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Effect of organic manures and bio-stimulants on growth and yield of Curry leaf (*Murraya koenigii*)

***R. CHITRA, D. JANAKI AND P. JANSIRANI**

Department of Spices and Plantation Crops
Horticultural College and Research Institute, TNAU, Periyakulam, Tamil Nadu, India

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ABSTRACT

Curry leaf (Murraya koenigii Spreng.) is a perennial nutritious herbal spice crop grown for its aromatic leaves. As, curry leaf is indispensably used in our culinary preparations of South India, there is a need to improve the herbage yield and to optimize the usage of organic manures and bio-stimulants for the leaf production. Hence, the trial was taken to study the effect of organic manures (FYM, neem cake, vermicompost, biocompost) and biostimulants (Panchagavya, humic acid and liquid biofertilizer) on growth and yield of curry leaf at Department of Spices and Plantation Crops, HC & RI, TNAU, Periyakulam. The highest plant height of 102.83 cm and 106.10 cm were recorded in rabi and summer season plants applied with 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%) as foliar spray (T_3). The more number of matured shoots of 28.05 and 32.42 were recorded in rabi and summer season respectively in the plants which received 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%) as foliar spray. Highest fresh leaf yield of 4.50 tonnes and 6.90 tonnes per hectare were recorded in rabi and summer season respectively in the plants raised in the soil supplemented with various organic manure and sprayed with 3% panchagavya.

Keywords: Bio-stimulants, curryleaf, organic nutrients, panchagavya, vermicompost

Curry leaf (*Murraya koenigii* Spreng.) is a perennial nutritious herbal spice crop grown for its aromatic leaves. Besides, being a spice crop, curry leaf plays a major role in the Ayurveda and Unani systems of medicine due to its wide range of medicinal properties. Leaves of curry leaf plant are used as a green leafy vegetable to garnish food recipes. Curry leaf is sold both as fresh leaves and dried leaf powder. An essential volatile oil extracted from green leaves of curry leaf is commercially exploited in flavour and food industries. Essential oil of curry leaf has both domestic and export demand (Sivasubramaniam and Selvarani, 2012).

Curry leaf is extensively used in South India and Sri Lanka for its authentic flavour. The large scale commercial cultivation of curry leaves is seen in Guntur, Nellore, Anantapur and Krishna districts of Andhra Pradesh, Sanga Reddy, Medak, Siddipet, Kama Reddy and Nizamabad districts of Telangana and Coimbatore, Tiruppur, Salem and Thoothukudi districts of Tamil Nadu (Mohan, 2012). From UAS Dharwad, two varieties of curry leaf were released *viz*., Dharwad 1 and Dharwad 2 which are popular not only in Karnataka but also in Tamil Nadu, Andhra Pradesh and Maharastra. In Tamil Nadu, curry leaf is cultivated in around 500 acres in Coimbatore, Erode, Madurai, Salem and Trichirappalli districts (Jagadeeshkanth *et al*., 2018). Curry leaf has a huge demand in India and abroad which has made the commodity of immense trade value. The fresh leaves of curry leaf are exported to Gulf, European and African countries etc.

Among the horticulture crops, most of the spices and plantation crops are majorly cultivated by the application of organic manures for maintaining its quality. Since, curry leaf is cultivated for it's green leaf, nitrogen plays a major role on growth, yield and keeping quality. Moreover nitrogen availability from the applied sources to throughout the crop growth period is also of considerable importance. As, curry leaf is indispensably used in our culinary preparations of South India, there is a need to improve the herbage yield and to optimize the usage of organic manures and bio-stimulants for the leaf production. Therefore, taking above facts into consideration, the present investigation has been undertaken to evaluate the effect of different organic manures and bio-stimulants on growth and yield of curry leaf.

MATERIALS AND METHODS

The field experiment was conducted at the College Orchard, Department of Spices and Plantation Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Periyakulam during 2017-18 to 2018-19. The trial was taken to study the effect of organic manures (FYM, neem cake, vermicompost, biocompost – Sugar mill pressmud) and biostimulants (Panchagavya, humic acid and liquid biofertilizer - *Azospirillum*) on growth and yield of curry leaf. The

Email: chitra.varadharaj@gmail.com

field was located at $10^0 12'$ North latitude and $77^0 58'$ East longitude and at an altitude of 356 m above Mean Sea Level. The soil of the experimental field was red sandy loam in texture and pH of 7.3. The present study was conducted on ten years old curry leaf local ecotype Senkambu. The plot size was 6 × 1.2 m with a plant spacing of 60 × 60 cm having 20 plants per plot. The initial nutrient status of the soil was 182:14.9:354 kg NPK ha^{-1}. Before the study, curry leaf plants are purely grown under organic manure using farm yard manure and neem cake. Regular cultural operations were followed for the curry leaf as prescribed in Horticultural Crop Production Manual (Anon., 2018). In general, three crops are harvested in a year with 3 - 4 months interval during *rabi*, summer and *kharif* season. But *rabi* (October - December) and summer (March – May) are the two main seasons for leaf production. The experiment was laid out in randomized block design with ten treatment combinations of organic manure and bio-stimulants replicated thrice. The treatment details were as follows,

T_1 25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Panchagavya (3%)
T_2 50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Panchagavya (3%)
T_3 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%)
T_4 25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Humic acid (0.5%)
T_5 50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Humic acid (0.5%)
T_6 50% N as Vermicompost + 50% N as Neem cake + Humic acid (0.5%)
T_7 25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Liquid biofertilizer (1%)
T_8 50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Liquid biofertilizer (1%)
T_9 50% N as Vermicompost + 50% N as Neem cake + Liquid biofertilizer (1%)
T_{10} Control (RDF)

Organic manures like farm yard manure, neem cake, vermicompost and biocompost were applied in four splits at three months intervals after each clipping as per the treatment schedule. The fertilizers were applied as straight fertilizers to the control plot in the form of urea, superphosphate and muriate of potash @ 150:25:50 g of NPK $plant^{-1}$ $year^{-1}$ (Kumar *et al*., 2006). The foliar spray of bio-stimulants *viz*., Panchagavya (3%) was given three times using hand sprayer at 21 days interval. Humic acid (0.5%) and liquid *Azospirillum* (1%) were applied through soil application. Irrigation was given once in ten days through drip. At the time of harvest (90 days after last crop), morphological parameters such as plant height (cm), number of matured shoots, inter nodal length between two compound leaves (cm), length of matured shoot (cm), number of compound leaves per matured shoot and number of leaflets per compound leaf and fresh leaf yield (kg) were recorded during *rabi* and summer season. In each treatment, five plants per replication were selected at random and utilized for recording observations on the above characters and the mean values were subjected to statistical scrutiny as suggested by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

In pooled mean, significant variation in growth attributes during December (*rabi*) and May (summer) month were observed due to foliar spray of biostimulants and nutritional treatments (Table 4 and 5). The plant height measured at 90 days after last harvest resulted in the greatest value in summer season crop compared to *rabi* season crop. During summer season, the highest value of plant height (106.10 cm) was recorded by the plants treated with 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%) as foliar spray (T_3). Combined application of organic manures and bio-stimulants exerted a positive effect on the plant height at the harvest stage. The increase in plant height might be due to improvement in soil physical condition *viz.,* increased water holding capacity, improved particle density, pore spaces, texture and soil available nutrient status (Mbagulu, 1992). Abdullah Adil Ansari (2008) stated that organic amendments like vermicompost and vermiwash promote humification, increased microbial activity and enzyme production, which, in turn, bring about the aggregate stability of soil particles, resulting in better aeration and they also has a property of binding mineral particles like calcium, magnesium and potassium in the form of colloids of humus and clay, facilitating stable aggregates of soil particles for desired porosity to sustain plant growth. The possible reason for the acceleration of growth by the application of panchagavya might be due to the presence of nitrogen, the chief constituent of protein, essential for the formation of protoplasm which leads to cell division and cell enlargement. The nitrogen is also an important constituent of amino acids and coenzymes which exerted considerable role in enhancement of plant growth (Balkly, 1974). Whyte (1960) established that the temperature of the natural environment in which a plant grows was one of the chief determinants of growth and

reproductive development in many plant species. The high temperature, solar radiation and sunshine that prevailed during summer season (March to May) compared to winter season, might have favoured the greater plant height recorded in these seasons although it was not beneficial from the stand point of net income.

The more number of matured shoots of 28.05 and 32.42 were recorded in *rabi* season harvest and summer season respectively in the plants which received 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%) as foliar spray (T_3). The treatment T_3 recorded the highest length of matured shoot of 82.40 cm and 94.94 cm in *rabi* season and summer season respectively. The increase in number of shoots and length of shoots might be attributed due to the presence of auxins, cytokinins and gibberellins like substances present in combined application of organic manure and foliar spray of panchagavya which would activate the cell division and cell elongation in the axillary buds there by leading to the formation of more number of shoots and increased the length of shoots in curry leaf as attributed by Sridhar (2003) in *Solanum nigrum*, by Irene and Syama (2018) in Palak.

The lowest inter nodal length between two compound leaves of 2.05 cm and 2.02 cm were recorded in the plants fed with above mentioned manure (T_3) in *rabi* season and summer season harvest respectively. More number of compound leaves per matured shoot *i.e.* 45.58 and 53.00 and more number of leaflets per compound leaf *i.e.*18.90 and 18.90 were recorded in *rabi* season and summer season respectively in the plants given with 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%) as foliar spray (T_3). The combined application of organic manure and foliar spraying of panchagavya had favourable effect on intermodal length, number of leaves and number of leaflets in a compound leaf. This might be due to the presence of optimum C: N ratio, which on decomposition releases nitrogen in the form of usable nutrient ions such as ammonium and nitrate. This increase in the mineral constituents of soil might have exerted more number of leaves, since nitrogen is the chief constituent of amino acid and coenzymes of biological importance. This is in concurrence with the findings of Maheswarappa *et al*. (2001) in galangal and Subha *et al.* (2009) in curry leaf.

Table 1: Nutrient content of applied organic manures

Nutrient	Farmyard manure	Vermicompost	Neem cake	Bio-compost (Sugar mill pressmud)
Organic carbon (%)	5.1	9.5	1.2	32.60
N (%)	0.50	2.00	5.20	1.00
P_2O_5 (%)	0.20	0.31	0.98	1.15
K_2O (%)	0.57	0.52	2.30	0.62

Table 2: Chemical composition of biostimulants

Panchagavya		Liquid biofertilizer(*Azospirillum*)	Humic acid	
pH	5.6	Fixing Atmospheric nitrogen	Carbon (%)	50
EC (dS m^2)	4.6	20 kg ha^{-1}	Oxygen (%)	40
N (%)	1.4		Hydrogen (%)	5
P_2O_5 (%)	0.08		Nitrogen (%)	3
K_2O (%)	0.5		Phosphorous (%)	<1
			Sulfur (%)	<1

Table 3: Application of organic manure as per the treatment

Organic manure	FYM	Vermicompost	Neem cake	Biocompost
25% N	7.500 kg/plant	1.875 kg/plant	0.720 kg/plant	3.750 kg/plant
50% N	15.00 kg/plant	3.750 kg/plant	1.440 kg/plant	7.500 kg/plant
100% N	30.000 kg/plant	7.500 kg/plant	2.880 kg/plant	15.000 kg/plant

Table 4: Effect of organic manures and bio-stimulants on plant height, number of matured shoots and internodal length of curry leaf during *rabi* and summer season (Pooled mean)

Treatments	Plant height (cm)		Number of matured shoots		Internodal length between two compound leaves (cm)	
	***Rabi* season**	**Summer season**	***Rabi* season**	**Summer season**	***Rabi* season**	**Summer season**
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Panchagavya (3%)	91.23	91.05	21.58	25.25	2.21	2.28
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Panchagavya (3%)	89.68	95.80	22.53	26.92	2.33	2.18
50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%)	102.83	106.10	28.05	32.42	2.05	2.02
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Humic acid (0.5%)	89.20	95.60	21.70	25.39	2.31	2.25
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Humic acid (0.5%)	97.10	96.50	22.32	26.83	2.31	2.25
50% N as Vermicompost + 50% N as Neem cake + Humic acid (0.5%)	91.37	96.55	23.50	27.09	2.29	2.19
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Liquid biofertilizer (1%)	91.22	92.60	23.44	25.89	2.33	2.33
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Liquid biofertilizer (1%)	101.62	103.80	27.94	31.89	2.11	2.06
50% N as Vermicompost + 50% N as Neem cake + Liquid biofertilizer (1%)	96.08	93.95	23.02	27.27	2.34	2.29
Control (RDF)	83.39	86.50	18.84	22.37	2.55	2.47
Mean	**93.37**	**95.85**	**23.29**	**27.13**	**2.28**	**2.23**
SEm(±)	**2.03**	**2.00**	**0.47**	**0.47**	**0.01**	**0.04**
LSD (0.05)	**4.42**	**4.35**	**1.04**	**1.03**	**0.04**	**0.08**

Table 5: Effect of organic manures and bio-stimulants on length of matured shoot, number of compound leaves and number of leaflets per compound leaf of Curry leaf during *rabi* and summer season (Pooled mean)

Treatments	Length of a matured shoot (cm)		Number of compound leaves per matured shoot		Number of leaflets per compound leaf at the time of harvest	
	***Rabi* season**	**Summer season**	***Rabi* season**	**Summer season**	***Rabi* season**	**Summer season**
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Panchagavya (3%)	71.90	80.49	42.40	43.15	17.26	17.50
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Panchagavya (3%)	72.32	85.63	43.21	44.00	16.48	17.80
50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%)	82.40	94.94	45.58	53.00	18.90	18.90
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Humic acid (0.5%)	71.73	88.51	40.35	44.00	16.33	17.40
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Humic acid (0.5%)	72.29	88.89	41.44	45.50	16.23	17.50
50% N as Vermicompost + 50% N as Neem cake + Humic acid (0.5%)	71.80	82.54	42.36	46.40	16.08	17.90
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Liquid biofertilizer (1%)	74.50	81.49	41.29	43.40	16.74	17.30
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Liquid biofertilizer (1%)	79.90	94.58	45.56	52.00	18.73	18.80
50% N as Vermicompost + 50% N as Neem cake + Liquid biofertilizer (1%)	75.26	79.90	42.85	43.10	17.38	17.30
Control (RDF)	64.60	77.49	38.57	40.55	15.24	16.20
Mean	**73.67**	**85.45**	**42.36**	**45.51**	**16.94**	**17.66**
SEm(±)	**0.36**	**0.33**	**0.04**	**1.08**	**0.08**	**0.29**
LSD (0.05)	**0.79**	**0.72**	**0.10**	**2.36**	**0.18**	**0.64**

Table 6: Effect of organic manures and bio-stimulants on fresh leaf yield per plant, fresh leaf yield per plot and estimated fresh leaf yield per hectare in curry leaf during *rabi* and summer season (Pooled mean)

Treatments	Yield per plant (g)		Yield per plot (kg) (6 m × 1.2 m)		Estimated yield (t /ha)		BCR	
	Rabi season	Summer season	*Rabi* season	Summer season	*Rabi* season	Summer season	*Rabi* season	Summer season
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Panchagavya (3%)	350.56	590.67	3.15	5.31	3.50	5.90	1.31	1.11
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Panchagavya (3%)	310.73	580.48	2.79	5.22	3.10	5.80	1.28	1.20
50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%)	450.65	690.52	4.05	6.21	4.50	6.90	2.24	1.72
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Humic acid (0.5%)	340.71	595.95	3.06	5.36	3.40	5.95	1.29	1.13
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Humic acid (0.5%)	435.65	640.71	3.92	5.76	4.35	6.40	1.82	1.34
50% N as Vermicompost + 50% N as Neem cake + Humic acid (0.5%)	395.87	650.25	3.56	5.85	3.95	6.50	2.00	1.65
25% N as FYM + 25% N as Vermicompost + 25% N as Neem cake + 25% N as Biocompost + Liquid biofertilizer (1%)	380.34	550.67	3.42	4.95	3.80	5.50	1.44	1.07
50% N as Vermicompost + 25% N as Neem cake + 25% N as FYM + Liquid biofertilizer (1%)	438.74	680.61	3.94	6.12	4.38	6.80	1.83	1.42
50% N as Vermicompost + 50% N as Neem cake + Liquid biofertilizer (1%)	405.27	580.81	3.65	5.22	4.05	5.80	2.04	1.46
Control (RDF)	305.63	530.39	2.74	4.77	2.05	3.50	1.23	1.05
Mean	**381.42**	**609.11**	**3.43**	**5.48**	**3.81**	**6.09**	-	-
SEm(±)	**20.40**	**33.38**	**0.18**	**0.30**	**0.20**	**0.33**	-	-
LSD (0.05)	**42.56**	**69.63**	**0.38**	**0.62**	**0.42**	**0.69**	-	-

In curry leaf the major yield components are leaves. The highest leaf yield plant^{-1} (450.65 g and 690.52 g), fresh leaf yield plot^{-1} (4.05 and 6.21 kg) and estimated leaf yield per hectare (4.50 and 6.90 tonnes) were recorded in the plants fed with 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%) as foliar spray (T_3) in *rabi* season harvest and summer season harvest respectively (Table 6). The result is in concurrence with the findings of Kundu *et al*. (2015) in ber. The increased leaf yield might have occurred due to the presence of growth promoting hormones. This result is found to be in accordance with Madhavi Latha and Veena (2013) in palak and amaranthus, who stated that the application of organics 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. Abdullah Adil Ansari (2008) observed better growth of plants and higher yield in onion by slow release of nutrients for absorption with additional nutrients like giberellin, cytokinin and auxins, by the application of organic inputs like vermicompost in combination with vermiwash.

Among the various treatments, the plants fed with 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%) as foliar spray resulted in maximum B:C ratio of 2.24:1 and 1.72:1 during *rabi* and summer season respectively. The minimum B:C ratio of 1.23:1 and 1.05:1 during *rabi* and summer season respectively was observed in treatment T_{10} (control). The winter season (*rabi*) generally fetches very good market price since the leaf production is very limited in this season.

It can be concluded that the plants fed with 50% N as Vermicompost + 50% N as Neem cake + Panchagavya (3%) as foliar spray (T_3) recorded the highest fresh leaf yield of 4.50 and 6.90 tonnes ha^{-1} in *rabi* season and summer season respectively.

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