Journal of Pharmacognosy and Phytochemistry
Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2020; 9(1): 999-1005
Received: 16-11-2019
Accepted: 18-12-2019

Vishaw Vikas
Division of Soil Science & Agricultural Chemistry, SKUAST, Jammu, Jammu and Kashmir, India

Jag Paul Sharma
Directorate of Research, SKUAST, Jammu, Jammu and Kashmir, India

Balbir Dhotra
Directorate of Research, SKUAST, Jammu, Jammu and Kashmir, India

Amitesh Sharma
Directorate of Research, Skuast Jammu, Jammu and Kashmir, India

Divyansh Verma
Division of Soil Science & Agricultural Chemistry, SKUAST, Jammu, Jammu and Kashmir, India

Corresponding Author:
Vishaw Vikas
Division of Soil Science & Agricultural Chemistry, SKUAST, Jammu, Jammu and Kashmir, India

Application of organic manures and their influence on okra growth parameters

Vishaw Vikas, Jag Paul Sharma, Balbir Dhotra, Amitesh Sharma and Divyansh Verma

Abstract
A study was conducted at Organic Farming Research Centre of SKUAST -Jammu to find out the impact of organic manures on okra growth parameters. Maximum and minimum value identified was 12.23 g and 11.05 g in T_8 and T_1 in per fruit weight, 239.17 g and 186.42 g in T_8 and T_1 in fruit weight per plant, 146.32 q ha^{-1} and 111.03 q ha^{-1} in T_8 and T_1 in crop yield, 40.66 and 33.33 in T_8 and T_1 in seeds per fruit, 26.32 q ha^{-1} and 24.58 q ha^{-1} in T_8 and T_1 in total seed yield, 789.36 g and 562.50 g in T_8 and T_1 in seed yield per plant, 31.53 cm^3 and 21.75 cm^3 in T_8 and T_1 in root volume, 15.69 cm and 13.53 cm in T_8 and T_1 in root length, 40.00 cm and 29.23 cm in T_8 and T_1 in plant height (25 DAS), 80.14 cm and 76.12 cm in T_8 and T_1 in plant height (50 DAS), 119.43 cm and 99.03 cm in T_8 and T_1 (75 DAS), 19.66 and 16.66 in T_8 and T_1 in no. of fruits per plant, 12.71 cm and 10.66 cm in T_8 and T_1 in fruit length of okra.

Keywords: Okra, organic manures, yield

Introduction
In recent years, because of awareness among human population about the Earth's capability to support enough crop yields to sustain the world's growing population much has been written about impact on soil quality in relation to food security (Lal and Stewart 2010) [5]. In the context of this brief discussion of organic fertilizers and soil health, it is important to put the global situation with respect to food availability. The food balance sheets prepared by the United Nations Food and Agricultural Organization (FAO) show that more than 99.7% of human food (calories) comes from the terrestrial environment, i.e., agricultural land (Pimentel and Wilson 2004) [7] and much efforts are required to sustain the production and soil health. With this regard, organics come as a savior in soil sustainability and productivity concept. Okra (Abelmoschus esculentus) which is an important summer vegetable which belongs to family Malvaceae (Maurya *et al*., 2013) [6]. Okra responds very well to organic manure application and is an efficient in fertilizer use which is the key to its higher growth and yield (Buob, 2008; Kumar, 2019) [3].

Material and Method
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.

Experimental details

The experiment consisted of following 10 treatments:

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

*Blanket application of FYM @10 tonne ha^{-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

Data collection
There were altogether 30 plants in each plot. There were 18 border plants and 12 inner plants. Out of the 12 inner plants, 5 plants were sampled by using randomizer application and the data were collected on the following parameters.
Per fruit weight
Fruit Weight per plant
Crop yield
Seeds per fruit
Total seed yield
Seed yield per plant
Root Volume
Root Length
Plant Height 25 DAS
Plant Height 50 DAS
Plant Height 75 DAS
No. of fruits per plant
Fruit Length

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.

Results
Effect of manures on okra growth parameters
Per fruit weight of Okra
During 1st year of experiment, significant improvement in per fruit weight with organic manure application was observed in Okra as compared to control (Table 1). In year 2016, the maximum weight per fruit observed was 10.19 g in T_8 and minimum of 9.21 g in T_1. However; T_8 was at par with T_7. Also in individual applications the T_4 performance with value 9.91 g was better as compared to T_2, T_3 and T_5 and was at par with T_6, T_9 and T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 10.19 g was noticed.

Table 1: Effect of organic manures on per fruit weight (g) in okra

Treatment	2016	2017	Mean
T1: Control	9.21^{a}	11.05^{a}	10.13^{a}
T2: FYM	9.43^{ab}	11.32^{ab}	10.38^{ab}
T3: VC	9.78^{cd}	11.74^{cd}	10.76^{cd}
T4: PM	9.91^{de}	11.89^{de}	10.90^{de}
T5: NC	9.58^{bc}	11.50^{bc}	10.55^{bc}
T6: FYM + PM	10.33^{de}	12.04^{de}	11.03^{de}
T7: FYM + NC	10.14^{e}	12.17^{e}	11.16^{e}
T8: VC + PM	10.19^{e}	12.23^{e}	11.21^{e}
T9: VC + NC	9.94^{de}	11.93^{de}	10.94^{de}
T10: NC + PM	10.08^{de}	12.10^{de}	11.09^{de}

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

In consecutive year 2017, again significant effect of treatments on fruit weight was observed. Maximum and minimum value identified was 12.23 g and 11.05 g in T_8 and T_1. However; T_8 was at par with T_7. In individual treatment, the T_4 performed well as highest value observed was 11.89 g which was also at par with T_6, T_9 and T_{10}. In combination context, the finest performance was observed in T_8 which depicted highest fruit weight of 12.23 g.
Similarly, mean values followed the same pattern as above. The maximum value 11.21 g was observed in T_8 and minimum was 10.13 g in T_1. Similarly, T_8 was at par with T_7 and T_4 was at par with T_6, T_9 and T_{10}.

Fruit Weight per plant
During 1st year of experiment, significant improvement in fruit weight per plant was observed in Okra as compared to control. (Table 2) In year 2016, the maximum weight per fruit observed was 173.31 g in T_8 and minimum observed was 135.08 g in T_1. Also in individual applications the T_4 performance with value 150.87 g was better as compared to T_2, T_3 and T_5 and was at par with T_9 and T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 173.31 g was noticed. Similarly, T_2 was found at par with T_3.

Table 2: Effect of organic manures on per fruit weight per plant (g) in okra

Treatment	2016	2017	Mean
T1: Control	135.08^{a}	186.42^{a}	160.75^{a}
T2: FYM	147.78^{abc}	203.94^{abc}	175.86^{abc}
T3: VC	146.76^{abc}	202.52^{abc}	174.64^{abc}
T4: PM	150.87^{bcd}	211.38^{abc}	181.12^{abc}
T5: NC	143.90^{ab}	198.58^{ab}	171.24^{ab}
T6: FYM + PM	167.22^{cd}	230.77^{cd}	198.99^{cd}
T7: FYM + NC	165.74^{cd}	228.72^{cd}	197.23^{cd}
T8: VC + PM	173.31^{d}	239.17^{d}	206.24^{d}
T9: VC + NC	159.28^{bcd}	219.81^{bcd}	189.54^{bcd}
T10: NC + PM	161.36^{bcd}	222.68^{bcd}	192.02^{bcd}

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 239.17 g and 186.42 g in T_8 and T_1. However, T_8 was at par with T_7. In individual treatment, the T_4 performed well as highest value notified was 211.38 g which was also at par with T_9 and T_{10}. In combination context, the finest performance was observed in T_8 which depicted highest weight of 239.17 g.
Similarly mean values followed the same pattern as above. The maximum value of 206.24 g was observed in T_8 and minimum of 160.75 g in T_1. Similarly, T_2 was found to be at par with T_3 and T_4 and T_9 was at par with T_{10}.

Crop yield: Okra

During 1st year of experiment, significant improvement in crop yield was observed in Okra as compared to control (Table 3). In year 2016, the maximum yield observed was 135.49 q ha^{-1} in T_8 and minimum observed was 105.87 q ha^{-1} in T_1. Also in individual applications the T_4 performance with value 134.78 q ha^{-1} was better as compared to T_2, T_3 and T_5 and was at par with T_8. In combination of manures, the best performing treatment was T_8 in which the highest value of 135.49 q ha^{-1} was noticed. Similarly, T_{10} was found to be at par with T_6 and T_3. Also, T_7 was found at par with T_9.

Table 3: Effect of organic manures on per fruit yield (quintals ha^{-1}) of okra

Treatment	2016	2017	Mean
T1: Control	105.87[a]	111.03[a]	108.45[a]
T2: FYM	120.86[b]	130.67[b]	125.77[b]
T3: VC	131.02[e]	133.95[c]	132.49[d]
T4: PM	134.78[f]	139.29[e]	137.04[f]
T5: NC	126.52[c]	131.06[b]	128.80[c]
T6: FYM + PM	131.08[e]	141.02[e]	136.06[ef]
T7: FYM + NC	129.03[d]	135.27[cd]	132.15[d]
T8: VC + PM	135.49[f]	146.32[f]	140.91[g]
T9: VC + NC	129.15[d]	136.74[d]	132.95[d]
T10: NC + PM	131.30[e]	139.13[e]	135.22[e]

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 146.32 q ha^{-1} and 111.03 q ha^{-1} in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 139.29 q ha^{-1}; however, T_4 was at par with T_6 and T_{10}. Also, T_5 was at par with T_2. In combination of manures, the finest performance was observed in T_8 which depicted highest yield of 239.17 q ha^{-1}.

Similarly, mean values followed the same pattern as above. The maximum value of 140.91 q ha^{-1} was observed in T_8 and minimum of 108.45 q ha^{-1} in T_1. T_3 was found at par with T_7 and T_9.

Seeds per fruit in Okra

During 1st year of experiment, significant improvement in seeds per fruit was observed in Okra as compared to control (Table 4). In year 2016, the maximum value observed was 36.66 in T_8 and minimum observed was 30.33 in T_1. Also in individual applications the T_4 performance with value 34.00 was better as compared to T_2, T_3 and T_5. In combination of manures, the best performing treatment was T_8 in which the highest value 36.66 was noticed. Similarly, T_{10} was found at par with T_6, T_7 and T_9. Also, T_5 was found at par with T_2.

Table 4: Effect of organic manures on seeds per fruit in okra

Treatment	2016	2017	Mean
T1: Control	30.33[a]	33.33[a]	32.33[a]
T2: FYM	32.00[ab]	35.00[bc]	34.00[ab]
T3: VC	33.33[bc]	36.33[bc]	35.33[bc]
T4: PM	34.00[bcd]	37.33[bcd]	36.00[bcd]
T5: NC	32.00[ab]	35.00[ab]	34.00[ab]
T6: FYM + PM	34.66[cd]	38.33[cde]	36.66[cd]
T7: FYM + NC	35.66[cd]	39.66[de]	37.66[cd]
T8: VC + PM	36.66[d]	40.66[e]	38.66[d]
T9: VC + NC	35.66[cd]	39.66[de]	37.66[cd]
T10: NC + PM	36.00[cd]	40.00[de]	38.00[cd]

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 40.66 and 33.33 in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 37.33. In combination context, the finest performance was observed in T_8 which depicted highest value of 40.66. T_{10} was found at par with T_6, T_7 and T_9. Also, T_5 was found at par with T_2.

Similarly, mean values followed the same pattern as above. The maximum value 38.66 was observed in T_8 and minimum was 32.33 g in T_1. T_{10} was found at par with T_6, T_7 and T_9. Also, T_5 was found at par with T_2.

Total seed yield in Okra

During 1st year of experiment, significant improvement in total seed yield was observed in Okra as compared to control (Table 5). In year 2016, the maximum value observed was 21.93 q ha^{-1} in T_8 and minimum observed was 19.85 q ha^{-1} in T_1. Also in individual applications the T_4 performance with value 21.10 q ha^{-1} was better and was also at par with T_6, T_7, T_9 and T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 21.93 q ha^{-1} was noticed. Also, T_5 was found at par with T_2.

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 26.32 q ha^{-1} and 24.58 q ha^{-1} in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 25.12 q ha^{-1} which was at par with T_6, T_7, T_9 and T_{10}. In combination context, the finest performance was observed in T_8 which depicted highest yield of 26.32 q ha^{-1}. Also, T_5 was found at par with T_2.

Table 5: Effect of organic manures on total seed yield (quintals ha^{-1}) in okra

Treatment	2016	2017	Mean
T1: Control	19.85[a]	23.82[a]	21.84[a]
T2: FYM	20.48[ab]	24.58[ab]	22.54[ab]
T3: VC	20.95[abc]	25.14[abc]	23.05[abc]
T4: PM	21.10[bc]	25.12[bc]	23.11[bc]
T5: NC	20.49[ab]	24.59[ab]	22.54[ab]
T6: FYM + PM	21.76[bc]	26.11[bc]	23.94[bc]
T7: FYM + NC	21.29[bc]	25.55[bc]	23.42[bc]
T8: VC + PM	21.93[c]	26.32[c]	24.13[c]
T9: VC + NC	21.57[bc]	25.89[bc]	23.70[bc]
T10: NC + PM	21.12[bc]	25.35[bc]	23.24[bc]

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

Similarly, mean values followed the same pattern as above. The maximum value 24.13 q ha^{-1} was observed in T_8 and minimum was 21.84 q ha^{-1} in T_1. T_4 was at par with T_6, T_7, T_9 and T_{10}. Also, T_5 was found at par with T_2.

Seed yield per plant in Okra

During 1st year of experiment, significant improvement in seed yield per plant was observed in Okra as compared to control (Table 6). In year 2016, the maximum value observed was 345.50 g in T_8 and minimum observed was 239.48 g in T_1. Also in individual applications the T_4 performance with value 306.65 g was better and was also at par with T_6, T_7 and T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 345.50 g was noticed. Also, T_9 was found at par with T_2.

Table 6: Effect of organic manures on seed yield per plant (g) in okra

Treatment	2016	2017	Mean
T1: Control	239.48^{a}	562.50^{a}	400.99^{a}
T2: FYM	272.040^{abc}	634.18^{abc}	453.11^{abc}
T3: VC	292.203^{bc}	632.50^{abc}	462.35^{abc}
T4: PM	306.65^{cd}	702.91^{bcd}	504.78^{bcd}
T5: NC	252.12^{ab}	607.62^{ab}	429.87^{ab}
T6: FYM + PM	306.77^{cd}	730.74^{cd}	518.76^{cd}
T7: FYM + NC	317.36^{cd}	736.65^{cd}	527.00^{cd}
T8: VC + PM	345.50^{d}	789.36^{d}	567.43^{d}
T9: VC + NC	285.16^{abc}	721.89^{cd}	503.52^{bc}
T10: NC + PM	310.90^{cd}	729.48^{cd}	520.19^{cd}

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 789.36 g and 562.50 g in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 702.91 g. Similarly, T_{10} was found at par with T_6, T_7 and T_9. In combination context, the finest performance was observed in T_8 which depicted highest yield of 789.36 g. Also, T_3 was found at par with T_2.

Similarly, mean values followed the same pattern as above. The maximum value 567.43 g was observed in T_8 and minimum was 400.99 g in T_1. T_9 was found at par with T_6 and T_7. Also, T_3 was found at par with T_2.

Root Volume of Okra

During 1st year of experiment, significant improvement in root volume was observed in Okra as compared to control (Table 7). In year 2016, the maximum value observed was 30.03 cm^3 in T_8 and minimum observed was 20.71 cm^3 in T_1. Also in individual applications the T_4 performance with value 25.92 cm^3 was better and was also at par with T_8. In combination of manures, the best performing treatment was T_8 in which the highest value 30.03 cm^3 was noticed. Also, T_7 was found at par with T_5 and T_6.

Table 7: Effect of organic manures on root volume (cm^3) in okra

Treatment	2016	2017	Mean
T1: Control	20.71^{a}	21.75^{a}	21.23^{a}
T2: FYM	23.12^{b}	24.27^{b}	23.70^{b}
T3: VC	23.84^{bc}	25.03^{bc}	24.44^{bc}
T4: PM	25.92^{d}	27.22^{d}	26.57^{d}
T5: NC	24.62^{c}	25.85^{c}	25.24^{c}
T6: FYM + PM	24.29^{c}	25.51^{c}	24.90^{c}
T7: FYM + NC	24.75^{c}	25.99^{c}	25.37^{c}
T8: VC + PM	30.03^{f}	31.53^{f}	30.78^{f}
T9: VC + NC	25.73^{d}	27.02^{d}	26.37^{d}
T10: NC + PM	28.63^{e}	30.09^{e}	29.83^{e}

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 31.53 cm^3 and 21.75 cm^3 in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 27.22 cm^3 and was also at par with T_8. In combination context, the finest performance was observed in T_8 which depicted highest value of 31.53 cm^3. Also, T_7 was found at par with T_5 and T_6.

Similarly, mean values followed the same pattern as above. The maximum value 30.78 cm^3 was observed in T_8 and minimum was 21.23 cm^3 in T_1. T_4 was found at par with T_8. Also, T_7 was found at par with T_5 and T_6.

Root Length of Okra

During 1st year of experiment, significant improvement in root length was observed in Okra as compared to control (Table 8). In year 2016, the maximum value observed was 15.36 cm in T_8 and minimum observed was 10.60 cm in T_1. Also in individual applications the T_4 performance with value 13.26 cm was better and was also at par with T_9. In combination of manures, the best performing treatment was T_8 in which the highest value 15.36 cm was noticed. Also, T_7 was found at par with T_5 and T_6.

Table 8: Effect of organic manures on root length (cm) in okra

Treatment	2016	2017	Mean
T1: Control	10.60^{a}	10.81^{a}	10.71^{a}
T2: FYM	11.83^{b}	12.07^{b}	11.95^{b}
T3: VC	12.20^{bc}	12.44^{bc}	12.32^{bc}
T4: PM	13.26^{d}	13.53^{d}	13.40^{d}
T5: NC	12.60^{c}	12.85^{c}	12.73^{c}
T6: FYM + PM	12.43^{c}	12.68^{c}	12.55^{c}
T7: FYM + NC	12.66^{c}	12.92^{c}	12.79^{c}
T8: VC + PM	15.36^{f}	15.69^{f}	15.53^{f}
T9: VC + NC	13.16^{d}	13.42^{d}	13.29^{d}
T10: NC + PM	14.66^{e}	14.96^{e}	14.81^{e}

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 15.69 cm and 13.53 cm in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 13.53 cm and was also at par with T_9. In combination context, the finest performance was observed in T_8 which depicted highest value of 15.69 cm. Also, T_7 was found at par with T_5 and T_6.

Similarly mean values followed the same pattern as above. The maximum value 15.53 cm was observed in T_8 and minimum was 10.71 cm in T_1. T_4 was found at par with T_9. Also, T_7 was found at par with T_5 and T_6.

Plant Height 25 DAS in Okra

During 1st year of experiment, significant improvement in plant height was observed in Okra 25 DAS as compared to control (Table 9). In year 2016, the maximum value observed was 36.90 cm in T_8 and minimum observed was 27.73 cm in T_1. Also in individual applications the T_4 performance with value 13.26 cm was better and was also at par with T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 36.90 cm was noticed. Also, T_7 was found at par with T_5 and T_3.

Table 9: Effect of organic manures on plant height 25 DAS (cm) in okra

Treatment	2016	2017	Mean
T1: Control	27.73^{a}	29.23^{a}	28.48^{a}
T2: FYM	30.20^{b}	32.30^{b}	31.25^{b}
T3: VC	32.46^{c}	34.96^{e}	33.71^{d}
T4: PM	34.63^{e}	37.43^{fg}	36.03^{e}
T5: NC	31.66^{c}	33.46^{c}	32.56^{c}
T6: FYM + PM	35.83^{f}	37.93^{f}	36.88^{f}
T7: FYM + NC	31.63^{c}	33.03^{c}	32.33^{c}
T8: VC + PM	36.90^{g}	40.00^{g}	38.45^{g}
T9: VC + NC	32.50^{d}	34.20^{d}	33.35^{d}
T10: NC + PM	34.63^{e}	36.83^{f}	35.73^{e}

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 40.00 cm and 29.23 cm in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 37.43 cm. In combination context, the finest performance was observed in T_8 which depicted highest value of 40.00 cm. Also, T_7 was found at par with T_5. Similarly, T_{10} was found at par with T_6.

Similarly, mean values followed the same pattern as above. The maximum value 38.45 cm was observed in T_8 and minimum was 36.03 cm in T_1. T_4 was found at par with T_{10}. Also, T_7 was found at par with T_5. In similar pattern, T_9 was found at par with T_3.

Plant Height 50 DAS in Okra

During 1st year of experiment, significant improvement in plant height was observed in Okra 50 DAS as compared to control (Table 10). In year 2016, the maximum value observed was 73.53 cm in T_8 and minimum observed was 68.83 cm in T_1. Also in individual applications the T_4 performance with value 71.77 cm was better. In combination of manures, the best performing treatment was T_8 in which the highest value 73.53 cm was noticed. Also, T_9 was found at par with T_3, T_6 and T_7. Similarly, T_5 was found at par with T_2.

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 80.14 cm and 76.12 cm in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 78.23 cm. In combination context, the finest performance was observed in T_8 which depicted highest value of 80.14 cm. Also, T_9 was found at par with T_3, T_6 and T_7. Similarly, T_5 was found at par with T_2.

Table 10: Effect of organic manures on plant height 50 DAS (cm) in okra

Treatment	2016	2017	Mean
T1: Control	69.83^{a}	76.12^{a}	72.97^{a}
T2: FYM	70.87^{ab}	77.24^{ab}	74.06^{ab}
T3: VC	71.33^{abc}	77.76^{abc}	74.54^{abc}
T4: PM	71.77^{abcd}	78.23^{abcd}	75.00^{abcd}
T5: NC	71.00^{ab}	77.39^{ab}	74.20^{ab}
T6: FYM + PM	72.06^{bcd}	78.55^{bcd}	75.30^{bcd}
T7: FYM + NC	71.99^{bcd}	78.47^{bcd}	75.23^{bcd}
T8: VC + PM	73.53^{d}	80.14^{d}	76.840^{d}
T9: VC + NC	72.90^{bcd}	79.46^{bcd}	76.18^{bcd}
T10: NC + PM	73.63^{cd}	79.96^{cd}	76.66^{cd}

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

Similarly, mean values followed the same pattern as above. The maximum value 76.84 cm was observed in T_8 and minimum was 72.97 cm in T_1. Also, T_9 was found at par with T_3, T_6 and T_7. Similarly, T_5 was found at par with T_2.

Plant Height 75 DAS in Okra

During 1st year of experiment, significant improvement in plant height was observed in Okra 75 DAS as compared to control (Table 11). In year 2016, the maximum value observed was 116.33 cm in T_8 and minimum observed was 97.53 cm in T_1. Also in individual applications the T_4 performance with value 114.53 cm was better and was found at par with T_6 and T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 116.33 cm was noticed. Also, T_9 was found at par with T_3 and T_7.

Table 11: Effect of organic manures on plant height 75 DAS (cm) in okra

Treatment	2016	2017	Mean
T1: Control	97.53^{a}	99.03^{a}	73.13^{a}
T2: FYM	109.53^{c}	111.63^{c}	85.66^{c}
T3: VC	112.30^{d}	114.80^{d}	88.26^{d}
T4: PM	114.53^{e}	117.33^{e}	90.46^{e}
T5: NC	107.00^{b}	108.80^{b}	84.33^{b}
T6: FYM + PM	114.96^{e}	117.06^{e}	90.68^{e}
T7: FYM + NC	113.20^{d}	114.60^{d}	88.78^{d}
T8: VC + PM	116.33^{f}	119.43^{f}	92.81^{f}
T9: VC + NC	112.26^{d}	113.96^{d}	88.43^{d}
T10: NC + PM	114.53^{e}	116.73^{e}	90.16^{e}

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 119.43 cm and 99.03 cm in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 117.33 cm and was found at par with T_6 and T_{10}. In combination context, the finest performance was observed in T_8 which depicted highest value of 119.43 cm. Also, T_9 was found at par with T_3 and T_7.

Similarly, mean values followed the same pattern as above. The maximum value 92.81 cm was observed in T_8 and minimum was 73.13 cm in T_1. Also, T_4 was found at par with T_6 and T_{10}. Similarly, T_9 was found at par with T_3 and T_7.

No. of fruits per plant

During 1st year of experiment, significant improvement in fruits per plant was observed in Okra as compared to control (Table 12). In year 2016, the maximum value observed was 17.00 in T_8 and minimum observed was 14.66 in T_1. Also in individual applications the T_4 performance with value 16.33 was better and was found at par with T_2, T_3, T_5, T_6, T_7, T_9 and T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 17.00 was noticed.

Table 12: Effect of organic manures on number of fruits per plant in okra

Treatment	2016	2017	Mean
T1: Control	14.66^{a}	16.66^{a}	15.77^{a}
T2: FYM	15.66^{bc}	17.66^{a}	16.84^{ab}
T3: VC	15.00^{bc}	17.00^{a}	16.12^{ab}
T4: PM	16.33^{bc}	18.66^{a}	17.56^{ab}
T5: NC	15.00^{bc}	17.00^{a}	16.12^{ab}
T6: FYM + PM	16.66^{bc}	19.33^{a}	17.92^{ab}
T7: FYM + NC	16.33^{bc}	18.66^{a}	17.56^{ab}
T8: VC + PM	17.00^{c}	19.66^{a}	18.27^{b}
T9: VC + NC	16.00^{bc}	18.33^{a}	17.20^{ab}
T10: NC + PM	16.22^{bc}	18.33^{a}	17.20^{ab}

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

In consecutive year 2017, no significant effect of treatments was observed. Maximum and minimum value identified was 19.66 and 16.66 in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 18.66. In combination context, the finest performance was observed in T_8 which depicted highest value of 19.66.

In mean values, the maximum value 18.27 was observed in T_8 and minimum was 15.77 in T_1. Also, T_4 was found at par with T_2, T_3, T_5, T_6, T_7, T_9 and T_{10}.

Fruit Length of Okra

During 1st year of experiment, significant improvement in fruit length was observed in Okra as compared to control (Table 13). In year 2016, the maximum value observed was 9.42 cm in T_8 and minimum observed was 7.85 cm in T_1. Also in individual applications the T_4 performance with value 8.76 cm was better and was found at par with T_3, T_6, T_7 and T_{10}. In combination of manures, the best performing treatment was T_8 in which the highest value 9.42 cm was noticed. Also, T_5 was found at par with T_1.

Table 13: Effect of organic manures on fruit length (cm) in okra.

Treatment	2016	2017	Mean
T1: Control	7.85^{a}	10.66^{a}	9.28^{a}
T2: FYM	7.99^{ab}	10.99^{ab}	9.49^{ab}
T3: VC	8.49^{abc}	11.47^{abc}	9.98^{abc}
T4: PM	8.76^{abc}	11.83^{abc}	10.29^{abc}
T5: NC	7.87^{a}	10.62^{a}	9.24^{a}
T6: FYM + PM	8.84^{abc}	11.94^{abc}	10.39^{abc}
T7: FYM + NC	8.89^{abc}	12.01^{abc}	10.45^{abc}
T8: VC + PM	9.42^{c}	12.71^{c}	11.07^{c}
T9: VC + NC	9.01^{bc}	12.17^{bc}	10.59^{bc}
T10: NC + PM	8.62^{abc}	11.64^{abc}	10.13^{abc}

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

In consecutive year 2017, again significant effect of treatments was observed. Maximum and minimum value identified was 12.71 cm and 10.66 cm in T_8 and T_1. In individual treatment, the T_4 performed well as highest value notified was 11.83 cm and was found at par with T_3, T_6, T_7 and T_{10}. In combination context, the finest performance was observed in T_8 which depicted highest value of 12.71 cm.

Similarly, mean values followed the same pattern as above. The maximum value 11.07 cm was observed in T_8 and minimum was 9.28 cm in T_1. Also, T_4 was found at par with T_3, T_6, T_7 and T_{10}.

Discussion

Okra Growth Parameters

The per fruit weight, fruit weight per plant, seeds per fruit, total seed yield, seed yield per plant, root volume and length increased significantly in comparison to control and high values were observed in poultry manure and combinations which shows that poultry manure was available in the best form for easy absorption by the plant roots, hence there was a boost in the morphological growth of the plant. The results of morphological parameters like plant height which is genetically controlled character however showed significant improvement and this corroborated with the findings of Ajari *et al.* (2003) [1] in okra production in which they reported that organic manure could increase plant height of crops when compared with other sources of manures. The increase in number of leaves per plant, fruit length and plant girth with organic fertilizer application stressed the importance of organic manures during the vegetative growth of plants (Tindall, 1992) [10]. The increase in yield of okra can be attributed to poultry manure and vermicompost application and combination of both because of its easy solubilization effect of released plant nutrients having impact on improved nutrient availability, infiltration rate and water holding capacity of the soil. The results recorded were in agreement with the findings of Sanwal *et al.* (2007) [9] in turmeric (*Curcuma longa*) and by Premsekhar and Rajashree (2009) [8] in okra (*Abelmoscus esculentus*) in which they reported that higher yield response of crops due to organic manure application could be attributed to improved physical properties like reduced bulk density and biological properties which may include improvement in microbial and enzymatic status of the soil resulting in better supply of nutrients to plants. This yield boost also confirms findings of Akande *et al.* (2003) [2] that supply of organic manures could improve slightly acidic tropical soil to improve crop yield and production. The height of the okra studied is perhaps more of genetic than an environmental trait. The increase in number of leaf per plant with organic manure application in treatments related its importance to the improved vegetative growth of crop plants (Tindall, 1992) [10]. The improvement in other parameters like no. of fruits per plant, fruit length can be credited to the nutrients supplied by the different manure sources might have been diverted to increased vegetative growth. Also, due to the bulkiness of manures and higher amount of nutrients already present in the soil may contribute to this phenomenon.

Conclusion

In the experiment, applications of organic manures have a significant impact on the Per fruit weight of Okra, Fruit Weight per plant, Crop yield, Seeds per fruit, Total seed yield, Seed yield per plant, Root Volume, Root Length, Plant Height 25 DAS, Plant Height 50 DAS, Plant Height 75 DAS, No. of fruits per plant and Fruit Length. 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 positive impact on growth and yield of Okra.

References

1. Ajari O, Tsado LEK, Oladiran JA, Salako EA. Plant height and fruit yield of okra as affected by field application of fertilizer and organic matter in Bida, Nigeria. The Nigerian Agricultural Journal. 2003; 34:74-80.
2. Akande MO, Oluwatoyinbo FI, Adediran JA, Buari KW, Yusuf IO *et al* Soil amendments affect the release of P from rock phosphate and the development and yield of okra. Journal of Vegetable Crop Production. 2003; 9(2):3-9.
3. Buob T. Fertilizing the Organic Garden. University of New Hampshire Cooperative Extension, 2008; 1-4.
4. Kumar V, Chopra AK, Srivastava S, Singh J, Thakur RK. Irrigating okra with secondary treated municipal wastewater: Observations regarding plant growth and soil characteristics. International Journal of Phytoremediation. 2017; 19(5): 490-499. https://doi.org/10.1080/15226514.2016.1244169
5. Lal R, Stewart BA. Food security and soil quality. CRC Press, Boca Raton, Fl. USA, 2010.
6. Maurya RP, Bailey JA, Chandler JS. Impact of plant spacing and picking interval on the growth, fruit quality and yield of okra (*Abelmoschus esculentus* L. Moench). American Journal of Agriculture and Forestry. 2013; 1(4):48-54.
7. Pimentel D, Wilson A. World population, agriculture and malnutrition. World Watch, September/October. 2004; 22-25.
8. Premsekhar M, Rajashree V. Influence of organic manure on growth, yield and quality of okra. American Eurasian Journal of Sustainable Agriculture. 2009; 3(1):6-8.

9. Sanwal SK, Lakminarayana K, Yadav RK, Rai N, Yaldav DS, Mousumi B. Effect of organic manures on soil fertility, growth, physiology, yield and quality of turmeric. Indian Journal of Horticulture. 2007; 64(4):444-449.
10. Tindall HD. Vegetables in the Tropics. Macmillan Press Ltd, London, 1992; 533.