Original Research Article

Influence of soil drenching and foliar application of biostimulants on physiological and quality parameters in curry leaf.

Abstract

A field experiment was conducted to study the effect of soil drenching and foliar application of different biostimulants on physiological and quality parameters of curry leaf (*Murraya Koenigii* Spreng.) at Karamadai, Coimbatore during 2019 to 2021. This study was laid out in factorial randomized 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 that significantly higher leaf area (9.88 cm^2), chlorophyll a (0.89 mg/g), chlorophyll b (0.66 mg/) and total chlorophyll (1.80 mg/g) and fresh herbage yield (840.18g) in the treatment D_1S_3 (Humic acid + Panchagavya @3 %). Quality parameters like essential oil (0.19%) and oleoresin (2.86%) were significantly higher in the treatment D_1S_4 (Humic acid + sea weed extract).

Key words: Curry leaf, Soil drenching, Foliar spray, Leaf area, Chlorophyll, Quality.

Introduction

Murraya koenigii is commonly known as curry leaf or Karipatta in Indian accent and also called as miracle plant for its importance. *Murraya* belongs to the family Rutaceae, which represents more than 150 genera and 1600 species. Among fourteen global species belongs to the genus of *Murraya*, only *Murraya koenigii* Spreng and *Murraya paniculata* (Linn) is available in India (Nayak *et al*., 2010). It is native to South Asia particularly India, Sri Lanka and Bangladesh and distributed throughout India. It is considered as the most important ingredients in South Asian cuisine for its fragrance and aroma due to presenceof pinene, sabinene, caryophyllene, cardinol and cardinene (Dipika *et al*., 2021). Curry leaves are used as source of calcium to those with calcium deficiency besides, that it has Vitamin A, Vitamin B and B2, Vitamin C and iron. It has been used for centuries in the Ayurvedic System of Medicine. The leaves, bark and the roots of the plant are used in indigenous medicine as tonic, stomachic, stimulant and carminative (Singh et al., 2014). Curry leaf essential oil is used several industrial applications in the manufacturing of soaps, perfumes, cosmetics, food processing and many others. Dried leaf powder, food preparations using leaf powder and essential oils are exported to several countries

(Raghu et al. 2020). Curry leaf has richest source of carbazole alkaloids, which act as anti-tumor, anti-oxidative, anti-mutagenic and anti-inflammatory (Muthumani *et al*., 2010).

Biostimulants are environmental-friendly substances that can increase crop yield by acting on plant metabolism thus improving nutrient use efficiency (Yazdani *et al.,* 2014). 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 (Khan *et al*., 2009). They can alter the biological, biochemical, and physical properties of the soil and enhance the performance of plants under abiotic stress. They can also give impact on the overall transcriptome profile by modifying the plant metabolism (Battacharyya *et al*., 2015).

The main objective of using biostimulants are to the reduce chemical fertilizers and to accelerate the organic products for healthy life. The present study focused on determining the influence of soil drenching and foliar application of biostimulants on physiological and quality parameters in curry leaf.

Materials and methods

A field experiment was conducted in the farmer's field practicing organic farming, Karamadai, Coimbatore, during 2019-20 to 2020-21. The experiments were laid out in factorial RBD with control and 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 +Ebomidin @ 3% and Mixed herbal leaf extract @ 2% as foliar application). The local cultivar Senkambu (eight years old) with spacing 1m x 1m is used for this study. One week after pruning soil drenching was given and the foliar applications at 30, 50 and 70 days after pruning were imposed. Physiological parameters like leaf area (cm), chlorophyll a, chlorophyll b and total chlorophyll and quality parameters like essential oil (%) and oleoresin (%) were recorded 80 days after pruning. The harvesting was done four times per year with the harvest intervals of three months.

Comment [sm1]: Citation for the methods

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Table. 1 Treatment details

Treatments	Treatment combination	
	Factor 1 (Soil drenching)	Factor 2 (foliar application)
D_1S_1		EM culture @ 2%
D_1S_2		Egg amino acids @ 1%

D_1S_3	Humic acid @ 5 ml	Panchagavya @ 3%
D_1S_4		Sea weed extract @ 2%
D_1S_5		PPFM @ 1%
D_2S_1	Jeevamrutham @50 ml	EM culture @ 2%
D_2S_2		Egg amino acids @ 1%
D_2S_3		Panchagavya @ 3%
D_2S_4		Sea weed extract @ 2%
D_2S_5		PPFM @ 1%
Check (farmer's practice)	Tank silt @ 25 t/ ha. as a basal doses + fish oil resin soap + Ebomidin @ 3% and Mixed herbal leaf extract @ 2%	

Results and discussion

Physiological parameters

Leaf area

The effect of soil drenching and foliar application of biostimulants on leaf area is given in table 3 and figure 1. The foliar spray of biostimulnats showed significant differences in leaf area. The highest leaf area (9.81 cm^2) was recorded in panchagavya @ 3% (S_3) compared to check (9.57 cm^2) lowest leaf area (7.48 cm^2) in PPFM (S_5). The leaf area did not show significant differences in soil drenching treatments. Whereas, the interaction effect showed significant differences in leaf area among the treatments. Availability of nutrients, would have aided in increased the number of leaves, leaf area, leaf area index, photosynthetic rate. Turkmen *et al.* (2005) reported that application of humic acid increased the nitrogen content of shoot and root and which may lead to increase biomass of the crops. Similar observation for increase in leaf area was studied by Medeiros *et al*. (2001) [12] in lettuce. Beaulah (2001) reported that spraying with panchagavya produced bigger leaves and denser canopy in moringa.

Comment [sm3]: Highlight the method of estimating the area. Formula or calculation method. And please cite the procedure.

Comment [sm4]: Statistical way of explanation is required.

Fresh herbage yield

The data with respect to fresh herbage yield are presented in Table 3. The fresh leaf yield was significantly different for foliar spray of biostimulants. Foliar spray of Panchagavya @ 3 % recorded the highest fresh leaf yield per plant (840.18g) and lowest (808.10 g) in PPFM @ 1 %. Soil drenching treatment was significantly not different for fresh leaf yield per plant. Interaction effect was significantly different for fresh leaf yield per plant.

Comment [sm5]: Methods for estimating the herbage ? citation for the same

Chlorophyll

The data with respect to chlorophyll a, chlorophyll b and total chlorophyll is presented in table 2. Chlorophyll a was significantly influenced by foliar spray with different biostimulants. Among the foliar treatments, Panchagavya @ 3 % (S_3) recorded maximum chlorophyll a (0.88mg/g) and minimum (0.62 mg/g) in PPFM @ 1 % (S_5). The chlorophyll a showed non-

significant effect with respect to soil drenching. Furthermore, interaction effect also showed non-significant difference between foliar spray and soil drenching.

Chlorophyll b differed significantly for foliar application of biostimulants. Among the different foliar sprays, the chlorophyll b was highest (0.65 mg/g) in Panchagavya @ 3 % (S_3) and lowest (0.39 mg/g) in PPFM @ 1 % (S_5). Chlorophyll b showed non-significant effect on soil drenching. The interaction effect also showed non-significant difference between foliar spray and soil drenching.

Soil drenching and foliar application has shown significant differences on total chlorophyll content. In foliar spray maximum total chlorophyll (1.70 mg/g) were recorded in Panchagavya @ 3 % (S_3) compared to the check (1.40 mg/g) and minimum (0.85 mg/g) in PPFM @ 1 % (S_5). Significant differences were observed in total chlorophyll on soil drenching of biostimulants. Among the soil drenching treatments the highest value for total chlorophyll (1.27 mg/g) was recorded in humic acid (D_1) and lowest (1.24 mg/g) in jeevamrutham (D_2). The interaction effect was significantly different for both foliar spray and soil drenching. The higher total chlorophyll content was recorded in D_1S_3 (1.80 mg/g) compared to check (1.40 mg/g) and lower in D_2S_5 (0.80mg/g). Kaur *et al.* (2014) humic acid, panchagavya also have cytokinin which can influence various physiological activities such as chlorophyll synthesis leading to increase in photosynthesis and as a result induces growth of the plant. Ping *et al,* (2001) reported that the enhanced uptake of Mg^{2+} and Fe^{2+} in the presence of humic acid resulted in enhanced chlorophyll synthesis. Sreenivasa *et al.* (2010) reported that panchagavya sprayed on chilli produced dark green colour in leaves.

Quality parameters

The effect of soil drenching and foliar spray of biostimulants on essential oil is given in table 4 and figure 2. The foliar spray of biostimulants showed significant differences on essential oil. The higher essential oil content (0.18%) was recorded in sea weed extract (S_4) followed by EM culture (S_1) and lower (0.11%) in PPFM (S_5). The interaction effect between the soil drenching and foliar spray showed significant differences in essential oil. The higher essential oil observed in humic acid + sea weed extract (D_1S_4) compared to check (0.12 %) and the lower (0.13%) in PPFM (S_5).

The effect of soil drenching and foliar spray of biostimulants on oleoresin is given in figure 3. Significant differences were recorded in foliar spray treatments of biostimulants. Foliar spray of sea weed extract @ 2 % recorded the highest oleoresin content (2.83%) and lowest (2.30%) in PPFM @1 %. Significant differences for oleoresin was observed in soil drenching of biostimulants alone. While, the interaction effect showed significant differences in oleoresin among the treatments. Hamidreza Bayat (2019) reported that seaweed contain all required trace elements and plant growth hormones and sea weed manure is also rich in potassium and poor in nitrogen and phosphorus. The increased efficiency of translocation due to foliar spray of seaweed extract and humic acid in turn contributed to higher uptake of nutrients resulting in better quality. Similar findings were reported by Maheshwari *et al*. (2004) in chilli.

Conclusion

The present study revealed that soil drenching with humic acid @ 5 ml/plant and foliar application with panchagavya @ 3% at 30 days, 50 days and 70 days after pruning, has significantly increased the physiological characters and yield. Whereas foliar application of sea weed extract @ 2% showed better performance for quality characters than control in curry leaf. Hence, biostimulants can be used as an organic based compound which improves curry leaf production with increased quality under organic farming.

Comment [sm6]: Conclusion seems general. include a detailed discussion on the study.

Table 2. Effect of soil drenching and foliar spray of biostimulants on chlorophyll a (mg/g), chlorophyll b (mg/g) and total chlorophyll (mg/g)

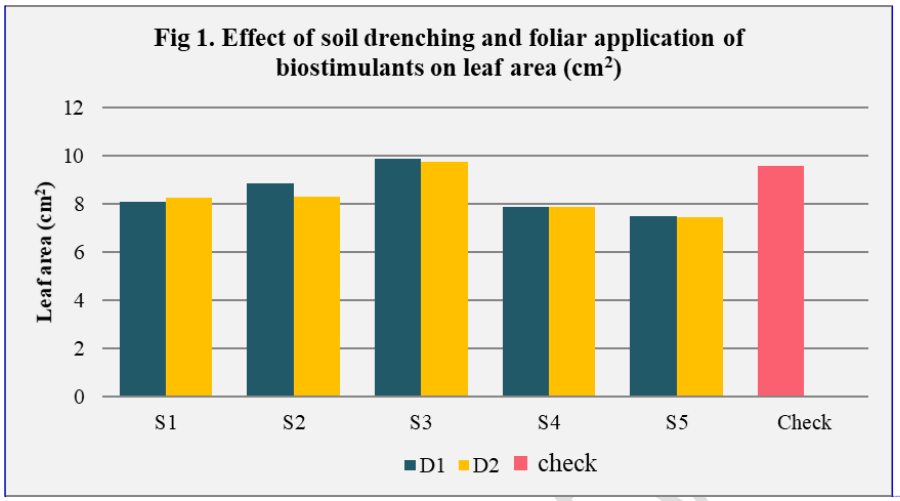
Treatment	Chlorophyll a (mg/g)			Chlorophyll b (mg/g)			Total chlorophyll (mg/g)		
	D_1	D_2	Mean	D_1	D_2	Mean	D_1	D_2	Mean
S_1	0.77	0.78	0.77	0.48	0.49	0.48	1.30	1.30	1.30
S_2	0.73	0.73	0.73	0.51	0.50	0.50	1.19	1.30	1.24
S_3	0.89	0.88	0.88	0.66	0.65	0.65	1.80	1.60	1.70
S_4	0.72	0.69	0.70	0.46	0.47	0.46	1.19	1.20	1.19
S_5	0.63	0.62	0.62	0.39	0.39	0.39	0.90	0.80	0.85
Mean	0.74	0.74	0.74	0.50	0.50	0.50	1.27	1.24	1.25
Check	0.85			0.53			1.40		
	S	D	S x D	S	D	S x D	S	D	S x D
SE	0.008	0.005	0.113	0.005	0.003	0.008	0.145	0.009	0.020
C.D(5%)	0.024*	0.015	0.034	0.016*	0.010	0.024	0.043*	0.027*	0.060*

Table 3. Effect of soil drenching and foliar spray of biostimulants on leaf area (cm^2) and fresh herbage yield / plant (g)

Treatment	Leaf area (cm^2)			Fresh herbage yield /plant (g)		
	D_1	D_2	Mean	D_1	D_2	Mean
S_1	8.11	8.25	8.18	820.10	817.50	818.80
S_2	8.86	8.32	8.59	817.91	810.31	814.11
S_3	9.88	9.75	9.81	845.57	834.80	840.18
S_4	7.89	7.88	7.88	814.62	810.87	812.74
S_5	7.51	7.46	7.48	810.60	805.60	808.10
Mean	8.45	8.33	8.39	821.76	815.81	818.78
Check	9.57			820.81		
	S	D	S x D	S	D	S x D
SE	0.074	0.047	0.105	5.64	3.57	7.98
C.D(5%)	0.220*	0.139	0.312*	16.69*	10.56	23.61*

Table 4. Effect of soil drenching and foliar spray of biostimulants on essential oil (%) and oleoresin (%)

Treatment	Essential oil (%)			Oleoresin (%)		
	D_1	D_2	Mean	D_1	D_2	Mean
S_1	0.15	0.15	0.15	2.48	2.48	2.48
S_2	0.13	0.13	0.12	2.31	2.34	2.32
S_3	0.12	0.13	0.12	2.34	2.45	2.39
S_4	0.19	0.17	0.18	2.86	2.81	2.83
S_5	0.12	0.12	0.11	2.23	2.37	2.30
Mean	0.14	0.13	0.13	2.44	2.48	2.46
Check	0.12			2.33		
	S	D	S x D	S	D	S x D
SE	0.002	0.001	0.003	0.023	0.015	0.033
C.D(5%)	0.006*	0.004	0.009*	0.044*	0.070*	0.136



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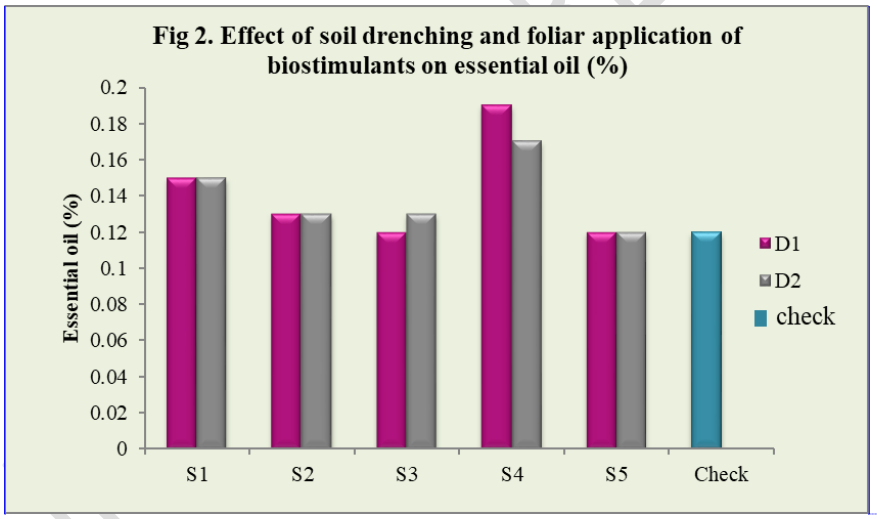

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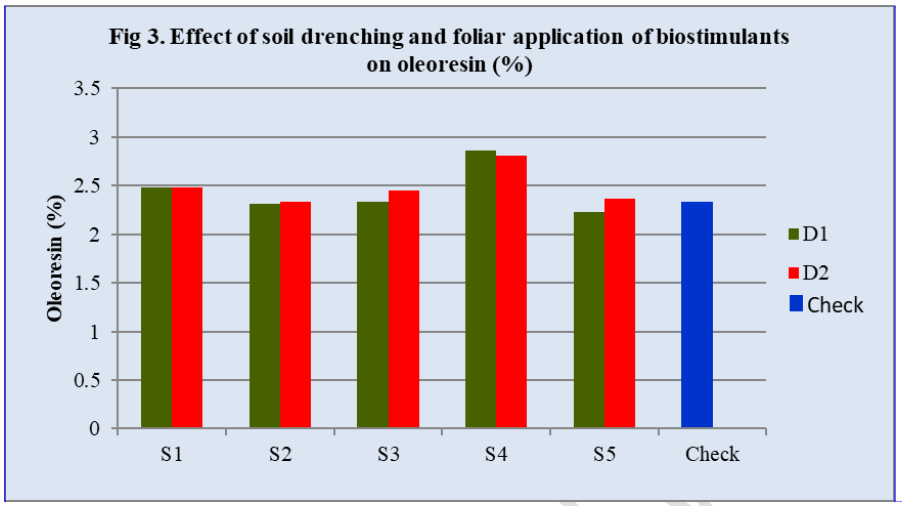
Foliar spray

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



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Foliar spray **Soil drenching**

S_1 – EM culture @ 2%, S_2 – Egg amino acid @ 1%, D_1 – Humic acid @ 5 ml
S_3 – Panchagavya @ 3%, S_4 – Sea weed extract @ 2% D_2 – Jeevamrutham @ 50 ml
S_5 –PPFM @ 1%

References

Battacharyya, D., Babgohari, M. Z., Rathor, P., and Prithiviraj, B. (2015). Seaweed extracts as biostimulants in horticulture. Sci. Hortic. 196, 39–48. doi: 10.1016/j.scienta.2015.09.012

Beaulah A. Growth and development of moringa (Moringa oleifera Lam.) under organic and inorganic systems of culture. Ph.D. Thesis, Tamil Nadu Agric. 57 .Univ, Coimbatore; 2001.

Dipika Bhusal and Dhirendra Pratap Thakur. 2021. Review of curry leaf (*Murraya koenigii*). Reviews in Food and Agriculture. 2(1): 36-38

Kaur S, Mondal P (2014) Study of total phenolic and flavonoid content, antioxidant activity and antimicrobial properties of medicinal plants. Journal of Microbiology and Experimentation 1(1): 1-6.

Khanam U, Oba S, Yanase E, Murakami Y (2012) Phenolic acids, flavonoids and total antioxidant capacity of selected leafy vegetables. Journal of Functional Foods 4(4): 979-987.

Maheshwari, T.U., Haripriya, K., Poonkodi, P. and Kamalakannan, S. 2004. Effect of foliar application of organic nutrients on some quality indices and economics of chilli (*Capsicum annuum* L.). Adv. Plant Sci. 17(1):259-262.

Medeiros LA, Manfron M, Medeiros PA, Bonnecarrere SLP. Growth and development of lettuce (*Lactuca sativa* L.) in a plastic greenhouse with fertigation in substrates. Cinecia Rural. 2001; 31(2):199-204.

Muthumani P, Ramseshu VK, Meera R, Devi P. 2010. Phytochemical Investigation and Anti Microbial and Enzyme Inhibition Activity of *Murraya Koenigii* (Linn). Int J Pharm Biol Archives. 1: 345-349.

Nayak A, Mandal S, Banerji A, Banerji J., Review on chemistry and pharmacology of *Murraya koenigii* Spreng (Rutaceae), Journal of Chemical and Pharmaceutical Research., 2010, 2(2), 286-299.

Peng Zheng Ping X, Shichuan S, Zhi Mei MM, Xin Z. A study of the effect of humic acid compound fertilizer on the quality and physiological index of Brassica. J Hebei Agric. Univ. 2001; 24(10):24-27.

Raghu B.R. 2020. Diversity and Distribution of Curry Leaf in India. *J. Hortl. Sci 15(1) : 1-8,*

Singh S, More PK, Mohan SM., Curry leaves (Murraya koenigii Linn. Sprengal)-a mircale plant, Indian Journal of Scientific Research., 2014, 4(1), 46-52.

Sreenivasa, M.N., Naik, N., Bhat, S.N and Nekar, M.M. (2010). Effect of organic liquid manures on growth, yield ad quality of chilli(Capsicum annuum L.) Green Farming 1(3): 282-284.

Yazdani, B., Nikbakht, A., and Etemadi, N. (2014). Physiological effects of different combinations of humic and fulvic acid on Gerbera. Commun. Soil Sci. Plant Anal. 45, 1357 1368. doi: 10.1080/00103624.2013.875200.

Turkmen OS, Demir S, Ensoy A. Effects of Arbuscular Mycorrhizal Fungus and Humic Acid on the Seedling Development and Nutrient Content of Pepper Grown under Saline Soil Conditions. J Bio. Sci. 2005; (5):565574.