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The Effect of Fruit Waste Compost with Inorganic Fortification on Spinach Quality

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Abstract: Spinach (Spinacia oleracea), locally known as Palak, is one of the most essential vegetables of the Chenopodiaceae family. It is a rich source of fiber, vitamins A, C, E, K, B6, B2 as well as magnesium, manganese, iron, calcium, potassium, copper, phosphorus, zinc, selenium, folate, betaine, folic acid, collagen, niacin, omega 3 fatty acids, beta carotene, lutein, carotenoids, and quercetin bioflavonoid with many other flavonoids. This study was conducted to evaluate the effect of different type of compost(T1 - Control, T2 -Sweet lime compost 2 Ton/ha, T3 -Sweet lime compost 4Ton/ha, T4 -Sweet lime compost with Zinc and Iron 2 Ton/ha, T5 -Sweet lime compost with Zinc and Iron 4Ton/ha, T6-Pineapple compost 2 Ton/ha, T7 -Pineapple compost 4Ton/ha, T8-Pineapple compost with Zinc and Iron 2 Ton/ha), T9 -Pineapple compost with Zinc and Iron 4Ton/ha) on spinach. The experiment was conducted at the Research Farm, Department of Horticulture, Banaras Hindu University, Varanasi, during the Rabi seasons of 2019 and 2020, respectively. The experiment was laid out in Randomized Block Design with three replications. The whole field was first divided into three blocks, and each block was further divided into nine plots. An analysis of variance for all the treatments in Randomized Block Design (RBD) was carried out. For testing the hypothesis, the ANOVA table was used. Except fat content, the results of the sweet lime waste compost were good in terms of the overall proximate composition of spinach. Maximum antioxidant levels in spinach were found at fortified pineapple waste compost rates of 2 and 4 tonnes per hectare, respectively.
Keywords: Compost, Inorganic Fertilizer, Spinach

I. INTRODUCTION

Green leafy vegetables (GLV) play an essential role in human nutrition. It is composed of cellulose, hemicellulose, and pectin, which give its texture and firmness. GLV provide a sufficient amount of dietary fiber, minerals, vitamins, and other nutrients to the human body. (Asaolu *et al*. 2012). Hence, green leafy vegetables are very essential protective foods and are useful for maintaining health and healing various diseases. (Mohammed and Sharif, 2011). They contain various minerals such as Ca, Fe, Cu, P, Zn, Cl, and Na, which are important for growth and metabolism. These provide an alkaline effect on the acidity produced by other foods (Arasaretnam et al. 2017).

Spinach (Spinacia oleracea), locally known as Palak, is one of the most essential vegetables of the Chenopodiaceae family (Alessa et al, 2017). It is a rich source of fiber, vitamins A, C, E, K, B6 and B2 as well as magnesium, manganese, iron, calcium, potassium, copper, phosphorus, zinc, selenium, folate, betaine, folic acid, collagen, omega-3 fatty acids, beta carotene, lutein carotenoids, and quercetin bioflavonoid with many other flavonoids (Roughani *et al.* 2011). This is particularly noted for its high vitamin A, iron, and copper content. Therefore, it is used as a dietary treatment for anaemia with good results (Tewani *et. al*. 2016).

Spinach leaves are traditionally used in several herbal medicines such as cooling, wholesome, antipyretic, diuretic, mature, laxative, digestible, anthelmintic, urinary calculus, inflammation of the lungs and intestines, sore throat, joint pain, appetite, lumbago, cold , sneezing, sore eye, ringworm, scabies, leucoderma, soothing diarrhea, vomiting, biliousness, and flatulence (Metha and Belemkar, 2014). Hemoglobin and red blood cells are formed after their absorption in the body therefore it has great benefit to build up the blood and to prevent and treat anaemia. It is especially rich in vitamin A and lack of this vitamin can cause night blindness.It is given in jaundice as a hepatic tonic and it has healing and building properties for the liver, gall bladder, blood,lymph flow, and large intestine. It is a good fibre source that reduces cholesterol levels in the body, thus reducing the risk of cardiovascular disease. Spinach contains a lot of calcium (76 mg/100 g). and it is beneficial to reduce calcium deficiency related disease.(Tewani *et. al*.2016).

Spinach is a cool climate crop which average seed germination temperature is 2^{0C} with a maximum 30^{0C} germination temperature and a median 7 to 24 ^{0C} germination temperature. Young plants can withstand temperatures as low as 9 degrees Celsius. The best plant growth takes place at 15 to 20 ^{0C} with a minimum temperature of 10 ^{0C} and a maximum temperature of 32 ^{0C}. Spinach harvest usually starts in the first week of June and continues until mid-July or as long as weather. Depending on the local microclimate (fall frosts), the fall crop will start in early September and continue until late October (Robert *et al* 2004).It can be grown on any soil that has sufficient drainage capacity. Soil pH ranges should be from 6 to 7. Ploughing should be done within 2-3 times to prepare the soil. Seed rates 4-6 kg for use in the winter season and seed rates 10-15 kg per acre for summer crops. Enough moisture content is required for proper seed germination and good growth. In the summer months, irrigation is applied at 4-6 day intervals, whereas irrigation occurs at 10–12 day intervals in the winter months. (Chitwood, 2016).

II. MATERIALS AND METHOD

A. *Study Site*

The experiment was conducted at the Research Farm, Department of Horticulture, Banaras Hindu University, Varanasi, during the *Rabi* seasons of 2019 and 2020, respectively. The whole field was first divided into three blocks, and each block was further divided into 9 plots. The treatments were allocated randomly in each block during the experiment. The experimental field was prepared by repeated ploughings.

B. *Experimental Design*

Randomized Bolck Design (RBD) with three replications was used in the experiment. The total number of treatments was nine, so the total number of plots with three replications was 27. Where the net plot size was 2.2 square metres and the plot and block border sizes were 30 centimetres. The main irrigation channel size was 1.0 m, the length of the field was 21 m, and the width of the field was 10.1 m.

C. *Treatments and their Combinations*

Treatments for the experiment included two types of compost made from two different types of fruit waste and fortified with zinc sulphide (ZnSO4; 6.25 g/kg) and iron sulphide (FeSo4; 3.75 g/kg) applied in two doses. In all, there were nine treatments.

D. *Crop Establishment and Agronomic Practices*

Spinach was grown between the winters of 2019 and 2022. Pineapple and sweet lime waste composted with fortification (ZnSO4 and FeSO4) were used in this study. To achieve complete decomposition, the organic manures were decomposed for one year before use. The organic manure application rates were applied according to the recommended blanket N. Hence, the quantities of organic manure applied were determined according to the amount of extractable NO2/NO3 (mg kg−1) in the manure.

E. *Antioxidant and Proximate Composition Analysis*

1) *Carotenoids, Lycopene, Chlorophyl:* The content of carotenoids, lycopene, and chlorophyll in spinach was determined using the method described by (Jana Braniša1 *et al*. 2014; Yang *et al.* 1998; Nagata and Yamashita 1992) on the fresh weight basis.
2) *Ascorbic Acid:* Ascorbic acid in spinach was determined by the method described by (Bhuvaneswari S. *et al*. 2015, http://www.isca.in/IJBS/Archive/v4/i7/9.ISCA-IRJBS-2015-081.pdf)
3) *Crude Fiber:* The estimation of crude fibre from plants is based on treating the moisture and fat-free material first with 1.25 percent H2SO4 and then with 1.25 percent alkali. The solution is filtered, and the residue is transferred to a weighed dish. It is dried in an oven at 100 degrees Celsius and then ignited to produce ash. The decrease in weight because of ignition is equal to crude fiber.
4) *Total ash:* In a previously weighed nickel dish, placed accurately 5-10gm of oven dried fine powder of sample then placed the sample in a muffle furnace at dull red heat (550°C) for 30 minutes. Grinded the resulting mass with a pestle and placed again in muffle furnace. Repeated this process till no more charred particles remained in the dish then placed the crucible in a desiccator and cooled it up to room temperature and weighed it.

$$\text{Calculations: Total ash (\% by weight)} = \frac{(W_2 - W) \times 100}{(W_1 - W)}$$

W= weight of the empty crucible (in g.)
W_1= Weight of the crucible with food material taken for the test (in g.)
W_2= Weight of the crucible with total ash (in g.)

5) *Moisture:* Vegetables were chopped finely and weighed accurately 10-50gm a flat bottomed dish and kept it in an oven at 100-110 ^{0c} overnight. Cooled the dish in a desiccator and weighed it to a constant weight. Moisture is calculated by the following formula:

$$\% \text{ of moisture content} = \frac{W_2 \times 100}{W1}$$

W1= Weight of the material taken for the test
W2= Weight of the material after heating.

6) *Fat:* After carefully weighed the sample approximately 4-10gm transferred it to an extraction thimble.For around 6 hours on a sand bath, kept the thimble in a Soxhlet extractor with a electric heater. The extraction was said to be complete when a drop of petrol or ether taken from the drippings of the extractor did not produce any greasy stain on a filter paper. Removed the thimble and heated so that the extractor filled up about two third with petrol, leaving only a small quantity of the petrol in the flask. Then stopped heating and removed the flask from the apparatus. Filtered the residual petrol having fat in solution using Whatmann No. 40 and collected the filtrate in the already weighed small beaker or a glass dish. Washed the flask as well as filter paper many times with redistilled petrol until a drop of the filtrate did not give greasy spot on the filter paper. Evaporated petrol in the dish very carefully and calculated the weight of the residue to constant weight. The amount of crude fat or ether extract would be calculated by increased weight of the dish.

$$\text{Percentage of crude fat} = \frac{\text{Weight of Ether soluble material x 100}}{\text{Weight of the sample}}$$

7) *Protein:* Protein content was determined by the Kjeldahl method.
8) *Energy (Physiological Calorific Value):* The physiological calorific value (Kcal/100g) of the sample was given by method Mudambi and Rao (1989), and calculated by summing up the products of multiplication of per cent protein, fat and carbohydrates present in the sample by 4,9 and 4 respectively i.e. Physiological calorific value (Kcal/100g) (4 Protein %6) + (9x Fat %) + (4 Carbohydrate %)

III. RESULTS AND DISCUSSIONS

A. *Proximate Composition of Spinach*

Table no-1 Effect of organic compost on proximate composition in spinach as influenced by fruits waste compost.

Treatment	Energy (Kcal/100g)	protein (g/100g)	Fat (g/100g)	Moisture (g/100g)	Ash (g/100g)	Crude fibre (g/100g)
T1 (Control)	11.34	1.7	0.37	94.99	2.67	0.38
T2 (Sweet lime compost 2 Ton/ha)	39.9	1.41	0.41	92.88	1.59	0.93
T3 (Sweet lime compost 4Ton/ha)	39.46	1.73	0.32	88.93	1.61	0.87
T4 (Sweet lime compost with Zinc and Iron 2 Ton/ha)	36.66	2	0.69	90.01	1.69	0.48
T5 (Sweet lime compost with Zinc and Iron 4Ton/ha)	38.47	1.7	0.21	89.08	1.64	0.56
T6 (Pineapple compost 2 Ton/ha)	34.82	1.92	0.47	89.61	2.25	0.94
T7 (Pineapple compost 4Ton/ha)	35.34	1.93	0.21	89.54	1.99	0.62
T8 (Pineapple compost with Zinc and Iron 2 Ton/ha)	36.13	1.71	0.22	89.54	1.77	0.66
T9 (Pineapple compost with Zinc and Iron 4Ton/ha)	39.58	2	0.78	89.53	1.53	0.58
SEM±	0.294	0.028	0.012	0.693	0.043	0.027
C. D. at 5%	0.883	0.084	0.038	2.080	0.130	0.081

Significantly maximum (39.9) energy content was recorded with T2. It was followed by T3 and T9 however T2 was found statistically at par with T3 and T9. Minimum (11.34) energy content was recorded with T1.Protein content was observed significantly maximum (2) with T4 and T9 and both were found statistically at par with T6 and T7. Minimum (1.41) protein content was observed under T2.

Highest (0.78) fat content was recorded in T9 and lowest (0.21) under T5 and T7. Highest (94.99) moisture content was observed under T1 while lowest (88.93) moisture content was observed under T3.

Significantly maximum (2.67) ash content was recorded in T1 and minimum (1.53) ash content was recorded under T9. Significantly maximum (0.93) crude fiber content was recorded with T2 and it was statistically at par with T3 (0.87). Lowest (0.38) crude fiber content was recorded with T1. N. Saada *at.al.*, (2009) concluded that that proximate content of fenugreek seeds is affected by the addition of the two types of organic compost. Conversely; the combination mixture of manures (Cow manure: Goat manure: Chicken manure) with Wheat husks is highly suggested as an organic compost product with a significantly better performance on the chemical characteristics of fenugreek plant.

B. Antioxidants Availability in Spinach

Table no-2 Effect of organic compost on antioxidant composition in spinach as influenced by fruits waste compost.

Treatment	Vitamin C (mg/100g)	Carotenoids (mg/100ml)	Lycopene (mg/100ml)	Total chlorophyll (mg/100ml)
T1 (Control)	62.7	7.69	0.40	54.14
T2 (Sweet lime compost 2 Ton/ha)	65.91	16.05	0.19	77.49
T3 (Sweet lime compost 4Ton/ha)	63.43	14.55	0.20	65.57
T4 (Sweet lime compost with Zinc and Iron 2 Ton/ha)	106.86	20.69	0.06	75.44
T5 (Sweet lime compost with Zinc and Iron 4Ton/ha)	147	19.94	0.06	94.92
T6 (Pineapple compost 2 Ton/ha)	165.65	12.95	0.16	74.78
T7 (Pineapple compost 4Ton/ha)	85.21	15.09	0.17	103.07
T8 (Pineapple compost with Zinc and Iron 2 Ton/ha)	152.63	25.26	0.10	98.82
T9 (Pineapple compost with Zinc and Iron 4Ton/ha)	153.99	22.43	0.05	113.82
SEM±	8.528	1.424	0.051	3.178
C. D. at 5%	26.566	4.269	0.154	9.526

Highest (165.65) vitamin C content was observed with T6 and it was statistically at par with T8 and T9. Lowest (62.7) vitamin C content was observed under T1. Carotenoids content significantly highest (22.43) recorded with T8. It was followed by T9 however T8 was statistically at par with T9. Lowest (7.69) carotenoids content was recorded under T1.Significantly highest (0.40) lycopene content was recorded under T1 and lowest (0.05) lycopene content was observed under T9. Chlorophyll a was significantly highest (85.60) observed under T9 and it was followed by T7 and T8 however T9 was statistically at par with T7 and T8. Lowest (12.19) chlorophyll content was observed under T1.Maximum (44.70) chlorophyll b content was observed with T9 and it was statistically at par with T1. Lowest (26.78) chlorophyll b was observed under T8. Maximum (113.82) total chlorophyll content was observed under T9 and minimum (54.14) total chlorophyll content was observed under T1.Purbajanti *et.al.*, (2019) it was concluded that the total chlorophyll content were achieved using 10 ton/ha cow dung and 100 kg/ha NPK 16 fertiliser.Positive relationship between chlorophyll and nutrient content was observed in black gram by using coir waste and cow dung. Baranisrinivasan (2011) organic matter content correlated positively with the yield and vitamin C content of amaranth. Adekayode *et.al.*(2011)

IV. CONCLUSION

The Highest energy and crude fibre content of spinach were found with without fortified sweet lime waste compost 2ton/ha whereas maximum moisture and ash content of spinach were recorded with fortified sweet lime waste compost 2ton/ha. Highest protein content of spinach was found with fortified sweet lime compost 2ton/ha while highest fat content was found with fortified pineapple waste compost 4ton/ha. However sweet lime waste compost result was good in overall proximate composition of spinach accept fat content. Maximum antioxidants and highest mineral composition in spinach were recorded with fortified pineapple waste compost 2ton/ha and 4 ton/ha. Maximum results of all parameters of fenugreek and spinach were best with application of fortified pineapple waste compost.

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