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Effect of Organic Manures and Biofertilizers on Quality of Spinach Beet (*Beta vulgaris* var. *bengalensis*)

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A B S T R A C T

A field experiment was conducted at Vegetable Experimental Field, SKUAST- K Shalimar during *Rabi* season 2016-17 to evaluate the effect of organic manures and biofertilizers on quality of spinach beet. The experiment was laid out in RCBD with nine treatment combinations replicated three times. The treatments comprised of organic manures *viz*., farm yard manure, sheep manure, vermicompost, mustard cake and two types of bio-fertilizers namely *Azospirillum* and PSB including RFD (recommended fertilizer dose) as control. Results revealed that quality parameters like dry matter content (15.92, 16.47 and 29.26), ascorbic acid content (202.52, 166.10 and 155.12 mg 100 g^{-1}), crude fibre content (9.50, 8.86 and 7.76 %) and leaf chlorophyll content (3.25, 0.98 and 0.76 mg g^{-1}) were highest with the treatment T_6 (vermicompost @ 3 tonnes ha^{-1} + biofertilizers @ 5 kg ha^{-1}). Lowest nitrate content (447.33, 348.33 and 268.33 mg kg^{-1}) in leaves were found with the treatment T_7 (FYM @ 12.0 t ha^{-1} + biofertilizers @ 5 kg ha^{-1}) and was statistically at par (453.00, 355.39 and 270.33 mg kg^{-1}) with treatment T_6 (vermicompost @ 3 tonnes ha^{-1} + biofertilizers @ 5 kg ha^{-1}). Highest leaf moisture content (91.97, 90.23 and 87.57 %) was registered where mustard cake @ 1.2 t ha^{-1} was applied.The highest benefit cost ratio (B:C) of spinach beet (3.84) was also obtained with the application of vermicompost @ 3 tonnes ha^{-1} + biofertilizers @ 5 kg ha^{-1}.

Introduction

Spinach beet (*Beta vulgaris* var. *bengalensis*; 2n=2x=18), commonly known as 'Indian spinach' in English and 'Palak' in Hindi, originated from Indo-Chinese region (Nath, 1976) belongs to the genus *Beta*, specie *vulgaris* and family Chenopodiaceae. Leaves of this might have been first used in Bengal and hence known as var. *bengalensis*. It is also called as Beet leaf and Desi palak. It is closely related to beet root, sugar beet, and Swiss chard. Sea beet (*Beta vulgaris* var. *maritima*) is the ancestor of palak. It is commonly grown for its tender and soft succulent leaves.

Spinach beet leaves are valued much for their medicinal properties. It is a good source of natural antioxidants such as flavonoids, polyphenols, vitamins and folic acid. Organic manures like vermicompost contains water soluble components such as humic acid,

growth regulators, vitamins and micronutrients which increase the availability of nutrients resulting in better quality produce.

Excessive use of inorganic fertilizers creates environment related problems and situation can be improved through the use of bio-fertilizer (Saadatnia and Riahi, 2009). Organic manures have the potential to mitigate the soil degradation and gave higher benefit cost ratio. In view of the above facts the research was conducted with the following objective:

To assess the effect of organic manures and biofertilizers on quality of spinach beet and to work out the economics.

Materials and Methods

The present study was carried out during *Rabi* season of 2016-17 at Vegetable Experimental Field of Division of Vegetable Science, SKUAST-Kashmir, using one variety of spinach beet "Pusa Jyoti" with a spacing of 30 cm apart in rows and later thinned to 10 cm spacing between plants within a row experimented in Randomized Complete Block Design with three replications. The treatment details are as below:

T_1=Recommended dose of fertilizer (RDF) *i.e.* N @ 60.0 kg ha^{-1}

T_2=Vermicompost @ 3.0 t ha^{-1}

T_3=Farmyard manure@ 12.0 t ha^{-1}

T_4=Sheep manure @ 10.0 t ha^{-1}

T_5=Mustard cake @1.2 t ha^{-1}

T_6=T_2+Biofertilizers (*Azospirillum* + PSB @ 5.0 kg ha^{-1})

T_7=T_3 +Biofertilizers (*Azospirillum* + PSB @ 5.0 kg ha^{-1})

T_8=T_4 +Biofertilizers (*Azospirillum* + PSB @ 5.0 kg ha^{-1})

T_9=T_5 +Biofertilizers (*Azospirillum* + PSB @ 5.0 kg ha^{-1})

The quality observations were recorded on moisture content, dry matter content, crude fibre content, leaf chlorophyll content, leaf ascorbic acid content and leaf nitrate content. To find out the BCR the following formula was used:

$$\text{Benefit cost ratio (B: C)} = \frac{\text{Gross returns}}{\text{Total cost of cultivation}}$$

Quality attributes were recorded at first, second and third cuttings respectively. Data was analyzed as per standard statistical procedures (Gomez and Gomez, 1984).

Results and Discussion

The findings of the present study as well as relevant discussion are summarized under following headings:

Leaf moisture content

Data presented in table 1 revealed that highest moisture content (91.97, 90.23 and 87.57 %) was recorded in treatment T_5 (Mustard cake @1.2 t ha^{-1}) followed by (89.15, 88.57 and 86.73 %) treatment T_3 (Farmyard manure@ 12.0 t ha^{-1}) whereas lowest moisture content (84.08, 83.53 and 81.73 %) was recorded with the treatment T_6 (Vermicompost@3.0 t ha^{-1}+ Biofertilizers @ 5.0 kg ha^{-1}). The above result is in conformity with Bharad *et al.,* (2013).

Regarding cutting effect on leaf moisture, maximum leaf moisture was recorded in first cutting (C_1), followed by second cutting (C_2) whereas minimum leaf moisture content was recorded in third cutting (C_3). The moisture

content was maximum in C_1 because moisture content is directly related to leaf area as cutting increases the leaf area and thus moisture content decreases.

Dry matter content

Table 1 depicts that the maximum value for dry matter (15.92, 16.47 and 18.27 %) was recorded in treatment T_6 (Vermicompost@3.0 t ha^{-1} + Biofertilizers @ 5.0 kg ha^{-1}) followed by (14.25, 16.33 and 17.73 %) treatment T_2 (Vermicompost @ 3.0 t ha^{-1}). Minimum dry matter (8.03, 9.77 and 12.43 %) was registered in treatment T_5 (Mustard cake @ 1.2 t ha^{-1}). The improvement in dry matter may be because of better availability and uptake of nitrogen which might have led to balanced C/N ratio and increased activity of plant metabolism. The above result is in conformity with that of Mehta *et al.,* (2012) and Joshi and Pal (2010).

With increase in leaf area, dry matter also increases and in response to cutting maximum dry matter was recorded in C_3 and minimum was recorded in C_1.

Crude fibre content

Table 1 showed that maximum fibre content (9.50, 8.86 and 7.76 %) was observed in treatment T_6 (Vermicompost@3.0 t ha^{-1}+ Biofertilizers @ 5.0 kg ha^{-1}) which was statistically at par(9.35, 8.68 and 7.45) and (9.10, 8.56 and 7.36 %) with the treatments T_8 (Sheep manure @ 10.0 t ha^{-1} + Biofertilizers @ 5.0 kg ha^{-1}) and T_7 (Farmyard manure @ 12.0 t ha^{-1} + Biofertilizers @ 5.0 kg ha^{-1}). Minimum fibre content (7.59, 6.55 and 6.25 %) was recorded in treatment T_3 (Farmyard manure @ 12.0 t ha^{-1}) and was at par (7.97, 7.02 and 6.02 %) with treatment T_5 (Mustard cake @ 1.2 t ha^{-1}). Maximum fibre content in palak was reported with the application of poultry manure (Dange *et al.,* 2013).

As regards to cutting, maximum crude fibre content was recorded in C_1 followed by C_2 and minimum was recorded in C_3.

Leaf chlorophyll

Table 1 revealed that maximum leaf chlorophyll content (3.25, 0.93 and 0.76 mg g^{-1}) in spinach beet was recorded with the treatment T_6 (Vermicompost@3.0 t ha^{-1}+ Biofertilizers @ 5.0 kg ha^{-1}) followed by (2.96, 0.86 and 0.73 mg g^{-1}) treatment T_2 (Vermicompost @ 3.0 t ha^{-1}) whereas minimum leaf chlorophyll (1.08, 0.28 and 0.21 mg g^{-1}) was recorded in the treatment T_1 (RFD). Similar results of improvement in chlorophyll content due to addition of organic manures have also been found by Singh *et al.,* (2014) and Narkhede *et al.,* (2011). More chlorophyll content in leaves might be due to macro and micro nutrients supplied by vermicompost and biofertilizers particularly nitrogen which is an important constituent of chlorophyll. As regards to cutting, maximum chlorophyll content was registered in first cutting (C_1) followed by C_2 whereas minimum chlorophyll content was recorded in C_3.The above result is in conformity with that of Gairola *et al.,* (2009).

Ascorbic acid content:

The maximum ascorbic acid content(202.52, 166.10 and 155.12 mg 100 g^{-1}) was recorded in treatment T_6 (Vermicompost@3.0 t ha^{-1}+ Biofertilizers @ 5.0 kg ha^{-1}) followed by (197.06, 99.02 and 85.24 mg 100 g^{-1}) treatment T_8 (Sheep manure @ 10.0 t ha^{-1} + Biofertilizers @ 5.0 kg ha^{-1}) whereas minimum ascorbic acid (119.01, 63.25 and 53.77 mg 100 g^{-1}) was registered in treatment T_5 (Mustard cake @ 1.2 t ha^{-1}). Increase in ascorbic acid in leaves with added biofertilizers along with vermicompost might be due to its efficacy to fix atmospheric nitrogen and enhanced carbohydrate synthesis.

Table.1 Effect of organic manures and biofertilizers on quality parameters of spinach beet

Treatments	Leaf moisture content (%)			Dry matter content (%)			Crude fibre content (%)		
	Ist cutting	2ndcutting	3rdcutting	Ist cutting	2ndcutting	3rd cutting	Ist cutting	2nd cutting	3rd cutting
T_1	87.96	86.17	84.17	12.04	13.83	15.83	8.41	7.53	7.29
T_2	85.75	83.67	82.27	14.25	16.33	17.73	8.67	7.61	7.34
T_3	89.15	88,57	86.73	10.85	11.43	13.27	7.59	6.55	6.25
T_4	87.97	86.37	85.63	12.03	13.63	14.37	8.51	7.52	6.41
T_5	91.97	90.23	87.57	8.03	9.77	12.43	7.97	7.02	6.02
T_6	84.08	83.53	81.73	15.92	16.47	18.27	9.50	8.86	7.76
T_7	87.03	85.60	84.47	12.97	14.40	15.53	9.10	8.56	7.36
T_8	86.16	85.30	83.57	13.84	14.70	16.43	9.35	8.68	7.45
T_9	87.40	85.99	84.99	12.60	14.01	15.01	8.00	7.21	6.58
C.D($p \leq 0.05$)	**0.96**	**1.05**	**1.49**	**0.07**	**0.35**	**0.30**	**0.65**	**0.75**	**0.67**

Treatments	Leaf chlorophyll content (mg g^{-1})			Ascorbic acid content (mg 100g^{-1})			Leaf nitrate content (mg kg^{-1})		
	Ist cutting	2nd cutting	3rd cutting	Ist cutting	2nd cutting	3rd cutting	Ist cutting	2nd cutting	3rd cutting
T_1	1.08	0.28	0.21	124.41	66.74	53.43	811.00	672.33	608.00
T_2	2.96	0.86	0.73	201.81	87.76	75.30	529.00	380.33	295.33
T_3	2.06	0.55	0.45	130.39	78.63	66.91	588.33	447.66	355.33
T_4	1.96	0.46	0.38	182.80	73.22	60.97	591.00	552.66	436.33
T_5	1.74	0.38	0.27	119.01	63.25	53.77	692.00	608.33	542.66
T_6	3.25	0.93	0.76	202.52	166.10	155.12	453.00	355.39	270.33
T_7	2.96	0.65	0.54	197.86	88.58	73.24	447.33	348.33	268.33
T_8	2.89	0.59	0.50	197.06	99.02	85.24	581.00	506.33	430.00
T_9	2.19	0.39	0.47	130.05	83.19	71.89	650.00	580.33	528.66
C.D($p \leq 0.05$)	**0.04**	**0.03**	**0.05**	**1.20**	**1.00**	**1.48**	**14.33**	**12.26**	**14.75**

Higher ascorbic acid content was reported in tomato (Meena *et al.*, 2014) with the application of vermicompost and biofertilizers.

The maximum ascorbic acid was recorded in first cutting (C_1), followed by second cutting (C_2) and minimum was recorded in third cutting (C_3). The nutritional quality of a crop decreases because the content of nutrients especially vitamin C decreases with increased plant age as reported by Sorenson (1994) in lettuce.

Leaf nitrate content

The data presented in Table 1 showed that minimum leaf nitrate content (447.33, 348.33 and 268.33 mg kg^{-1}) was recorded in treatment T_7 (Farmyard manure @ 12.0 t ha^{-1} + Biofertilizers @ 5.0 kg ha^{-1}) which was statistically at par(453.00, 355.39 and 270.33 mg kg^{-1}) with treatment T_6 (Vermicompost@3.0 t ha^{-1} + Biofertilizers @ 5.0 kg ha^{-1}). Maximum nitrate content (811.00, 672.33 and 608.00 mg kg^{-1}) was registered in treatment T_1 (RFD). Similar findings were reported by Qureshi *et al.*, (2014) and Mahmoud *et al.*, (2009).

Regarding cutting effect on leaf nitrate, the maximum leaf nitrate was recorded in C_1 which was followed by C_2 whereas, minimum was recorded in C_3. This might be due to nitrate reductase enzyme activity which increased with plant age and thus decreased the nitrate content. These results are in accordance with the findings of Ahmed *et al.*, (2000) and Ruiz and Romero (2002).

Benefit cost ratio

Figure 1 revealed that the highest benefit cost ratio (3.84) was observed in treatment T_6 (Vermicompost @ 3.0 t ha^{-1} + Biofertilizers @ 5.0 kg ha^{-1}) followed by (3.53) treatment T_2 (Vermicompost @ 3.0 t ha^{-1}). The lowest benefit cost ratio (2.12) was obtained from treatment T_5 (Mustard cake @ 1.2 t ha^{-1}). Vermicompost along with biofertilizers (T_6) was focused as more profitable than any other treatment giving highest benefit cost ratio (3.84) which is due to higher leaf quality. Unique succulence, tenderness, colour and size carried higher market value than other treatments. So, it is proved that positive effect of vermicompost on quality of spinach beet can easily compete with inorganic fertilizers or other treatments as having higher benefit cost ratio. Similar findings were reported by Narolia *et al.*, (2009) in pear millet and Sandeep (2013) in carrot.

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