Plant Archives Vol. 19 No. 2, 2019 pp. 2995-2999 e-ISSN:2581-6063 (online), ISSN:0972-5210

ORGANIC NUTRIENT MANAGEMENT ON THE LEAF PRODUCTION AND QUALITY PARAMETERS OF MORINGA. (*MORINGA OLEIFERA* LAM.) CV. PKM-1

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Abstract

The present study on the effect of soil and foliar application of organic nutrients on leaf production and quality parameters of moringa (*Moringa oleifera* Lam.) was carried out during 2018-19 in the Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar. The experiment was laid out in Randomized Block Design with thirteen treatments and three replications. The highest leaf production per plant was observed in the treatment T_8 (vermicompost @ 5 t ha^{-1} and azospirillum and phosphobacteria @ 2 kg ha^{-1} along with panchakavya @ 3 per cent foliar spray). This was followed by the treatment T_{12} (vermicompost @ 5 t ha^{-1} and azospirillum and phosphobacteria @ 2 kg ha^{-1} neemcake extract @ 10 per cent of foliar spray. The moringa leaves were dried and converted into moringa leaf powder. The nutrient content of dried leaves like nitrogen, phosphorous, potassium, calcium, magnesium, iron and protein were favourably influenced by the application of vermicompost @ 5 t ha^{-1} and azospirillum and phosphobacteria @ 2 kg ha^{-1} along with panchakavya @ 3 per cent foliar spray, which was followed by the application of of vermicompost @ 5 t ha^{-1} and azospirillum and phosphobacteria @ 2 kg ha^{-1} along with neem cake extract @ 10 per cent foliar spray. The lowest value was recorded in control.

Key words *:* Leaf Powder, Leaf quality, Vitamins, Protein, Minerals.

Introduction

Moringa is the most widely cultivated species of a monogenic family, Moringaceae. *Moringa oleifera* leaves are highly nutritious. Moringa leaves are an excellent source of vitamins and minerals. Bureau of plant industry reported that moringa is an outstanding source of nutritional components, its leaves have the calcium equivalent of four times that of milk, the vitamin C content in seven times that of bananas, three times the iron of spinach, four times the amount of vitamin A in carrots and two times the protein in milk. (Kamal, 2008). Moringa powder is made from naturally dried moringa leaves. It has a delicious spinach green flavor and it contains 25 per cent plant protein which includes all nine essential amino acids, 24 per cent fibre besides rich source of vitamin A, vitamin K, vitamin E and calcium. Iron is essential for the reduction of tiredness and fatigue in the body and vitamin A supports the metabolism of iron ensuring a greater uptake. Adding *Moringa oleifera* to our daily routine is an effective, natural way to prevent tiredness and fatigue. Drying is the most commonly used method for enhancing shelf life of leafy vegetables. It is a natural remedy for insomnia as it possesses certain properties that can treat sleeping disorders. It is effective in treating depression and anxiety. It is good for pregnant women and lactating mothers and it will treat minor infections. Due to its medicinal value, moringa leaf powder is used for the treatment of minor bacterial and fungal infections, lowering blood sugar levels and anemia and useful in weight loss programme. It is an excellent source of antioxidants with high contents of vitamin A, vitamin C, vitamin E and bioflavonoids. Active oxygen radicals cause skin diseases by stealing electrons from normal healthy biological molecules. These nutrients help to block the oxidation of healthy tissue by active oxygen, thus delaying the ageing process and lowering the appearance of fine lines and wrinkles. Six table spoons full of moringa leaf powder will provide nearly the woman's daily iron and calcium during pregnancy and breastfeeding. Hence *Moringa oleifera* has been used to combat malnutrition among infants and nursing mothers

(Asante *et al.,* 2011). Organic farming system relay on the management of soil organic matter to enhance the chemical, biological and physical properties of the soil. One of the basic principles of soil fertility management in organic systems is that plant nutrition depends on biologically derived nutrients instead of using readily soluble forms of nutrients; less available forms of nutrients such as those in bulky organic materials are used. These require release of nutrients to the activity of soil microbes and soil animals. Improved soil biological activity is also known to play a key role in suppressing weeds, pest and diseases. Under conditions of soil constraints and climate vagaries, organic inputs have proved more profitable compared to agrochemicals.

Materials and Methods

The present investigation on the effect of soil and foliar application of organic nutrients on leaf yield plant^{-1} was carried out vegetable unit, Department of Horticulture and studies on quality parameters of moringa (*Moringa oleifera* Lam.) was carried out at the post harvest lab, Department of Horticulture, Faculty of Agriculture, Annamalai University during 2018-19. The quality parameters was carried out with a known quantity of 100 g of plant sample from second harvest collected at random from each treatment and washed free of soil and dirt. The samples were then dried in a hot air oven at 105°C to a constant weight and the dry weight was recorded. The oven dried material from second harvest was powdered in a mixie and then sieved through 0.2 mm sieve. The dry powder recovery was calculated in percentage as detailed below:

$$\text{Dry powder recovery} = \frac{\text{Powder Weight}}{\text{Dry Weight}} \times 100$$

From this dried powdered sample nitrogen, phosphorus, potassium, calcium, magnesium, protein, iron and ascorbic acid content were estimated. The nitrogen content in crop sample was estimated by microkjeldahl method as suggested by Yoshida *et al.,* (1976). The total N uptake was computed by multiplying the dry matter production and recorded in Kg ha^{-1}.

The phosphorus content of the plant sample was analyzed calorimetrically from triple acid extract (Jackson, 1973) and P uptake was worked out by multiplying the dry matter production with the P content and recorded in Kg ha^{-1}.

The potassium content of the leaf powder of moringa was estimated using the triacid extract. 5 ml of tri- acid extract was neutralized with ammonia and the volume was made up to 25 ml. The content was fed directly to the flame photometer and from the standard the amount of K in plant sample was expressed in mg 100 g^{-1} (Jackson, 1973).

The calcium content in leaf petiole was determined by adopting versenate method and was expressed as mg 100g^{-1}. Leaf petiole samples were weighed accurately (1g), oven dried, powdered and digested in 15 ml of triacid mixture (9 : 2: 1= HNO_3: H_2 SO_4: $HCLO_3$). The digested samples were diluted to 100 ml and an aliquot of 5 ml of extract was pipetted out in a porcelain basin and titrated against 0.02 N EDTA solution using murexide as an indicator. End point is pinkish red to violet colur change (Jackson, 1973).

The magnesium content was determined by adopting versenate method and was expressed as mg 100 g^{-1}. Leaf petiole samples were weighed accurately (1g), oven dried, powdered and digested in 15 ml of triacid mixture (9:2:1=HNO_3:H_2SO_4: $HCLO_3$). The digested samples were diluted to 100 ml and an aliquot of 5 ml of extract was pipetted out in a porcelain basin and titrated against 0.02 N EDTA solution using erichrome black–T as an indicator. End point is wine red to sky blue colour change.

Protein content was estimated by the method suggested by Lowry *et al.* (1951). Leaf sample of 500 mg was ground well with pestle and mortar in 5 to 10 ml of phosphate buffer solution and centrifuged for 10 minutes at 15,000 rpm. The protein stock solution was prepared by dissolving 50 mg of Bovine Serum Albumin (BSA) in 50 ml distilled water, which served as stock standard. Ten ml of the stock solution was diluted to 50 ml with distilled water, which served as working standard. Series of 0.2, 0.4, 0.6, 0.8 and 1 ml of the working standard were pipetted out into test tubes. Sample extracts of 0.1 ml and 0.2 ml were pipetted out into two other test tubes. The volume was made up to 1 ml in all the test tubes with distilled water. A test tube with 1 ml of distilled water served as blank. Five ml of alkaline copper solution (prepared by mixing 2 per cent sodium carbonate in 0.1 N sodium hydroxide with 0.5 per cent copper sulphate in 1 per cent potassium sodium tartrate in 50: 1 ratio) was taken and added to each test tube including blank, mixed well and allowed to stand for 10 minutes. 0.5 ml of Folin-ciocalteau reagent (prepared by adding 100 g of sodium tungstate, 25 g of sodium molybdate, 700 ml of water, 50 ml of 85 per cent phosphoric acid, 100 ml of concentrated HCL and 150 g of lithium sulphate in 50 ml of water and a few drops of bromine water and the mixture was boiled for 15 minutes, cooled and diluted to 1 litre and filtered) was added to each test tube, mixed well and the tubes were incubated at room temperature in the dark for 30 minutes. Samples on development of blue colour in the solution, measured at 660 nm. The standard graph was drawn and the amount of protein in each sample was calculated and expressed in g 100 g^{-1}. The ascorbic acid content of leaves was estimated by using the A.O.A.C.

(1990) method and expressed in mg $100g^{-1}$ of leaf sample.

Results and Discussion

The data recorded on herbage yield $plant^{-1}$ due to the effect of various organic nutrients are furnished in Table 1.The treatment T_8 (Vermicompost @ 5 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + panchakavya @ 3 per cent foliar spray) recorded the highest herbage yield $plant^{-1}$ of 153.93, 192.73, 216.27, 252.38, 241.92and 234.19 g at 35, 70, 105, 140, 175 and 210 DAP respectively. It was followed by T_{12} (Vermicompost @ 5t ha^{-1}+azospirillum and phosphobacteria @ 2 kg ha^{-1} + neemcake extract @ 10 per cent foliar spray) which recorded 148, 186.15, 207.70, 242.81, 231.62 and 226.55 g at 35, 70,105,140,175 and 210 DAP respectively. The lowest herbage yield $plant^{-1}$ was found at T_{13} (control) which recorded 91.05, 113.77, 113.43, 137.54, 118.32 and 142.51 g at 35, 70, 105, 140, 175 and 210 DAP.

This enhanced yield because of vermicompost might be due to the presence of more amount of available nitrogen, which is essential for the synthesis of structural proteins Edwards, (1998). This is found to be in accordance with findings of Mahorkar *et al*., (2007) in Radish.

Latha and Veena (2013) reported that the application of organics mainly biofertilizers attributed to better growth of plants and higher yields by slow release of nutrients for absorption with additional production of plant growth promoting substances like Giberellin, Cytokinin and Auxins. Abdul (2008) also observed better growth of plants and higher yield in onion due to biofertilizer application.

The yield and its components in the best treatment might be due to the higher number of branches, number of leaves and leaf area recorded by panchakavya spray. The enhanced yield may be due to supply of all micro and macro nutrients and growth enzymes present in the panchakavya which favoured rapid cell division and multiplication. Panchakavya sprayed plants produced earlier and quicker emergence of seedlings and due to the presence of growth promoting substances like IAA, GA3 and Cytokinin and other mineral nutrients which favours translocation of more photo assimilates to reproductive parts there by inducing early flowering. These findings are in confirmation with Vijaykumar and Ramaswamy (2009) in tomato and Phate *et al.,* (2014) in Spinach.

The data on estimates of nitrogen, phosphorus and potassium content of plant sample is presented in Table 2. The treatment T_8 (Vermicompost @ 5 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + panchakavya @ 3per cent foliar spray) recorded the highest nitrogen, phosphorus and potassium content of 1.08, 0.29 and 2.83 per cent, The least value recorded in the treatment T_{13} (control) was 1.00, 0.10 and 2.29 per cent of nitrogen.

The present study clearly indicated that the nitrogen,

Table 1: Effect of organic nutrients on herbage yield $plant^{-1}$ (g) in moringa cv. PKM-1.

Treatment	Herbage yield $plant^{-1}$ (g)					
	35 DAP	70 DAP	105 DAP	140 DAP	175 DAP	210 DAP
T_1	96.29	120.35	122.10	147.11	128.62	150.15
T_2	106.77	133.51	139.14	166.25	149.22	165.43
T_3	101.53	126.93	130.57	156.68	138.92	157.79
T_4	112.01	140.09	147.71	175.82	159.52	173.07
T_5	132.97	166.41	181.99	214.10	200.72	203.63
T_6	143.45	179.57	199.13	233.24	221.32	218.91
T_7	122.49	153.25	164.85	194.96	180.12	188.35
T_8	153.93	192.73	216.27	252.38	241.92	234.19
T_9	127.73	159.83	173.42	204.53	190.42	195.99
T_{10}	138.21	172.99	190.56	223.67	211.02	211.27
T_{11}	117.25	146.67	156.28	185.39	169.82	180.71
T_{12}	148.69	186.15	207.70	242.81	231.62	226.55
T_{13}	91.05	113.77	113.43	137.54	118.32	142.51
Grand mean	123.51	154.47	166.37	196.51	181.78	189.58
S.ED	1.40	1.59	1.75	2.17	1.92	1.99
CDP =(0.05)	2.91	3.28	3.61	4.48	3.98	4.11

Table 2: Effect of organic nutrients on nitrogen, phosphorus, potassium content in moringa cv. PKM-1.

Treatment	Nutrient content in moringa (per cent)		
	Nitrogen	Phosphorus	Potassium
T_1	1.00	0.16	2.60
T_2	1.00	0.19	2.63
T_3	1.00	0.18	2.61
T_4	1.01	0.20	2.65
T_5	1.04	0.24	2.73
T_6	1.07	0.26	2.75
T_7	1.02	0.22	2.69
T_8	1.08	0.29	2.83
T_9	1.03	0.23	2.71
T_{10}	1.05	0.25	2.75
T_{11}	1.01	0.21	2.67
T_{12}	1.08	0.27	2.78
T_{13}	1.00	0.10	2.29
Grand mean	1.02	0.21	2.69
$S.E_D$	0.02	0.006	0.05
CDp =(0.05)	0.04	0.01	0.11

Table 3: Effect of organic nutrients on Calcium, Magnesium content in moringa cv. PKM-1.

Treatment	Nutrient content inmoringa (mg $100g^{-1}$)	
	Calcium	Magnesium
T_1	1.35	0.21
T_2	1.39	0.25
T_3	1.37	0.23
T_4	1.41	0.27
T_{5-}	1.49	0.35
T_6	1.53	0.39
T_7	1.45	0.31
T_8	1.60	0.43
T_9	1.47	0.33
T_{10}	1.51	0.37
T_{11}	1.43	0.29
T_{12}	1.54	0.41
T_{13}	1.30	0.19
Grand mean	1.45	0.30
$S.E_D$	0.03	0.01
CDp =(0.05)	0.062	0.02

Table 4: Effect of organic nutrients on protein, iron and ascorbic acid content in moringa cv. PKM-1.

Treatment	Protein content (g $100g^{-1}$)	Iron content (g $100g^{-1}$)	Ascorbic acid (mg g^{-1})
T_1	6.26	16.59	37.01
T_2	6.31	17.08	40.48
T_3	6.27	16.95	38.02
T_4	6.33	17.11	40.69
T_{5-}	6.50	17.37	43.23
T_6	6.73	17.53	45.30
T_7	6.38	17.23	41.65
T_8	6.80	17.75	47.90
T_9	6.45	17.25	42.25
T_{10}	6.58	17.49	44.10
T_{11}	6.36	17.21	41.29
T_{12}	6.76	17.69	46.54
T_{13} -	6.21	16.30	36.02
Grand mean	6.46	14.83	42.08
$S.E_D$	0.13	0.42	0.95
CDp =(0.05)	0.27	0.87	1.96

phosphorous and potassium was maximum in the treatment combination of organic manures *viz.,* vermicompost @ 5 t ha^{-1} along with azospirillum and phosphobacteria @ 2 kg ha^{-1} and panchakavya @ 3per cent foliar spray, which recorded the highest nitrogen content 1.08 per in leaves of plant. Nitrogen is a major constituent of proteins, enzymes, chlorophyll and nucleic acid. It involves in the cell division, cell enlargement and in respiration. Positive effects of higher nitrogen levels and uptake was reported earlier by Barani and Anburani (2001) in bhendi, Sharma *et al.,* (2009) in Onion. The cow's urine rich in uric acid, a source of nitrogen was readily soluble and liquid form, one of the important compounds in panchakavya and was readily available to the plants directly influencing the nitrogen content of leaves. Panchakavya eliminates the imbalance in physical, chemical and biological processes due to the cosmic energy produced by stirring of the stock solution. Similar findings were also reported by Sanjutha *et al.,* (2008) and Gore and Sreenivasan (2011).

In the present study, the maximum phosphorus content (0.29) in leaves was found in the treatment in which combination of organic manures *viz.,* vermicompost @ 5 t ha^{-1} along with azospirillum and phosphobacteria @ 2 kg ha^{-1} and panchakavya @ 3 per cent foliar spray. Phosphorous was influenced positively by organic nutrients. Phosphorous is a major constituent of lipo-proteins, nucleo protein, and co- enzymes. It plays a major role in development of reproductive parts and root formation. Similar results on increase in phosphorous content in leaves due to the application of organic manures have been reported by Kannan *et al.,* (2005). Similar findings were given by Sharma *et al*., (2009) in Onion and Dalal *et al*., (2010) in Okra.

Also in the present study, the maximum potassium content 2.83 per cent was recorded in the treatment in which combination of organic manures *viz.*, vermicompost @ 5 t ha^{-1} along with azospirillum and phosphobacteria @ 2 kg ha^{-1} and panchakavya @ 3 per cent foliar spray. Potassium is the third major element, which plays a major role in activating enzymes and fruit set. Similar findings have been reported by Paul *et al.,* (2004) in tomato. The higher uptake of potassium in leaves may be due to better utilization of soil available potassium, which has been reported by Sarkar *et al*., 1991. The results of the findings are supported by Prasannakumar *et al*., (2004) in tomato and Chakraborty *et al*., (2011) in tomato.

The data on estimates of calcium and magnesium content of plant sample is presented in Table 3. The treatment T_8 (Vermicompost @ 5t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + panchakavya @ 3 per cent foliar spray) recorded the highest calcium and magnesium content of 1.60 mg $100g^{-1}$ and 0.43 mg $100g^{-1}$. The least value was recorded in the treatment T_{13} which recorded 1.30 mg 100 g^{-1} and 0.19 mg $100g^{-1}$ of calcium and magnesium content.

The data on estimates of protein, iron and ascorbic acid content of plant sample is presented in Table 4. The treatment T_8 (Vermicompost @ 5t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} +panchakavya @ 3 per cent foliar spray) recorded the highest protein, iron and ascorbic acid content of 6.80 mg 100 g^{-1}, 17.75 mg 100 g^{-1} and

47.90 mg g^{-1} The least value was recorded in the treatment T_{13} (control) which recorded 6.21 mg 100 g^{-1}, 16.30 mg 100 g^{-1} and 36.02 mg g^{-1} 6.21 of protein, iron and ascorbic acid.

The mineral composition in present study revaealed that *Moringa oleifera* has good source of calcium, magenesium, iron, vitamin C and protein.(Fig.8). Similar findings were reported by Lakshmipriya *et al*., (2015) and Ali, (2014).

Shailaja *et al.,* 2014, found out the impact of panchakavya on the leaf quality of *Spinacia oleracea* and concluded that the quality parameters like vitamins, minerals and protein are more with panchakavya treatment. Similar observation also made by Zanu *et al.,* (2012).

Hence it can be concluded that the treatment T_8 (Vermicompost @ 5t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} +panchakavya @ 3 per cent foliar spray) recorded higher values for nitrogen, phosphorus, potassium, calcium, magnesium, protein, iron and ascorbic acid and hence adjudged as the best treatment for enhancing quality parameters.

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