Biological Forum – An International Journal **13(4): 918-922(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Effect of Soil Drenching and Foliar Application of Biostimulants on Growth and Yield of Curry Leaf (*Murraya koenigii* Spreng.)

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(Received 15 September 2021, Accepted 17 November, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: A field experiment was conducted to study the effect of soil drenching and foliar application of different biostimulants on growth and yield of curry leaf (*Murraya koenigii* Spreng.) at Karamadai, Coimbatore during 2019 to 2021. This study was laid out in factorial randomised block design with control, factor 1 as soil drenching (D_1- humic acid @ 5 ml/plant and D_2- jeevamrutham @ 50 ml/plant), factor 2 as foliar spray of different biostimulants (S_1- Effective microorganism culture @ 2 %, S_2-Egg amino acid @ 1%, S_3-Panchagavya @ 3%, S_4-Sea weed extract @ 2% and S_5- Pink Pigmented Facultative Methylotrops (PPFM) @ 1 % and control as farmer practices. The experimental results revealed significantly higher plant height (129.30 cm), number of secondary branches (18.00), number of compound leaves (52.27), number of leaves per rachis (18.30) and fresh leaf yield (845.57 g/ plant) were observed in Humic acid + EM culture (D_1S_1). The rachis length (27.50 cm), leaf let length (7.65 cm) and leaf let width (4.06 cm) were significantly higher in Humic acid + Panchagavya (D_1S_3).

Keywords: Curry leaf, Soil drenching, Foliar spray, Biostimulants, EM culture, Yield.

INTRODUCTION

Curry leaf (*Murraya koenigii* Spreng.) belongs to the family Rutaceae, is native to India and Sri Lanka. Being the aromatic perennial leafy vegetable, it is used for several culinary, nutraceutical, medicinal, therapeutic and industrial purposes owing to the presence of wide range of bio-active and aromatic compounds (Raghu *et al*., 2020).

It is a rich source of vitamin A, vitamin C and minerals like iron and calcium (Vandana, *et al*., 2012) and contains small amounts of carbohydrate and proteins as well as bioactive compounds that have antibacterial, antifungal, and antioxidant properties (Shrivastav *et al.*, 2013). It is an export-oriented cash crop grown extensively in the southern states of India viz., Kerala, Tamil Nadu, Karnataka and Andhra Pradesh. It is cultivated on a large scale in Tamil Nadu (2497 ha), especially in Coimbatore, Erode, Madurai, Salem and Thiruchirapalli districts. Coimbatore alone constitutes about half of the total area concentrating more in Karamadai and Mettupalayam. Fresh curry leaf is exported mainly to Gulf and European countries, and curry leaf powder is exported to various countries including USA, Saudi Arabia, UAE, UK, Qatar (Paramasivam, 2020).

Biostimulants are composed of bioactive compounds such as amino acids, peptides, humic substances, seaweed extracts, Effective microorganism, Panchagavya, jeevamrutham etc. Seaweeds are used as nutrient supplements such as biostimulants or biofertilizers to increase the plant growth and yield (Maheshwari *et al*., 2004). Biostimulants can be used to enhance and promote sustainable production of indigenous leafy vegetables like *A. hybridus* (Ngoroyemoto *et al.*, 2019). Effective microorganism has been shown to improve soil health, growth, yield and quality of the crops over wide range of agroecological conditions. Foliar application of EM mainly to suppress the occurrence of plant disease and facilitates nutrient uptake to enhance the plant growth and yield (Wididana and Higa 1994). Chen and Avaid, (1990) found that application of humic acid and humus substances influence the plant growth and development. Zakaria Fouad Fawzy (2010) reported that application of humic acid was found to improve the growth, yield and quality in lettuce. SEs contain major and minor nutrients, amino acids, vitamins, and also cytokinins, auxins, and ABA like growth substances. Positive responses observed in different crops with application of SE are attributed to the presence of cytokinin (Crouch *et al*., 1993).

Conventional farming leads to negative impact on environment and human health. Therefore, it is need of hour to reduce the use of synthetic fertilizer and

pesticide. Organic cultivation of curry leaves has dual benefit of improving both human and soil health. Keeping this in view in the present study effect of soil drenching and foliar application of biostimulants on growth and yield of curry leaf (*Murraya koenigii* Spreng.) was conducted.

MATERIALS AND METHODS

The experiment was conducted in the farmer's organic field, Karamadai Coimbatore, during 2019-20 to 2020-21. The experiment was laid out in factorial RBD with control, replicated thrice. Factor 1 as soil drenching (D_1- humic acid @ 5 ml/plant and D_2- jeevamrutham @ 50 ml/plant); factor 2 as foliar spray of different biostimulants (S_1- EM culture (Effective microorganism) @ 2 %, S_2-Egg amino acid @ 1%, S_3-Panchagavya @ 3 %, S_4-Sea weed extract @ 2% and S_5- PPFM (Pink Pigmented Facultative Methylotrops) @ 1 % and control is farmer practices (tank silt @ 25 t/ ha. as a basal doses + fish oil resin soap + Mixed herbal leaf extract). The local cultivar Senkambu (eight years old) with spacing 1m × 1 m is used for this study. One week after pruning soil drenching was given and the foliar application at 30, 50 and 70 days after pruning. Morphological parameters like plant height (cm), number of secondary branches per plant, number of compound leaves, number of leaves per rachis, rachis length (cm), leaflet length (cm), leaflet width (cm) and fresh leaf yield (g/plant) were recorded 90 days after pruning. Harvesting was done once in three months (four cuttings per year) and cumulative yield was taken as annual fresh leaf yield per plant.

RESULTS AND DISCUSSION

Plant height and number of secondary branches. Soil drenching and foliar spray has shown significant differences on plant height and number of secondary branches (Table 1). The humic acid + EM culture @ 2 % (D_1S_1) recorded highest plant height (129.30 cm) and number of secondary branches (18.00) in treatment than the check (plant height -126.80 cm, number of secondary braches -17.70). The treatment combinations and check also showed significant differences in plant heightand number of secondary branches. The lowest plant height (113.50 cm) and no. of secondary branches (16.35) were observed in jeevamrutham + PPFM (D_2S_5). Soil drenching exhibited non-significant difference between humic acid and jeevamrutham but the maximum plant height (121.29 cm) and no .of secondary branches (17.18) were observed in humic acid @ 5 ml in all the treatments. Hartwigson and Evans (2000) reported that increase in the plant height and more number of secondary branches might be due to the application of humic acid that which increased soil fertility due to increased availability of nutrients. Shokouhian *et al.,* (2013) observed a significant effect on highest plant height, more number of branches, number of leaves and leaf area in *Prunus dulcis.* Suresh *et al.,* (2016) reported that 30 cm pruning height and application of 0.3 % humic acid increased the plant height and number of secondary branches in curry leaf.

Table 1: Effect of soil drenching and foliar spray of biostimulants on plant height (cm) and number of secondary branches.

Treatment	Plant height(cm)			Number of secondary branches		
	D_1	**D_2**	**Mean**	**D_1**	**D_2**	**Mean**
S_1	129.30	128.50	128.90	18.00	17.90	17.95
S_2	119.60	118.29	120.04	16.80	17.00	16.90
S_3	121.81	120.57	120.10	17.41	17.30	17.35
S_4	121.60	118.40	120.00	17.39	17.20	17.29
S_5	114.20	113.50	113.85	16.39	16.35	16.34
Mean	121.29	119.86	120.57	17.18	17.15	17.16
Check	126.80			17.70		
	S	D	S × D	S	D	S × D
SE	1.28	0.81	1.81	0.16	0.10	0.22
C.D(5%)	3.78*	2.39	5.35*	0.47*	0.30	0.67*

Leaflet length and leaflet width. The data with respect to leaflet length and leaflet width are presented in Table 2. The leaflet length was significantly influenced by the foliar spray of different biostimulants. Among the foliar sprays, Panchagavya @ 3 % (S_3) was recorded maximum (7.46 cm) leaf let length and minimum (5.58 cm) in PPFM @ 1 % (S_5). The leaflet length showed non significant effect for soil drenching. The interaction effect showed significant difference between foliar spray and soil drenching. The maximum leaflet length was recorded in D_1S_3 (7.65 cm) than check (6.50 cm) and minimum in D_1S_5 (5.44 cm).

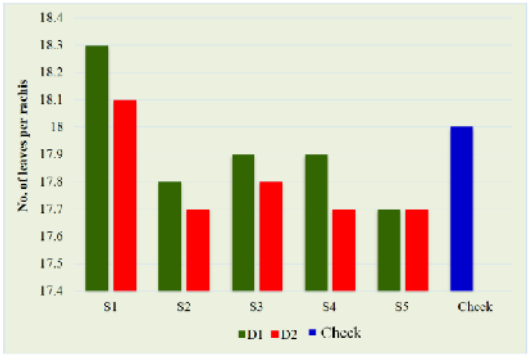
The leaflet width differed significantly for both soil drenching and foliar spray. Among the different foliar sprays, the leaflet width was highest (3.84 cm) recorded in Panchagavya @ 3 % (S_3) and lowest (3.21 cm) in PPFM @ 1 % (S_5). In soil drenching the maximum (3.80 cm) leaflet length was recorded in humic acid (D_1) and minimum (3.29 cm) in jeevamrutham (D_2). The interaction effect was non significant between soil drenching and foliar spray. Abdel *et al.,* (2013) reported that application of humic acid increased the leaf length and number of leaflets in garlic. These results might be due to the role of humic acid as a source of nutrients and increasing soil fertility which consequently increased the production of assimilates and resulted in increased leaf size.

Table 2: Effect of soil drenching and foliar spray of biostimulants on leaflet length (cm) and leaflet width (cm).

Treatment	Leaflet length (cm)			Leaflet width (cm)		
	D_1	D_2	Mean	D_1	D_2	Mean
S_1	6.16	6.20	6.18	3.80	3.44	3.62
S_2	5.61	6.01	5.81	3.39	3.30	3.55
S_3	7.65	7.27	7.46	4.06	3.87	3.84
S_4	6.37	6.45	6.41	3.57	3.24	3.52
S_5	5.44	5.73	5.58	2.81	2.61	3.21
Mean	6.24	6.33	6.28	3.80	3.29	3.55
Check	6.50			3.92		
	S	D	S × D	S	D	S x D
SE	0.05	0.03	0.08	0.03	0.02	0.04
C.D(5%)	0.17*	0.10	0.24*	0.09*	0.06*	0.14

Among the interaction, the treatment receiving humic acid + EM culture (D_1S_1) recorded the highest fresh leaf yield (845.57 g) compared to check (820.81g) and lowest (805.60g) in jeevamrutham + PPFM (D_2S_5). Javaid *et al.*, (2011) foliar spray with EM culture significantly enhanced shoot biomass over control in NPK fertilizer in pea. The effective microorganism culture consists of co-existing beneficial microorganisms, which improves crop growth and yield by increasing photosynthesis which producing bioactive substances such as hormones and enzymes. This controls soil diseases and accelerates decomposition of lignin materials in the soil (Hussain *et al.*, 2002).

Number of leaves per rachis. The effect of soil drenching and foliar spray of biostimulants on number of leaves per rachis is given in Fig. 1. Among all the treatment combinations, number of leaves per rachis was non-significant during the crop growth and development. However, the highest value (18.3) was found in treatment D_1S_1 and check was also found to be non significant. The check recorded higher number of leaves per rachis except their treatment combinations (D_2S_2, D_2S_3, D_2S_4 and D_2S_5). Influence of humic acid on enhancement of the number of leaflets per leaf was observed in garlic by Abdel *et al.*, (2013).



Foliar spray
S_1 – EM culture @ 2%, S_2 – Egg amino acid @ 1%,
S_3 – Panchagavya @ 3%, S_4 – Sea weed extract @ 2% S_5 –PPFM @ 1%

Soil drenching
D_1 – Humic acid @ 5 ml
D_2 – Jeevamrutham @ 50 ml

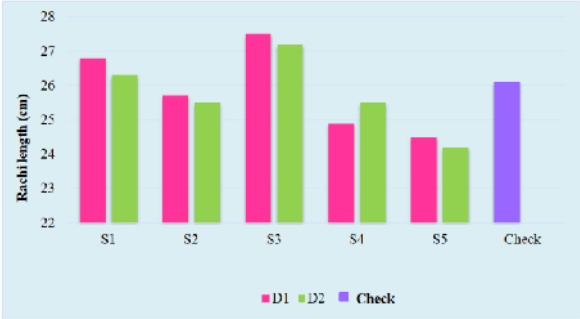
Fig. 1. Effect of soil drenching and foliar spray of biostimulants on Number of leaves per rachis.

Rachis length. The effect of soil drenching and foliar spray of biostimulants on rachis length is given in Fig. 2. The foliar spray of biostimulants showed significant difference on rachis length. The highest rachis length (27.5 cm) was recorded in panchagavya (S_3) compared to check (26.1 cm) followed by EM culture (S_1) and minimum (24.2 cm) in PPFM (S_5). The interaction effect between the soil drenching and foliar spray showed non significant differences on rachis length. Sanjutha *et al.*, (2008) reported that growth enzymes present in panchagavya might have aid to rapid cell division and multiplication which increases growth characters such as number of leaves, leaf area and leaf length in *Andrographis paniculata*.

Number of compound leaves and fresh leaf yield per plant. The data with respect to number of compound leaves and fresh leaf yield are presented in Table 3. The number of compound leaves were significantly different for soil drenching and foliar spray. In foliar spray more number of compound leaves (51.86) were recorded in EM culture @2 % (S_1) than check (50.10) and least number of compound leaves (45.43) in PPFM @1 % (S_5). Significant differences were observed in number of compound leaves on soil drenching of biostimulants. The higher number of leaves (48.16) observed in humic acid (D_1) and lower number of leaves (47.98) in jeevamrutham (D_2).

The interaction effect were significant difference for the foliar spray and soil drenching. More number of compound leaves were recorded in D_1S_1 (52.27) compared to check (50.10) and minimum in D_2S_5 (45.15).

Significant differences were also recorded in foliar spray treatments of biostimulants. The foliar spray of EM culture @ 2 % recorded the highest fresh leaf yield per plant (840.18g) and lowest (808.10g) in PPFM @1 %. The fresh leaf yield per plant did not show significant differences among the soil drenching treatments. While, the interaction effect showed significant differences in fresh leaf yield per plant among the treatments. In curry leaf Suresh *et al.*, (2016) reported the enhanced the number of compound leaves and leaf yield due to application of humic acid at 0.3 %.



Foliar spray
S_1 – EM culture @ 2%, S_2 – Egg amino acid @ 1%,
S_3 – Panchagavya @ 3%, S_4 – Sea weed extract @ 2% S_5 –PPFM @ 1%

Soil drenching
D_1 – Humic acid @ 5 ml
D_2 – Jeevamrutham @ 50 ml

Fig. 2. Effect of soil drenching and foliar spray of biostimulants on Rachi length (cm).

Table 3: Effect of soil drenching and foliar spray of biostimulants on number of compound leaves and fresh leaf yield per plant (g).

Treatment	Number of compound leaves			Fresh leaf yield /plant (g)		
	D_1	D_2	Mean	D_1	D_2	Mean
S_1	52.27	51.45	51.86	845.57	834.80	840.18
S_2	48.13	46.14	47.13	817.91	810.31	814.11
S_3	48.61	48.49	48.55	820.10	817.50	818.80
S_4	46.10	48.66	47.38	814.62	810.87	812.74
S_5	45.70	45.15	45.43	810.60	805.60	808.10
Mean	48.16	47.98	48.07	821.76	815.81	818.78
Check	50.10			820.81		
	S	D	S × D	S	D	S × D
SE	0.35	0.22	0.50	5.64	3.57	7.98
C.D(5%)	1.04*	0.66*	1.48*	16.69*	10.56	23.61*

CONCLUSION

From the study, it was concluded that the soil drenching with humic acid @ 5ml per plant and foliar spray with EM culture @ 2% followed by Panchagavya @ 3% showed better performance over the farmer's practice for plant growth and yield in curry leaf. Thereby, biostimulants can be used as organic based compounds which improves curry leaf production under organic farming.

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How to cite this article: Chinnapappa, M.; Ramar, A.; Manickam, S.; Velmurugan, S.; Ravichandran, V. and Bhuvaneswari, K. (2021). Effect of Soil Drenching and Foliar Application of Biostimulants on Growth and Yield of Curry Leaf (*Murraya koenigii* Spreng.). *Biological Forum – An International Journal*, *13*(4): 918-922.