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Research Article

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Effect of organic manures and biofertilizers on growth and yield of watermelon (*Citrullus lanatus* Thunb.)

Arvind M. Sonkamble*, Aditya Mapari, Surendra R.Patil and Vishal D. Tayade
Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (M.S.) India
Corresponding author e-mail: arvind.pdkv@gmail.com
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ABSTRACT
A field experiment entitled "Effect of organic manures and biofertilizers on growth and yield of watermelon *(Citrullus lanatus* Thunb.)" was conducted at Instructional Farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during summer season of 2019 - 2020. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments viz.T1 (Farm Yard Manure @ 40 t ha^{-1}), T2 (Compost (NADEP) @ 18 t ha^{-1}), T3 (Vermicompost @ 13.5 t ha^{-1}), T4 (Poultry manure @ 6.6 t ha^{-1}) and T5 (Farm Yard Manure @ 40 t ha^{-1} + Soil application of *Azotobacter*+ PSB @ 5 kg ha^{-1} each), T6 (Compost (NADEP) @18 t ha^{-1} + Soil application of *Azotobacter*+ PSB @ 5 kg ha^{-1} each), T7 (Vermicompost @ 13.5 t ha^{-1} + Soil application of *Azotobacter*+ PSB @ 5 kg ha^{-1} each), T8 (Poultry manure @ 6.6 t ha^{-1} + Soil application of *Azotobacter*+ PSB @ 5 kg ha^{-1} each), T9 Control (RDF- 200:100:100 NPK Kg/ha). The various observations in respect of vine growth and yield of watermelon were recorded periodically. From the present findings, it was observed that the growth parameters in respect length of main vine, number of leaves, number of primary branches, chlorophyll index, days for first female flower appearance, internodal distance and male female ratio were found better with Vermicompost @ 13.5 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each. Yield parameters viz days required for edible maturity, number of fruits per vine, average fruit weight kg, fruit yield kg per vine and fruit yield per ha^{-1} (tons) were found to be maximum with Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each.
Keywords: Watermelon, Compost, Poultry manure, Farm yard manure, Azotobacter, PSB, Growth, Yield.

INTRODUCTION

Cucurbits were among the first group of plants used by man. They include dessert salad, pickling and culinary types. Among the dessert type, watermelon is the most important crop in the tropical regions of the world. Wa termelon (*Citrullus lanatus* Thunb.) is an important cucurbitaceous vegetable. It is known as tarbuj, tarmuj, kalinda and kalingad in different parts of India. An excellent desert fruit, it is relished by rich as well as poor. The fruit contain 92% water, 0.2% protein, 0.3% minerals, and 7% carbohydrate in 100 g edible flesh. The fruit juice makes an excellent refreshing and cooling beverage. Watermelon is a rich source of citrulline, an amino acid that can be metabolized to arginine, an essential amino acid. Watermelon (*Citrullus lanatus* Thunb.) is believed to have originated in Africa and spread to other parts of world. In India current status of area is 110 mha. With production 2787 MT (NHB database 2019-20). In India Uttar Pradesh is first in area and production and Maharashtra is with area 6.12 mha and at 10^{th} in production i.e 46.99 MT.

Organic manures are effective source of nitrogen for sustainable crop production, the manure application enhances soil productivity, increases the soil organic carbon content, soil micro-organisms, improves soil crumb structure, the nutrient status of the soil and enhances crop growth and yield. In order to improve soil health and to keep the soil sustainable for a long-time addition of organic sources play an important role. In this context biofertilizers which contain ecofriendly, agriculturally beneficial microorganisms help in enriching the soil with nutrients to maintain the soil fertility and supplies essential nutrients for crop growth. Organic manures are essential for obtaining optimum production, productivity and good quality of Watermelon. Amongst the cultural practices organic manures has a greater significance for better productivity of watermelon. Different organic manures may have better effect on growth, yield and quality of watermelon. Biofertilizers may result in more vegetative growth and increases the availability of soil nutrients. However due to suitable combination of organic manures and biofertilizers may have better effect on yield per unit area may be increased. Thus, application of different organic manures and biofertilizers influences growth per unit

area under same variety which results in variation in growth and yield of watermelon.

Hence considering above facts the present investigation is aimed to find out a suitable combination of organic manures and biofertilizers, their effect on the growth and yield of organic watermelon cultivation.

MATERIALS AND METHODS

The field experiment entitled "Effect of organic manures and biofertilizers on growth and yield of watermelon *(Citrullus lanatus* Thunb.)" was conducted at Instructional Farm, Department of Vegetable Science, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during summer season of 2019 - 2020. The experiment was laid out in Randomized Block Design (RBD) with three replications and nine treatments viz.T1 (Farm Yard Manure @ 40 t ha^{-1}), T2 (Compost (NADEP) @ 18 t ha^{-1}), T3 (Vermicompost @ 13.5 t ha^{-1}), T4 (Poultry manure @ 6.6 t ha^{-1}) and T5 (Farm Yard Manure @ 40 t ha^{-1} + Soil application of *Azotobacter*+ PSB @ 5 kg ha^{-1} each), T6 (Compost (NADEP) @18 t ha^{-1} + Soil application of *Azotobacter*+ PSB @ 5 kg ha^{-1} each), T7 (Vermicompost @ 13.5 t ha^{-1} + Soil application of *Azotobacter*+ PSB @ 5 kg ha^{-1} each), T8 (Poultry manure @ 6.6 t ha^{-1} + Soil application of *Azotobacter*+ PSB @ 5 kg ha^{-1} each), T9 Control (RDF- 200:100:100 NPK Kg/ha).

The data obtained on various characters were statistically analyzed by Randomized Block Design by Panse and Sukhatme (1967). Critical difference for examining treatment means for their significance was calculated at 5 % level of significance.

RESULTS AND DISCUSSION

Length of main vine (cm) as influenced by organic manures and biofertilizers in watermelon:

The data regarding length of main vine (cm) as influenced by organic manures and biofertilizers were recorded at 30, 60, 90 DAT presented in table no. 1 The growth parameters like length of main vine was maximum throughout the growth period (58.80 cm, 176.63 cm and 246.17 cm at 30, 60, 90 DAT respectively) in treatment T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas minimum length of main vine was recorded (47.19 cm, 159.98 cm and 229.94 cm) in T_4 (Poultry manure @ 6.6 t ha^{-1}) at 30, 60, 90 DAT respectively. The results of present investigation are in agreement with the findings of Tahir *et al.* (2018) in watermelon, Kucinkas *et al*. (2000), Atiyeh *et al.* (2002) and Bindiya *et al.* (2014) in cucumber.

Number of leaves as influenced by organic manures and biofertilizers:

The data presented in table no. 1 indicated that, the differences in number of leaves influenced by organic manures and biofertilizers were found to be significant at all the stages of growth i.e., 30, 60 and 90 DAT. At 30 DAT, maximum number of leaves per vine (30.37, 152.86 and 242.67) were observed in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each) at 30, 60 and 90 DAT respectively. Whereas, minimum number of leaves per vine (26.16, 140.20 and 229.53) were observed in treatment T_1 (Farm Yard Manure @ 40 t ha^{-1}). It is well evident from the data that, use of vermicompost produced significantly a greater number of leaves per vine than other manures. This might be due to the fact that Vermicompost gave an opportunity for more availability of nutrients, moisture for development of a greater number of leaves. Similar results were also reported by Tahir *et al.* (2018) in watermelon, Kucinkas *et al*. (2000), Atiyeh *et al.* (2002) and Bindiya *et al.* (2014) in cucumber.

Number of primary branches influenced by organic manures and biofertilizers:

The data regarding number of primary branches as influenced by organic manures and biofertilizers were recorded and presented in table no. 1 maximum number of primary branches (3.79, 6.60 and 8.89) were observed in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each) at 30, 60 and 90 DAT respectively. Whereas, minimum number of primary branches (2.33, 4.60 and 6.64) were observed in T_4 (Poultry manure @ 6.6 t ha^{-1}). These results are in the line with the findings of Tahir *et al.* (2018), Bindiya *et al*. (2014) in cucumber.

Internodal distance (cm) influenced by organic manures and biofertilizers:

The data regarding internodal distance (cm) as influenced by organic manures and biofertilizers were recorded and presented in table no. 2 the minimum internodal distance (5.17cm) was observed in treatment T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas maximum internodal distance was observed (6.36 cm) in treatment T_4 (Poultry manure @ 6.6 t ha^{-1}) at 60 DAT respectively. These results are in the agreement with the findings of Anita and Elham (2015) in pumpkin.

Chlorophyll index influenced by organic manures and biofertilizers:

The data presented in table no. 2 indicated that, the differences in chlorophyll index of leaves as influenced by different organic manures and biofertilizers was found to be significant. The maximum chlorophyll index was observed (60.39 and 60.48) in treatment T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). at 45 and 60 DAT respectively. Whereas the minimum chlorophyll index (59.31 and 59.37) was observed in treatment T_1 (Farm Yard Manure @ 40 t ha^{-1}). It is observed from the data that chlorophyll index significantly maximum with Vermicompost + soil application of Azotobacter +PSB. These results are in accordance with the results reported by Tahir *et al.* (2018), Azarmi *et al*. (2009) in cucumber.

Table 1. Length of main vine (cm), number of leaves and number of primary branches as influenced by organic manures and biofertilizers in watermelon

Treatments	Length of main vine(cm)			Number of leaves			Number of primary branches		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_1- Farm Yard Manure @ 40t ha-1	48.40	164.40	230.60	26.16	140.20	229.53	2.66	4.90	6.91
T_2-Compost (NADEP) @ 18 t ha-1	49.68	165.48	230.68	27.22	143.86	232.40	2.70	5.22	6.98
T_3-Vermicompost @ 13.5 t ha-1	50.52	170.10	231.86	28.13	144.80	234.13	2.80	5.43	7.17
T_4-Poultry manure @ 6.6 t ha-1	47.19	159.98	229.94	27.02	141.93	231.80	2.33	4.60	6.64
T_5- Farm Yard Manure @ 40t ha-1 + soil application of Azotobacter +PSB @ 5kg ha-1 each	54.67	169.37	239.2	29.10	146.66	240.07	3.07	6.12	8.18
T_6- Compost (NADEP) @ 18 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	56.00	172.75	241.53	30.19	151.66	241.53	3.56	6.30	8.81
T_7- Vermicompost @ 13.5 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	58.80	176.63	246.17	30.37	152.86	242.67	3.79	6.60	8.89
T_8- Poultry manure @ 6.6 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	50.10	167.03	237.56	28.19	146.00	237.20	2.90	5.87	7.42
T_9-Control (RDF-200:100:100 NPK kg ha-1)	51.12	163.39	238.30	30.07	147.33	240.27	2.96	5.90	7.69
'F test'	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
S.E.(m)±	1.72	3.82	4.01	0.98	3.06	3.13	0.19	0.36	0.48
CD at 5 %	5.19	11.48	12.02	2.95	9.20	9.34	0.57	1.07	1.45

Table 2. Internodal distance (cm) 60 DAT, chlorophyll index (SPAD value), node at which first female flower appeared and days to first female flower appearance as influenced by organic manures and biofertilizers in watermelon.

Treatments	Internodal distance (cm)	Chlorophyll index (SPAD value)		Node at which first female flower appeared	Days to first female flower appearance
	60 DAT	45 DAT	60 DAT		
T_1- Farm Yard Manure @ 40t ha-1	6.29	59.31	59.37	10.88	40.69
T_2-Compost (NADEP) @ 18 t ha-1	6.13	59.78	59.83	10.21	40.34
T_3-Vermicompost @ 13.5 t ha-1	5.9	60.03	60.1	9.25	39.33
T_4-Poultry manure @ 6.6 t ha-1	6.36	59.73	59.81	9.74	39.74
T_5- Farm Yard Manure @ 40t ha-1 + soil application of Azotobacter +PSB @ 5kg ha-1 each	5.84	60.09	60.19	9.83	39.99
T_6- Compost (NADEP) @ 18 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	5.58	60.26	60.32	8.37	37.8
T_7- Vermicompost @ 13.5 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	5.17	60.39	60.48	7.6	37.72
T_8- Poultry manure @ 6.6 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	6.1	60.16	60.25	8.58	38.03
T_9-Control (RDF-200:100:100 NPK kg ha-1)	5.7	60.36	60.39	9.1	38.58
'F test'	Sig.	Sig.	Sig.	Sig.	Sig.
S.E.(m)±	0.24	0.19	0.21	0.6	0.65
CD at 5 %	0.72	0.57	0.63	1.8	1.94

Male female ratio influenced by organic manures and biofertilizers:

The data regarding to the male female flower ratio as influenced by organic manures and biofertilizers was recorded at flowering stage and presented in table no. 2 maximum male female ratio was observed (6.97) in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas minimum male female ratio was observed (4.57) in T_4 (Poultry manure @ 6.6 t ha^{-1}). These results are in the agreement with the findings of Anita and Elham (2015) in pumpkin.

Node at which first female flower appearance influenced by organic manures and biofertilizers.

The data regarding node at which first female flower appeared as influenced by organic manures and biofertilizers were recorded and presented in table no. 2 node at which first female flower appearance was observed (7.60) in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas first female flower appearance at longest node was observed (10.88) in T_1 (Farm Yard Manure @ 40 t ha^{-1}). These results are supported by the findings of Tahir

et al. (2018) in watermelon and Karuthamam *et al*. (1995) in pumpkin.

Days for first female flower appeared influenced by organic manures and biofertilizers:

The data regarding days for first female flower appearance as influenced by organic manures and biofertilizers were recorded and presented in table no. 2 minimum days for first female flower appeared was observed (37.72) in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas maximum days for first female flower appeared was observed (40.69) in T_1 (Farm Yard Manure @ 40 t ha^{-1}). These results are in agreement with the results of Tahir *et al.* (2018) in watermelon and Karuthamam *et al*. (1995) in pumpkin.

Effect of organic manures and biofertilizers on yield attributes of watermelon:

Days required for edible maturity as influenced by organic manures and biofertilizers in watermelon.

The data regarding days required for edible maturity as influenced by organic manures and biofertilizers was recorded and depicted in table no. 3 minimum days required for edible maturity (74.63) was recorded in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas, maximum days required for edible maturity (77.68) was recorded in T_1 (Farm Yard Manure @ 40 t ha^{-1}).

Number of fruits per vine as influenced by organic manures and biofertilizers in watermelon:

The data regarding number of fruits per vine as influenced by organic manures and biofertilizers was recorded and presented in table no. 3 maximum number of fruits vine (3.71) was recorded in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas, minimum number of fruits vine (2.93) was recorded in T_1 (Farm Yard Manure @ 40 t ha^{-1}). Similar results were found with the findings of Chinanshuk *et al*. (2016) in watermelon and Rasool *et al*. (2009) in cucumber.

Average fruit weight (kg) as influenced by organic manures and biofertilizers:

The data regarding average fruit weight as influenced by organic manures and biofertilizers was recorded and presented in table no. 3 maximum average fruit weight (3.73 kg) was recorded in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas, minimum average fruit weight (3.04 kg) was recorded in T_1 (Farm Yard Manure @ 40 t ha^{-1}). These results were recorded with the findings of Chinanshuk *et al*. (2016) and Ceren *et al.* (2021) in watermelon.

Fruit yield per vine (kg) as influenced by organic manures and biofertilizers:

The data regarding fruit yield per vine (kg) as influenced by organic manures and biofertilizers were recorded and presented in table no. 3 maximum fruit yield kg per vine (13.83 kg) was recorded in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). Whereas minimum fruit yield kg per vine (8.90 kg) was recorded in treatment T_1 (Farm Yard Manure @ 40 t ha^{-1}). Similar results were found with the findings Muzeev *et al*. (2019) and Rasool *et al*. (2009) in cucumber.

Fruit yield per hectare as influenced by organic manures and biofertilizers:

The data on total fruit yield per hectare as influenced by organic manures and biofertilizers was recorded and presented in table no. 3 data indicated significant differences among the treatments. The maximum fruit yield ha^{-1} (87.68 tons) were recorded in T_7 (Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each). While T_1 (Farm Yard Manure @ 40 t ha^{-1}) recorded minimum fruit yield ha^{-1} (56.42 tons). These results are in accordance with the findings Muzeev *et al*. (2019) in watermelon and Anita *et al.* (2003), Rasool *et al*. (2009) in cucumber.

Table 3. Days required for edible maturity, number of fruits per vine, average fruit weight (kg) and yield (tons) ha^{-1} as influenced by organic manures and biofertilizers in watermelon.

Treatments	Days required for edible maturity	Number of fruits per vine	Average fruit weight (kg)	Yield (tons) ha^{-1}
T_1- Farm Yard Manure @ 40t ha-1	77.68	2.93	3.04	56.42
T_2-Compost (NADEP) @ 18 t ha-1	76.26	3.2	3.42	69.35
T_3-Vermicompost @ 13.5 t ha-1	76.41	3.33	3.51	74.05
T_4-Poultry manure @ 6.6 t ha-1	77.12	3.21	3.47	70.56
T_5- Farm Yard Manure @ 40t ha-1 + soil application of Azotobacter +PSB @ 5kg ha-1 each	76.38	3.13	3.21	63.65
T_6- Compost (NADEP) @ 18 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	75.07	3.69	3.61	84.44
T_7- Vermicompost @ 13.5 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	74.63	3.71	3.73	87.68
T_8- Poultry manure @ 6.6 t ha-1+ soil application of Azotobacter +PSB @ 5kg ha-1 each	75.53	3.67	3.59	83.49
T_9-Control (RDF-200:100:100 NPK kg ha-1)	74.78	3.43	3.68	80.01
'F test'	Sig.	Sig.	Sig.	Sig.
S.E.(m)±	0.5	0.11	0.14	2.37
CD at 5 %	1.5	0.34	0.43	7.12

CONCLUSION

On the basis of present findings, it can be concluded that, effect of organic manures and biofertilizers has influenced the growth and yield parameters of watermelon. Regarding the growth parameters, in respect of length of main vine, number of leaves, number of primary branches, chlorophyll index, days for first female flower appearance, internodal distance and male female ratio were found better with Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each. Yield parameters viz days required for edible maturity, number of fruits per vine, average fruit weight kg, fruit yield kg per vine and fruit yield per ha^{-1} (tons) were found to be maximum with Vermicompost @ 13.5 t ha^{-1}+ soil application of *Azotobacter* +PSB @ 5kg ha^{-1} each.

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