with an aim to figure out which groups in our sample differ by using "Honest Significant Difference," a number that represents the distance between groups, to compare every mean with every other mean.

Table.A Treatment details

Treatments	Input	Qty. applied tonne ha^{-1}on the basis of Nitrogen requirement *,**
T_1	No application	Nil
T_2	Farm Yard Manure	10.00
T_3	Vermicompost	6.60
T_4	Poultry Manure	2.91
T_5	Neem Cake	2.00
T_6	Farm Yard Manure + Poultry Manure	5 + 1.45
T_7	Farm Yard Manure + Neem Cake	5 + 1.00
T_8	Vermicompost + Poultry Manure	3.30 + 1.45
T_9	Vermicompost + Neem Cake	3.30 + 1.00
T_{10}	Neem Cake + Poultry Manure	1.00 + 1.45

Results and Discussion

Size of curd in broccoli

During 1st year of experiment, significant improvement in size of curd was observed in broccoli as compared to control (Table 1). In year 2016, the maximum value observed was 5.53 cm in T_8 and minimum observed was 4.93 cm in T_1. Also in individual applications the T_4 performance with value 5.33 cm was better and was found at par with T_7, T_9 and T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 5.53 cm was noticed. Also, T_5 was found at par with T_2 and T_3.

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 5.86 cm and 5.13 cm in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 5.60 cm and was found at par withT_7 and T_9. In combination context, the finest performance was observed in T_8 which depicted highest value of 5.86 cm. Also, T_5 was found at par with T_2 and T_3. Similarly, T_{10} was found at par with T_6.

Similarly, in mean values the maximum value 5.73 cmwas observed in T_8 and minimum was 5.03 cm in T_1. Also, T_5 was found at par with T_3.

Plant height of broccoli

During 1st year of experiment, significant improvement in plant height was observed in broccoli as compared to control (Table 2). In year 2016, the maximum value observed was 57.36 cm in T_8 and minimum observed was 51.96 cm in T_1. Also in individual applications the T_4performance with value 55.13 cm was better. In combination of manures, the best performing treatment was T_8 in which the highest value 57.36 cmwas noticed and was found at par with T_6 and T_{10}.
In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 63.83 cm and 55.20 cm in T_8 and T_1. In individual treatment, the T_4 performed well as highest

value notified was 60.53 cm and was found at par with$T_{10.}$ In combination context, the finest performance was observed in T_8 which depicted highest value of 63.83 cm. Also, T_5 was found at par with T_3.

Similarly in mean values the maximum value 60.63 cmwas observed in T_8 and minimum was 53.63 cm in T_1. Also, T_5 was found at par with T_3.

Number of leaves of broccoli

During 1st year of experiment, no significant improvement in leaf number was observed in broccoli as compared to control (Table 3). In year 2016, the maximum value observed was 12.00 in T_8 and minimum observed was 10.00 in T_1. Also in individual applications the T_3 performance with value 11.33 was better. In combination of manures, the best performing treatment was T_8 in which the highest value 12.00was noticed.

In consecutive year 2017, again as per tukey's post hoc analysis non-significant effect of treatments was observed.

Maximum and minimum value identified was 12.66 and 10.33 in T_{10} and T_1. In individual treatment, the T_3 and T_4 performed at par as value notified was 12.00. In combination context, the finest performance was observed in T_{10} which depicted highest value of 12.00.

Similarly, in mean values the maximum value 12.16was observed in T_{10} and minimum was 10.16 in T_1.

Curd weight

During 1st year of experiment, significant improvement in curd weight was observed in broccoli as compared to control (Table 4). In year 2016, the maximum value observed was 301.66 g in T_8 and minimum observed was 269.33 g in T_1. Also in individual applications the T_4 performance with value 289.66 g was better and was at par with T_9. In combination of manures, the best performing treatment was T_8 in which the highest value 301.66 gwas noticed. T_5 was found at par with T_3 and T_2. Also T_{10} was found at par with T_6.

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 314.33 g and 275.66 g in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 300.33 g. In combination context, the finest performance was observed in T_8 which depicted highest value of 314.33 g. Also, T_9 was found at par with $T_{7,}$ T_5 and T_3. Similarly, T_{10} was found at par with T_6 and T_3 was found at par with T_2.

In mean values the maximum value 308.00 gwas observed in T_8 and minimum was 272.50 g in T_1. Also, T_5 was found at par with T_2 along with T_7 was found at par with T_9.

Curd diameter

During 1st year of experiment, significant improvement in curd diameter was observed in broccoli as compared to control (Table 5). In year 2016, the maximum value observed was 11.10 cm in T_8 and minimum observed was 9.90 cm in T_1. Also in individual applications the T_4performance with value 10.63 cm was better. In combination of manures, the best performing treatment was T_8 in which the highest value 11.10 cmwas noticed. T_5 was at par T_3 and T_9 was found at par with T_7. Also, T_{10} was found at par with T_6.

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 11.73 cm and 10.33 cm in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 11.20 cm. In combination context, the finest performance was observed

in T_8 which depicted highest value of 11.73 cm. Also, T_9 was found at par with T_7, T_5, T_3 and T_2. Similarly, T_{10} was found at par with T_6.

Similarly, in mean values the maximum value 11.43 cmwas observed in T_8 and minimum was 10.10 cm in T_1. Also, T_5 was found at par with T_2 and T_3. T_9 was found at par with T_7 and T_4. Also, T_{10} was found at par with T_6.

Effect on manures on soil quality

The ultimate purpose of researching and assessing soil quality is not to achieve high aggregate stability, biological activity, or some other soil property. It's basically is to protect and improve long-term agriculture productivity, water quality, and habitats of all organisms, including people. We use soil characteristics as indicators of soil quality, but in the end, soil quality must be identified by how soil performs its functions.This short duration experiment conducted in year 2016 and 2017 in which maximum soil parameters like pH, EC, OC, Available potassium, sulphur, Total N, Zn, Mn, Cu, Ca, Mg, Microbial Biomass Nitrogen and Acid Phosphatase values were found to be non-significant as minor variations in treatments were observed as compared to control but still due to the additive effects of organic manures the all parameters trend was continuously observed improvised in comparison to time except Potassium. In an overall reflectance of soil parameters impact on soil health there seems a very less improvement due to the short span of experiment i.e. 2 years, however major improvements in all soil quality parameter might be expected in further course of time.

Table.1 Effect of organic manures on size of curd (cm) in broccoli

Treatment	2016	2017	Mean
T1: Control	4.93^{a}	5.13^{a}	5.03^{a}
T2: FYM	5.20^{b}	5.43^{b}	5.30^{b}
T3: VC	5.20^{b}	5.50^{b}	5.33^{bc}
T4: PM	5.33^{bc}	5.60^{bc}	5.46^{cde}
T5: NC	5.20^{b}	5.43^{b}	5.33^{bc}
T6: FYM + PM	5.40^{c}	5.73^{cd}	5.56^{e}
T7: FYM + NC	5.26^{bc}	5.53^{bc}	5.43^{bcde}
T8: VC + PM	5.53^{d}	5.86^{d}	5.73^{f}
T9: VC + NC	5.26^{bc}	5.53^{bc}	5.40^{bcd}
T10: NC + PM	5.33^{bc}	5.73^{cd}	5.53^{de}

*Mean values with similar alphabet in a subset are statistically at par.

Table.2 Effect of organic manures on plant height (cm) of broccoli

Treatment	2016	2017	Mean
T1: Control	51.96^{a}	55.20^{a}	53.63^{a}
T2: FYM	53.03^{b}	57.50^{b}	55.30^{b}
T3: VC	54.66^{c}	59.00^{c}	56.76^{c}
T4: PM	55.13^{cde}	60.53^{de}	57.86^{de}
T5: NC	54.70^{cd}	59.00^{c}	56.90^{c}
T6: FYM + PM	56.76^{f}	61.86^{f}	59.33^{g}
T7: FYM + NC	55.70^{e}	61.33^{ef}	58.50^{ef}
T8: VC + PM	57.36^{f}	63.83^{g}	60.63^{h}
T9: VC + NC	55.40^{de}	59.80^{cd}	57.60^{d}
T10: NC + PM	57.00^{f}	60.53^{de}	58.76^{fg}

*Mean values with similar alphabet in a subset are statistically at par.

Table.3 Effect of organic manures on number of leaves in broccoli

Treatment	2016	2017	Mean
T1: Control	10.00	10.33	10.16
T2: FYM	11.00	11.33	11.16
T3: VC	11.33	12.00	11.66
T4: PM	11.32	12.00	11.67
T5: NC	10.33	11.00	10.66
T6: FYM + PM	11.22	11.33	11.33
T7: FYM + NC	11.33	11.66	11.50
T8: VC + PM	12.00	12.00	12.00
T9: VC + NC	10.66	11.33	11.00
T10: NC + PM	11.66	12.66	12.16

*As per Tukey's Post-hoc analysis, the values are non-significant.

Table.4 Effect of organic manures on curd weight (g) in broccoli

Treatment	2016	2017	Mean
T1: Control	269.33^{a}	275.66^{a}	272.50^{a}
T2: FYM	282.33^{b}	292.66^{b}	287.50^{b}
T3: VC	282.33^{b}	294.00^{b}	288.16^{bc}
T4: PM	289.66^{bc}	300.33^{bc}	295.00^{cde}
T5: NC	283.66^{b}	293.00^{b}	288.33^{bc}
T6: FYM + PM	294.00^{c}	306.66^{c}	300.33^{e}
T7: FYM + NC	288.00^{bc}	296.33^{b}	292.16^{bcd}
T8: VC + PM	301.66^{d}	314.33^{d}	308.00^{f}
T9: VC + NC	288.00^{bc}	296.66^{b}	292.33^{bcd}
T10: NC + PM	291.33^{c}	306.66^{c}	299.00^{de}

*Mean values with similar alphabet in a subset are statistically at par.

Table.5 Effect of organic manures on curd diameter (cm) in broccoli

Treatment	2016	2017	Mean
T1: Control	9.90^{a}	10.33^{a}	10.10^{a}
T2: FYM	10.33^{b}	10.93^{b}	10.66^{b}
T3: VC	10.36^{bc}	10.96^{b}	10.70^{b}
T4: PM	10.63^{cd}	11.20^{bc}	10.93^{bc}
T5: NC	10.40^{bc}	10.96^{b}	10.70^{b}
T6: FYM + PM	10.76^{d}	11.46^{cd}	11.10^{c}
T7: FYM + NC	10.56^{bcd}	11.10^{b}	10.83^{bc}
T8: VC + PM	11.10^{e}	11.73^{d}	11.43^{d}
T9: VC + NC	10.56^{bcd}	11.10^{b}	10.83^{bc}
T10: NC + PM	10.70^{d}	11.46^{cd}	11.06^{c}

*Mean values with similar alphabet in a subset are statistically at par.

Broccoli growth parameters

The increase in size of curd, plant height and curd diameter from application of the poultry manureover control may be attributed to the presence of readilyavailable form of nutrient i.e. ammonia and nitrate (Gross *et al.*, 2008) and also to its property to enhance soil aggregation, soil aeration and water holding capacity, offers good environmental conditions for the root system of broccoli plants. This better availability of soil nutrients and favorablesoil condition resulted in healthy plants with large vegetative growth, which

lead to higher curd weight and curd diameter as compared to control. Improvement in overall growth attributes of broccoli as compared to control with the application of poultry manure, vermicompost, FYM and combinations might be due to better photosynthesis, energy storage, cell division and cell enlargement, moisture holding capacity, supply of micronutrients and availability of major nutrients due to favorable soil condition (Uddin *et al.,* 2009). Poultry manure also enhanced the vegetative growth of broccoli. It might be due to the fact that poultry manure contains uric acid having 60 per cent nitrogen. The uric acid rapidly changes to ammonia form causing its immediate and efficient utilization for better plant growth and development. These results are in partial conformity with the findings of (Choudhary *et al.,* 2012; Kumar *et al.,* 2013; Mohapatra *et al.,* 2013; Yadav *et al.,* 2016). Similar observations due to incorporation of organic manures with respect to quality attributes were reported by Chaterjee *et al.,* (2005) and Damir and Polat (2011) in broccoli.

Soil quality

No major variations were observed in the soil properties within a span of two years of organic farming. As such changes in soil quality were not expected during this short period among the various treatments. It has been observed that shorter periods of cultivation do not have significant effect on soil quality as reported in the literature (Lazcano *et al.,* 2013). However, over long periods the continuous uses of manures have had a significant effect on soil quality (Memoli *et al.,* 2017). Van-Camp *et al.,* (2004) found that organic amendments influence soil characteristics by the interdependent modification of biological, chemical and physical properties. Also, quality improvement through an effective management of these properties has the capability of optimizing crop production. The Woburn Market Garden Experiment showed increase in percent C from 0.87% to 1.46 % from FYM additions and 2 % from composted FYM additions over a 25 year period (Johnston *et al.,* 1989). Vitosh *et al.,* (1973) calculated that applying fresh cattle manure at 67.2 Mg ha-1 yr-1 increased the organic matter content of a sandy loam soils by 0.1% each year in 15 year experiment. There are reports in the literature of composts both increasing and lowering the pH of soils, and others where no or little effect was measured (Crecchio *et al.,* 2001). In relation to soil physical properties effects of organic matter additions vary with climate, soil type, texture and rate and type of organic matter addition. The latter is in agreement with the findings of that quality is more important than quantity in relation to effects of organic matter on aggregate stability. It has also been observed that a greater quantity of organic material is needed to improve soil structural properties than is necessary to supply the nutrient requirements of a growing crop (Tisdall and Oades, 1980) with time. Since, the experiment was of 2 years only, no drastic change has been noticed in all parameters, and however it is possible that after a certain period of time change can be noticed in almost all soil parameters.

It is concluded in the experiment, applications of organic manures have a significant impact on the size of curd, plant height, curd weight and curd diameter. However, no. of leaves on broccoli was found to be non-significant in two year cropping system. The best performing treatment was Treatment No. 8 which includes the application of combination of Vermicompost and Poultry Manure as compared to control. In overall aspect, the application of manures and their combination can have a deep impact on growth and yield of broccoli.

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How to cite this article:

Vishaw Vikas, A. K. Mondal, Jag Paul Sharma and Divyansh Verma. 2020. Application of Organic Manures and their Influence on Broccoli Growth and Yield Parameters. *Int.J.Curr.Microbiol.App.Sci.* 9(02): 1127-1136. doi: https://doi.org/10.20546/ijcmas.2020.902.132