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Influence of Vermicompost and Biofertilizers on Yield and Economic Feasibility of Dragon Fruit

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Abstract

An experiment was carried out in the Garden, Department of Fruit Science, C. S. Azad University of Agriculture and Technology, Kanpur (U.P.) during March to October 2022 and 2023 to evaluate the influence of vermicompost and biofertilizers on yield and economic feasibility of newly planted Dragon Fruit (*Hylocereus costarecencis*) in Kanpur region using eleven treatments viz., T_1-Control; T_2-Vermicompost (0.5 kg plant^{-1}); T_3-Azotobacter (50 g plant^{-1}); T_4-Azospirillium (50 g plant^{-1}); T_5-PSB (50 g plant^{-1}); T_6-Vermicompost (0.5 kg plant^{-1}) and Azotobacter (50 g plant^{-1}); T_7-Vermicompost (0.5 kg plant^{-1}) and Azospirillium (50 g plant^{-1}); T_8-Vermicompost (0.5 kg plant^{-1}) and PSB (50 g plant^{-1}); T_9-Vermicompost (0.5 kg plant^{-1}), Azotobacter (50 g plant^{-1}) and Azospirillium (50 g plant^{-1}); T_{10}-Vermicompost (0.5 kg plant^{-1}), Azotobacter (50 g plant^{-1}) and PSB (50 g plant^{-1}) and T_{11}-Vermicompost (0.5 kg plant^{-1}), Azospirillium (50 g plant^{-1}) and PSB (50 g plant^{-1}) in RBD with three replications. Data obtained during experimentation revealed that from the second year of planting, the yield and economics were significantly influenced by vermicompost and biofertilizer application. The maximum number of fruits per pillar (12.64), estimated yield (6.50 t ha^{-1}), cost of cultivation (₹ 131645.60 ha^{-1}), gross return (₹ 520000.00 ha^{-1}), net return (₹ 388354.40 ha^{-1}) and benefit: cost ratio (3.95) were found with vermicompost (0.5 kg plant^{-1}), Azospirillium (50 g plant^{-1}) and PSB (50 g plant^{-1}) in the second year of planting which may increase in subsequent years due to increase the number of fruits and yield plant^{-1}. Dragon fruit has high potential in northern India, remaining remunerative from the second year after planting and up to twenty years.

Keywords: Dragon fruit, vermicompost, biofertilizers, fruit yield, economics, returns

1. Introduction

Dragon fruit is an attractive and nutritious fruit with chromosome number 2n=22. It originated in Central America and Mexico. Dragon fruit is a member of the Cactaceae family belonging to the genus *Selenicereus.* Among different species of *Selenicereus, S. undatus, S. monacanthus, S. costaricensis* and *S. megalanthus* are cultivated commercially (Gunasena et al., 2007). It is commonly known as Kamalam, Night blooming cereus, and Queen of Night, which is a newly introduced exotic fruit crop in India having highly potential for its commercial cultivation. It is a fast-growing perennial climber-type plant that requires vertical support to grow. The stem section of pitaya forms aerial roots which adhere to the surface upon the trellis. The edible portion of the fruit is white and red, studded with numerous edible tiny black soft seeds (Pandey et al., 2023). Dragon fruit crop is valued for its nutritional worth concerning pigment, vitamins, mineral contents and anti-oxidative properties (Abirami et al., 2021). Regular consumption of fresh dragon fruit greatly controls asthma, cough, cholesterol, and high blood pressure, helps with stomach disorders, is good for heart health, helps in preventing cancer, prevents congenital glaucoma, boosts immune power, and reduces arthritis pain.

The fruit is the source of natural dye which is used as a natural colourant in the food industry (Parmar et al., 2019). This plant prefers a tropical dry climate with a temperature ranging from 20 to 29°C, but can also withstand temperatures up to 40°C, and a minimum of 10°C for shorter periods (Karunakaran et al., 2014). The plants will get damaged at temperatures above 40°C, causing yellowing of the stem. The rainfall requirement for dragon fruit cultivation ranges from 500 to 1500 mm year^{-1}. Dragon fruit can be grown in a wide range of well-drained soils. However, slightly acidic soil rich in organic matter are ideal for this crop.

In India, Gujarat, Karnataka, and Maharashtra are the leading producers which contributing about 70% of India's dragon fruit production. Dragon fruit production increased drastically to more than 12,000 mt over an area of 3,000-4,000 ha in 2020 with a productivity of 8.0-10.5 mt ha^{-1} (Wakchaure et al., 2020). Fruits are highly valued in the fields of healthcare, food processing, nutraceutical and cosmeceutical industries. It is low in calories and rich in vitamins, minerals, and other nutrients. The red flesh species i.e., Hylocereus costaricensis are additionally rich in betalains, meeting the increasing trade interest for antioxidant products and natural food colorants.

Due to high demand both in domestic and international markets, dragon fruit production could be an economical avocation to both backyard growers as well as entrepreneurs of medium and large-scale plantations.

The application of 1.8 kg of inorganic fertilizer incorporated with 3 kg of organic fertilizer per pillar (trellis) per year to be applied alternately in twelve rounds.

Compost application is very important for red pitaya planting which was able to improve the total fruit number, average fruit weight, and total yield when applied at a higher rate of 12 kg pillar^{-1} year^{-1} alone or incorporated with 1.2 kg mixture fertilizer pillar^{-1} year^{-1} (Hoe, 2014). Application of 100% Nitrogen through vermicompost, PSB at 10 kg ha^{-1}, and VAM at 10 kg ha^{-1} had a significantly greater impact on flowering and yield parameters (Siddiqua et al., 2024). For commercial exploitation of this newly introduced crop, it is very necessary to know the yield and economics of its cultivation in the plains of north India. As mentioned above, this study aimed to improve the yield, and cost of economics of Dragon fruit.

2. Materials and Methods

Present investigation for assessing the effect of vermicompost and biofertilizers on yield and economic feasibility of newly planted dragon fruit was carried out in the Garden, Department of Fruit Science, C. S. Azad University of Agriculture and Technology, Kanpur for two consecutive years i.e. 2022 and 2023 (March to October). The site falls under a sub-tropical climate in Indo-Gangetic central plains between 25°-26’ to 26°-28’ North latitude and 79°31’ to 80°34’ East longitude at an elevation of 125.90 meters above mean sea level and characterizes between semi and sub-tropical climate with hot dry summers and cold winters. The normal rainfall of the locality is about 750–1000 mm annum^{-1}, which is mostly received from last June to September with occasionally some scattered showers during winter months from N-E monsoon. The maximum temperature ranges between 20° to 44°C and the minimum from 7.0° to 29°C with relative humidity of 45–80% in different months of the year. The site has alluvial soil with an assured irrigation facility by tube well. The pole was wrapped with a green net. Four-month-old healthy plants were planted on 22nd March 2022 at a distance of 2×2 m^2 around the pole. Around each pillar, three plants were placed 15 cm apart from the pole.

The experiment was conducted in randomized block design with three replications and eleven treatments viz. T_1-Control; T_2-Vermicompost (0.5 kg plant^{-1}); T_3-Azotobacter (50 g plant^{-1}); T_4-Azospirillium (50 g plant^{-1}); T_5-PSB (50 g plant^{-1}); T_6 -Vermicompost (0.5 kg plant^{-1}) and Azotobacter (50 g plant^{-1}); T_7-Vermicompost (0.5 kg plant^{-1}) and Azospirillium (50 g plant^{-1}), T_8-Vermicompost (0.5 kg plant^{-1}) and PSB (50 g plant^{-1}); T_9-Vermicompost (0.5 kg plant^{-1}), Azotobacter (50 g plant^{-1}) and Azospirillium (50 g plant^{-1}); T_{10}-Vermicompost (0.5 kg plant^{-1}), Azotobacter (50 g plant^{-1}) and PSB (50 g plant^{-1}); and T_{11}-Vermicompost (0.5 kg plant^{-1}), Azospirillium (50 g plant^{-1}) and PSB (50 g plant^{-1}) which were applied in three equal, first imposition was carried out after planting on 6th March, second imposition was done before one month of flowering on 10th May and the last imposition was done before fruiting of plants on 20th June. The yield and economic feasibility of dragon fruit viz., total number of fruits pillar^{-1}, estimated fruit yield ha^{-1}, cost of cultivation ha^{-1}, gross return ₹ ha^{-1}, net return ₹ ha^{-1}, and cost: benefit ratio was worked out during the investigation period. The number of fruits pillar^{-1} was counted from first fruit to the last fruit manually and recorded at the time of harvesting. The average number of fruits pillar^{-1} was worked out.

2.1. Fruit yield (kg pillar^{-1})

The weight of fruit harvested pillar^{-1} at each harvesting was recorded and from the same, the total yield pillar^{-1} was worked out and expressed in kilogram (kg).

2.2. Estimated fruit yield hectare^{-1}

Yield per hectare was computed by multiplying the yield pillar^{-1} by the number of plants that can be accommodated in one hectare and expressed in t ha^{-1}.

2.3. Cost of cultivation (₹ ha^{-1})

The cost of cultivation of dragon fruit (treatment-wise) was calculated separately by adding the value of each input i.e. labour charges, cost of plants and poles, cost of organic inputs and biofertilizers, etc. in each treatment during the experimental period, and expressed as rupees ha^{-1} (₹ ha^{-1}).

2.3.1. Gross return (₹ ha^{-1})

The yield of dragon fruit (treatment-wise) was converted into gross income based on the prevailing market price.

2.3.2. Net return (₹ ha^{-1})

The net income ha^{-1} was calculated for each treatment by deducting the cost of production from the gross income obtained in each treatment.

2.3.3. Benefit-cost ratio

The Benefit-cost ratio of different treatments was calculated by dividing the grass income by the respective cost of cultivation of different treatments using the following formula.

Benefit-Cost ratio=Gross income (₹ ha^{-1})/Cost of cultivation (₹ ha^{-1})

3. Statistical Analysis

The statistical analysis of the data obtained in different sets of experiments was calculated as suggested by Panse and Sukhatme (1985).

4. Results and Discussion

4.1. Number of fruits pillar^{-1}

Plants after 18 months of planting start fruiting in Kanpur condition and number of fruits was significantly influenced by the application of organic manure and biofertilizer individually or in combination with different treatments. The maximum number of fruits pillar^{-1} (12.64) was recorded which were fertilized with Vermicompost (0.5 kg plant^{-1}), Azospirillium (50 g plant^{-1}) and PSB (50 g plant^{-1}) in treatment (T_{11}) followed by T_{10} treatment (10.51), whereas, the least number of fruits pillar^{-1} (5.23) was recorded which were kept as control (T_1), without any treatment (Table 1 and Figure 1). This increase in the number of fruits pillar^{-1} as compared to control may be due to the reason that the applied doses of vermicompost and biofertilizers increased microbial activity in the soil which led to better soil absorption of nutrients by the plants and had a beneficial effect on the supply of nutrients to the plants which results in the production of a greater number of fruits. These observations conform with the findings of Pandey et al. (2023) recorded the highest number of fruits pole^{-1} (14.0) in dragon fruit, Tripathi et al. (2010) recorded the number of fruits (25.66) per plant, Tripathi et al. (2016) found the maximum number of fruits per plant, and Kumar and Tripathi (2020) recorded the maximum number fruits per plant (28.35) in strawberry.

Table 1: Effect of different organic manure and biofertilizers on growth and yield characters of dragon fruit

Treatments	No. of fruits pillar^{-1}	Fruit yield (kg pillar^{-1})	Estimated fruit yield (t ha^{-1})
T_1	5.23	0.55	1.38
T_2	5.73	0.78	1.94
T_3	6.23	0.92	2.31
T_4	6.48	1.06	2.65
T_5	5.84	0.87	2.18
T_6	7.52	1.29	3.23
T_7	8.34	1.51	3.78
T_8	7.23	1.20	3.00
T_9	9.58	1.79	4.47
T_{10}	10.51	2.09	5.22
T_{11}	12.64	2.60	6.50
SEm±	0.11	0.02	0.05
CD (*p*=0.05)	0.31	0.05	0.13

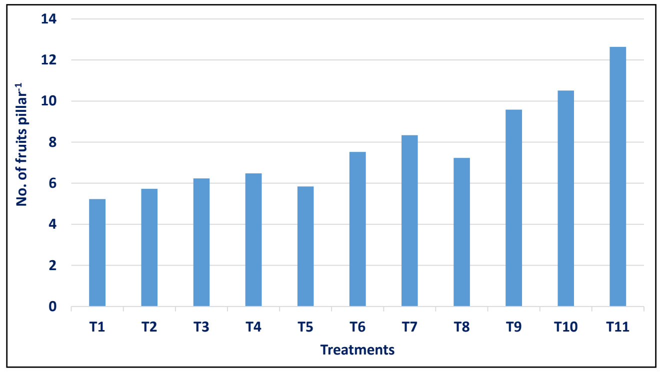

Figure 1: Influence of vermicompost and biofertilizers on number of fruits pillar^{-1}

4.2. Fruit yield pillar^{-1}

The number of fruits was significantly influenced by the application of organic manure and biofertilizer individually or in combination as compared to those that were kept without any treatment (Table 1). The analysis of data indicates that the estimated fruit yield kg pillar^{-1} varied between 0.55 kg pillar^{-1} and 2.60 kg pillar^{-1}. Among the different treatments applied, plants that were provided with Vermicompost (0.5 kg plant^{-1}), Azospirillum (50 g plant^{-1}), and PSB (50 g plant^{-1}) produced a maximum yield (2.60 kg pillar^{-1}) followed by 2.09 kg pillar^{-1} in treatment T_{10} while the lowest fruit yield (0.55 kg pillar^{-1}) was noticed in plants kept under control (T_1). This increase in fruit yield may be because the applied Vermicompost along with biofertilizers enhanced microbial activity in the soil which led to high soil fertility this had a beneficial effect on better metabolic activities in the plant which ultimately increased protein and carbohydrate levels, which might have enhanced the yield. The observations recorded are in line with the findings of Bhadauria and Tripathi (2023) reported the maximum yield plant^{-1} in mango, Siddiqua et al. (2021) recorded the maximum yield of 4.5 kg plant^{-1}, Pandey et al. (2023) recorded the maximum fruit yield (3.91 kg pole^{-1}) in dragon fruit, Kumar and Tripathi (2020) can significantly record more yield (185.75 g plant^{-1}).

4.3. Estimated fruit yield ha^{-1}

Since there is no fruit set was noticed on the plants in the first year of planting and in the second year when fruiting starts, the number of fruits was significantly influenced by the application of organic manure and biofertilizer individually or in combination as compared to those which were kept without any treatment (Table 1 and Figure 2). The analysis of data indicates that the estimated fruit yield hectare^{-1} varied between 1.38 t ha^{-1} and 6.50 t ha^{-1}. Among the different treatments applied, plants that were provided with Vermicompost (0.5 kg plant^{-1}), Azospirillum (50 g plant^{-1}), and PSB (50 g plant^{-1}) produced a maximum yield (6.50 t ha^{-1}) followed by 5.22 t ha^{-1} in treatment T_{10} while the lowest fruit yield (1.38 t ha^{-1}) was noticed in plants kept under control (T_1). The increase in fruit yield may be because the applied Vermicompost along with biofertilizers enhanced microbial activity in the soil which led to high soil fertility this had a beneficial effect on better metabolic activities in the plant

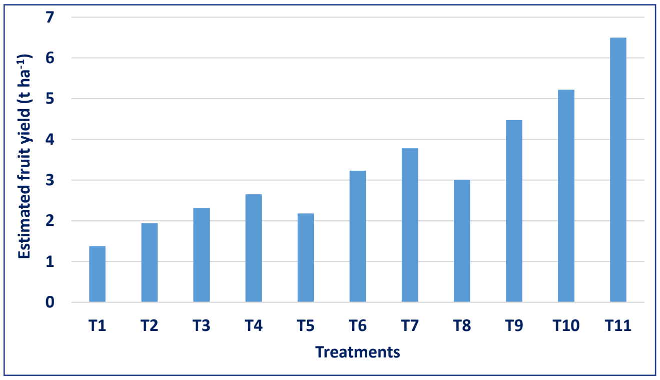

Figure 2: Influence of vermicompost and biofertilizers on estimated fruit yield ha^{-1}

which ultimately increased protein and carbohydrate levels, which might have enhanced the yield. The observations recorded are in line with the findings of Bhadauria and Tripathi (2023) reported the maximum yield per hectare in mango, and Kumar and Tripathi (2020) recorded the maximum yield per hectare in strawberry, Tripathi et al. (2017) reported the maximum yield per hectare in strawberry, Nayyer et al. (2014) recorded the estimated maximum yield per hectare in banana.

4.4. Cost of cultivation (₹ ha^{-1})

The cost of cultivation is divided into two categories: fixed and variable costs. The fixed cost remained consistent across all the treatments; however, the variable cost varies among different treatments due to the different amounts of manure and biofertilizers used in different treatments. The maximum cost of cultivation (₹ 131645.60 ha^{-1}) was recorded from the plants that were treated with vermicompost (0.5 kg plant^{-1}), Azospirillum (50 g plant^{-1}), and PSB (50 g plant^{-1}). The plants kept as untreated (control) have a significant minimum cost of cultivation (₹ 74594.59 ha^{-1}) as compared to all other treated plants. The variation in the cost of cultivation was due to the variation in different treatment combinations and price of inputs viz. labour charges, cost of plants and poles, cost of organic inputs, etc. The present results are in close conformity with the findings of Pandey et al. (2023) recorded the maximum cost of cultivation (₹ 72937) in dragon fruit.

4.4.1. Gross return (₹ ha^{-1})

There is no fruit set was noticed on the plants in the first year of planting, which is why there is no return was found in the first year of planting from all treatments, and from the second year when fruiting started, gross return was significantly influenced by the application of organic manure and biofertilizers at different doses. The maximum gross return (₹ 520000 ha^{-1}) was obtained from the plants fertilized with vermicompost (0.5 kg plant^{-1}), Azospirillum (50 g plant^{-1}) and PSB (50 g plant^{-1}), whereas, untreated plants (control) produced significantly minimum gross return (₹ 110400 ha^{-1}) presented in Table 2. This increase in gross return from the second year is due to the production of commercial yield in the second year and onwards. The present results are in close conformity with the findings of Pandey et al. (2023) recorded the maximum gross return (₹ 329418) in dragon fruit.

4.4.2. Net return (₹ ha^{-1})

The result obtained during the experimentation period reveals that there is no return in the first year among all the treatments as there is no fruiting takes place and from the second year onwards, when fruiting starts, the net return was significantly influenced by the application of organic manure and biofertilizers. The maximum net return (₹ 388354.4 ha^{-1}) was obtained from the plants, which were fertilized with vermicompost (0.5 kg plant^{-1}), Azospirillum (50 g plant^{-1}), and PSB (50 g plant^{-1}), which produced more yield. The plants which were kept untreated (control), produced significantly minimum net return (₹ 35805.41 ha^{-1}), as compared to all other treated plants (Table 2). The lesser net return is due to the reason that returns from the plantings starts from the second year onwards, so this will increase in next coming years. The present results are by the findings of Pandey et al. (2023) recorded the highest net return (₹ 256481) in dragon fruit.

Table 2: Effect of different organic manure and biofertilizers on the economics of treatments and B:C ratio in dragon fruit

Treat-ments	Cost of culti-vation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B: C ratio
T_1	74594.59	110400	35805.41	1.48
T_2	83891.89	155200	71308.11	1.85
T_3	88846.15	184800	95953.85	2.08
T_4	89830.51	212000	122169.50	2.36
T_5	89435.90	174400	84964.10	1.95
T_6	97509.43	258400	160890.60	2.65
T_7	106478.90	302400	195921.10	2.84
T_8	97959.18	240000	142040.80	2.45
T_9	113523.80	357600	244076.20	3.15
T_{10}	118974.40	417600	298625.60	3.51
T_{11}	131645.60	520000	388354.40	3.95

1US$=INR 82.28 and 83.23 (Average value for October, 2022 and 2023)

4.4.3. Benefit: cost ratio

The maximum Cost-benefit ratio (3.95) was recorded from the plants fertilized with vermicompost (0.5 kg plant^{-1}), Azospirillum (50 g plant^{-1}), and PSB (50 g plant^{-1}). The untreated (control) plants produced a significant minimum benefit-cost ratio (1.48), as compared to treated plants (Table 2). This increase in cost: benefit ratio may be due to the reason that the combined application of vermicompost, phosphate solubilizing bacteria, and Azospirillum enhanced the microbial activity in the root zone of plants which resulted in an increase in the availability and uptake of nutrients by the treated plants. Hence, the plants supplied with higher doses of vermicompost and bio-fertilizers in combinations resulted in a maximum Cost-benefit ratio as compared to the plants supplied with little or non-amount of vermicompost and bio-fertilizers in combinations. The yield and market price are also a major factor that causes a huge difference in gross return rupees^{-1} invested (B: C ratio). These results are in line with the findings of Mehta et al. (2024) recorded the maximum B: C ratio (1.87) in dragon fruit, and Pandey et al. (2023) reported the highest benefit: cost ratio (4.52) in dragon fruit.

The lifespan of dragon fruit is approximately 20 years. Sometimes, plants planted with big segments of stem as cuttings, may produce few fruits during the initial days but not have commercial yield in the first year, yield increases significantly in the second year and onwards, and continues to grow fruits every year for the next 19–20 years.

5. Conclusion

The highest number of fruits pillar^{-1} with more estimated yield hectare^{-1} and cost: benefit ratio were found with the application of vermicompost (0.5 kg plant^{-1}), Azospirillium (50 g plant^{-1}) and PSB (50 g plant^{-1}) which may increase in subsequent years due to increasing the number of fruits and yield plant^{-1} from the second year after planting and onwards up to twenty years and gives better economic performance in the plains of north India.

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