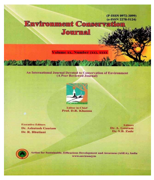
Environment Conservation Journal 25 (3): 668-673, 2024

Journal homepage:https://www.environcj.in/

Environment Conservation Journal

ISSN 0972-3099 (Print) 2278-5124 (Online)



Effects of mulching and nutritional strategies on the growth and yield of sweet basil (*Ocimum basilicum* L.)

Nayana H. ✉
Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Bengaluru, UHS, Bagalkote, Karnataka, India

Maruthi Prasad B. N.
Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, Bengaluru, UHS, Bagalkote, Karnataka, India

Shivanna M.
Department of Soil Science and Agricultural Chemistry, College of Horticulture, Bengaluru, UHS, Bagalkote, Karnataka, India

Halesh G. K.
Department of Biotechnology and Crop Improvement, College of Horticulture, Bengaluru, UHS, Bagalkote, Karnataka, India

Prasanna H. S.
International Potato Center, C/o College of Horticulture, Bengaluru, UHS, Bagalkote, Karnataka, India

Meghana H. R.
Department of PSMAC, College of Horticulture, Bagalkote, Karnataka, India

ARTICLE INFO

Received : 14 December 2023
Revised : 09 March 2024
Accepted : 24 March 2024

Available online: 20 April 2024

Key Words:
Growth
Humic acid
Microbial consortia
Mulch
Yield

ABSTRACT

The effect of mulching and nutrition on the growth and yield of sweet basil was examined by experimenting with four mulch treatments, *viz*., without mulch, black plastic, silver plastic, and organic mulch combined with four different nutrient compositions, *viz*., a 100% recommended dose of fertilizer (RDF), a combination of 75% RDF with humic acid, 75% RDF with microbial consortia and 75% RDF, and humic acid and microbial consortia, which served as sixteen treatment combinations with 100% RDF without mulch as a control. Among the different treatments, mulch had a significant effect on growth and yield parameters, with black plastic mulch having the maximum plant height (88.20 cm), number of branches (14.95), plant spread (5415 cm^2), stem diameter (12.64 mm), fresh herbage yield (24.55 t/ha) and dry herbage yield (8.72 t/ha). Thus, the study revealed that among the various mulch treatments, black plastic mulch significantly enhanced the growth and yield parameters of sweet basil, demonstrating its efficacy in promoting optimal plant development and productivity.

Introduction

The genus *Ocimum* belongs to the Lamiaceae family and consists of a wide array of species that are great sources of phenolic compounds and are esteemed for their therapeutic potential (Ramesh and Satakopan, 2010). *Ocimum* spp. are perennial herbs and shrubs native to tropical and warm temperate regions. There are approximately 150-200 species of the genus *Ocimum,* among which *Ocimum basilicum* L., popularly known as "sweet basil", is an important essential oil-yielding species. It is cultivated in many countries for industrial value and is used in both the Unani and Ayurvedic systems of medicine (Muralidharan and Dhananjayan, 2004). Leaves and inflorescences are rich sources of terpenes, of which methyl chavicol and linalool are predominant. In addition, it also contains camphor, 1,8-cineole, pinenes, methyl cinnamate, thymol, etc. It is a widely used aromatic herb in the food industry and is highly appreciated for its rich and spicy, mildly peppery flavor; hence, it is used in flavoring, confectionery, baked foods, and meat products. It is also associated with Iranian, Italian, Chinese and Indian cuisines (Akbari *et al.*, 2019). The essential oils from leaves and inflorescences have

Corresponding author E-mail: *nayanaN32@gmail.com*
Doi:https://doi.org/10.36953/ECJ.26422774
This work is licensed under Attribution-Non Commercial 4.0 International (CC BY-NC 4.0)
© ASEA

applications in both the perfumery and pharmaceutical industries. Intensive farming practices that intend to produce higher yields require the extensive use of agrochemicals, which are costly and cause environmental pollution. Weeds diminish the vitality of cultivated crops by vying for essential resources such as light, water, and nutrients, leading to a decline in the strength and growth of the crop. Mulching is a highly viable option in crop production because it helps to reduce weed growth, retain soil moisture, improve nutrient use efficiency, modify the microclimate by optimizing soil temperature, and increase the photosynthetic efficiency of the plant, thus contributing to better growth and yield (Helaly *et al.*, 2017). The application of humic substances to medicinal and aromatic plants has recently gained prominence (Aytac *et al.*, 2022). Humic acid behaves as a soil conditioner when applied to soil; it increases the nutrient availability of plants and chlorophyll synthesis and improves the permeability of plant membranes (Verillo *et al.*, 2021). However, biofertilizers help fix, solubilize, and mobilize the major nutrients in the soil and make them available to plants (Macik *et al.*, 2020). This study aimed to investigate how various mulches and approaches to plant nutrition impact the growth and yield of sweet basil.

Material and Methods

Site characterization

In the Rabi season of 2018-2019, a field trial was carried out at the Department of Plantation, Spices, Medicinal, and Aromatic Crops within the College of Horticulture, University of Horticultural Sciences Campus in Bengaluru. The experimental site is situated at approximately 12°58^1 N latitude, 77°35^1 longitude, and an elevation of 930 meters above sea level. The experimental area featured fairly level land and had red sandy clay loam soil with consistent fertility levels, categorized under the alfisol order. The experiment was laid out in a factorial randomized complete block design with sixteen treatment combinations replicated three times. The treatments consisted of four levels of mulch and nutrition. These treatments included four mulch types (M_0 – no mulch, M_1 – black plastic mulch, M_2 – silver plastic mulch, and M_3 – organic mulch) and various nutrient combinations (N_0 – 100% RDF, N_1 – 75% RDF with humic acid, N_2 – 75% RDF with microbial consortia, and N_3 – 75% RDF with humic acid and microbial consortia). The microbial consortia obtained from the University of Agricultural Sciences, Bengaluru, included *Azospirillum*, *Pseudomonas fluorescens*, *Bacillus megaterium*, and *Frateuria aurantium*. Seeds of the sweet basil variety CIM-Saumya, obtained from IIHR, Bengaluru, were sown in a 1:5 sand mixture and exhibited a 90% germination rate within eight days. Before transplanting, organic manure (FYM) was applied fifteen days earlier. A recommended dose of fertilizer (RDF) of 160:80:80 kg of NPK (Farooqi and Sreeramu, 2004) was administered, with mulching performed using black and silver plastic of 50 µm thickness and organic mulch from spent lemon grass at 3 t ha^{-1}. Forty-day-old plants were transplanted to the main field at a spacing of 60 cm×40 cm, followed by regular drip irrigation. Humic acid (10 kg/ha) and microbial consortia (5 kg/ha) were applied fifteen days posttransplantation. Harvesting took place after sixty days at the fifty percent flowering stage, when the entire plant was cut 10 cm above ground level using secateurs. The harvested herb was segregated into leaves, stems, and inflorescences and then dried under partial shade for ten days. The growth and yield parameter data were analyzed using WASP 2.0 (Web Agri Stat Package) software. When the F test was significant for the comparison of treatment means, the critical difference (CD) was determined at a 0.05 probability level.

Results and Discussion

The mulch had a marked effect on the growth parameters, while nutrient level did not have a substantial impact on growth. Plants cultivated with black mulch exhibited superior growth characteristics, as indicated by the maximum plant height (88.20 cm), number of branches (14.95), stem diameter (12.64 mm), and extent of plant spread (5415 cm^2). Conversely, plants grown with organic mulch exhibited the least plant height (66.82 cm), number of branches (13.67), and plant spread (2356.75 cm^2), with the smallest stem diameter (9.52 mm) recorded in plants grown without any mulch. Plants grown on black mulch combined with 100% RDF application exhibited the greatest number of branches (15.47), whereas the lowest number

(12.80) of branches was detected in plants cultivated on organic mulch supplemented with 75% RDF, humic acid, and microbial consortia. Stem diameter was notably greater in plants grown on black mulch with 75% RDF and humic acid, while the smallest stem diameter occurred in plants without mulch with 75% RDF and humic acid (Table 1). The use of black plastic mulch resulted in maximum fresh and dry weights of the herb (1004.58 g/plant and 198.40 g/plant, respectively), followed by silver mulch (1003.60 g/plant and 190.14 g/plant, respectively). Furthermore, compared with the other treatments, black mulch significantly enhanced the fresh and dry herbage yields (24.55 t/ha and 8.72 t/ha, respectively). Regarding nutrition, plants supplied with 75% RDF and humic acid exhibited the highest estimated dry herbage yield (Table 2). The notable growth enhancement in black plastic

Table 1: Influence of mulching and nutrition on the growth parameters of sweet basil at harvest

Factor/Treatment		Plant height (cm)	Number of branches	Plant spread (cm^2)	Stem diameter (mm)
Varieties (V)	M_0	66.90	13.80	2592.55	9.52
	M_1	88.20	14.95	5415.92	12.64
	M_2	83.58	13.80	5163.31	11.35
	M_3	66.82	13.67	2356.75	10.91
	S.Em.±	**1.56**	**0.23**	**146.62**	**0.29**
	CD at 5%	**4.49**	**0.66**	**423.48**	**0.85**
N Levels (N)	N_0	76.02	14.10	3764.39	11.05
	N_1	77.45	14.05	3948.24	10.84
	N_2	78.35	14.03	3982.27	11.51
	N_3	73.68	14.03	3833.62	11.03
	S.Em.±	**1.56**	**0.23**	**146.62**	**0.29**
	CD at 5%	**NS**	**NS**	**NS**	**NS**
Interaction (V×N)	M_0N_0	66.13	13.33	3028.10	9.65
	M_0N_1	67.40	13.47	2515.55	9.06
	M_0N_2	67.20	13.07	2438.58	9.16
	M_0N_3	66.87	15.33	2387.95	10.22
	M_1N_0	88.00	15.47	5320.89	12.15
	M_1N_1	92.40	15.00	5583.58	13.97
	M_1N_2	91.27	15.07	5572.17	12.61
	M_1N_3	81.13	14.27	5187.06	11.83
	M_2N_0	78.73	13.73	4460.92	11.10
	M_2N_1	85.60	14.00	5711.11	10.42
	M_2N_2	86.13	13.73	5305.67	12.71
	M_2N_3	83.87	13.73	5175.53	11.19
	M_3N_0	71.20	13.87	2247.67	11.29
	M_3N_1	64.40	13.73	1982.72	9.89
	M_3N_2	68.80	14.27	2612.67	11.55
	M_3N_3	62.87	12.80	2583.93	10.90
	S.Em. ±	**3.11**	**0.45**	**293.24**	**0.59**
	CD at 5%	**NS**	**1.31**	**NS**	**1.69**

M_0- no mulch, M_1- black plastic mulch, M_2- silver plastic mulch, M_3- organic mulch, N_0- 100% RDF, N_1- 75% RDF with humic acid, N_2- 75% RDF with microbial consortia, N_3- 75% RDF with humic acid, and microbial consortia, S.Em. -Standard error of means, CD- Critical difference

Table 2: Influence of mulching and nutrition on yield parameters of sweet basil

Factor/Treatment		Fresh weight (g/plant)	Dry weight (g/plant	Fresh herbage yield (t/ha)	Dry herbage yield (t/ha)
Varieties (V)	M_0	476.17	104.72	13.42	6.02
	M_1	1004.58	198.40	24.55	8.72
	M_2	1003.60	190.14	20.45	7.10
	M_3	467.81	103.85	11.87	4.83
	S.Em.±	**42.75**	**10.14**	**0.89**	**0.35**
	CD at 5%	**123.46**	**29.30**	**2.56**	**0.99**
N Levels (N)	N_0	721.88	144.24	17.04	6.44
	N_1	745.28	150.19	16.97	5.92
	N_2	814.25	159.09	18.23	7.27
	N_3	670.76	143.60	18.05	7.03
	S.Em.±	**42.75**	**10.15**	**0.89**	**0.35**
	CD at 5%	**NS**	**NS**	**NS**	**0.99**
Interaction (V×N)	M_0N_0	492.17	100.51	13.47	5.73
	M_0N_1	427.44	114.13	13.14	5.65
	M_0N_2	493.08	94.32	12.79	5.57
	M_0N_3	492.00	109.93	14.26	7.12
	M_1N_0	1085.83	209.63	23.40	8.31
	M_1N_1	1037.00	218.18	24.34	7.63
	M_1N_2	1025.67	193.18	23.98	10.22
	M_1N_3	869.83	172.62	26.47	8.72
	M_2N_0	772.83	148.93	17.99	6.73
	M_2N_1	1144.83	188.08	20.13	6.57
	M_2N_2	1224.50	233.35	22.27	7.46
	M_2N_3	872.22	190.20	21.42	7.65
	M_3N_0	536.67	117.87	13.30	5.00
	M_3N_1	371.83	80.37	10.26	3.85
	M_3N_2	513.75	115.50	13.88	5.83
	M_3N_3	449.00	101.66	10.05	4.64
	S.Em. ±	**85.49**	**20.29**	**1.77**	**0.69**
	CD at 5%	**NS**	**NS**	**NS**	**NS**

M_0- no mulch, M_1- black plastic mulch, M_2- silver plastic mulch, M_3- organic mulch, N_0- 100% RDF, N_1- 75% RDF with humic acid, N_2- 75% RDF with microbial consortia, N_3- 75% RDF with humic acid, and microbial consortia, S.Em. -Standard error of means, CD- Critical difference

mulch is attributed to its ability to conserve moisture, suppress weed growth, and optimize the soil's hydrothermal conditions. These findings align with previous studies by Ashrafuzzaman *et al.* (2011) and Abaas (2014), who reported that black mulch maintains the optimum soil temperature and moisture availability and hinders weed growth due to reduced light penetration. Additionally, the use of mulch positively impacted soil properties, nutrient uptake, and chlorophyll content, thereby enhancing plant photosynthetic efficiency and carbohydrate accumulation in stems. The significant increase in fresh and dry herb weights with black plastic mulch further highlights its role in bolstering overall herbage yield. Its impermeability to CO_2, creating a chimney effect, facilitates increased photosynthesis, resulting in heightened metabolic activities, shoot numbers, and stem diameter. Jadhav *et al.* (2018) reported that the use of mulch improves the physical, chemical, and biological properties of the soil, thereby increasing nutrient uptake by plants. Similar findings were reported by Rajablariani *et al.* (2012) in tomato; Solberg and Dragland (2014) in perennial herbs such as *Hyssopus officinalis*, *Melissa officinalis*, *Thymus vulgaris,* and *Echinacea purpurea*; Sarrou *et al.* (2016) in sweet basil; and Thakur *et al.* (2019) in *Rosa damascene.* These authors suggested that the effectiveness of mulch could be attributed to an elevated water use efficiency, a moderate soil temperature, an increase in CO_2 levels around the plants, and a more efficient utilization of soil nutrients, which can contribute to enhanced root development and increased yield. Humic acid improves soil aggregation and soil aeration, enhances the availability of nutrients, and increases the chlorophyll content of plants by improving their photosynthetic efficiency, which in turn causes the accumulation of more carbohydrates in the stem (Iqbal *et al.*, 2020). Mulching with black polythene sheets was the best with respect to fresh biomass yield in vetiver (Sindhu and Beena, 2022), which was akin to conclusions drawn by Giri *et al.* (2021) in Basil and Sekeroglu *et al.* (2022) in Lavender.

Conclusion

The use of black plastic mulch and humic acid substantially promoted the growth and yield of sweet basil plants. The application of black plastic mulch contributed to the enhanced growth and yield of sweet basil. This success can be attributed to its effectiveness in conserving moisture, suppressing weed growth, and optimizing soil temperature. The CO_2 concentration of the mulch film and the resulting chimney effect facilitated an abundant CO_2 supply to the leaves, thereby increasing photosynthesis and metabolic activities and leading to increased plant growth and yield. The combination of black plastic mulch and humic acid significantly maximized fresh and dry herbage yield, illustrating their collective positive impact on plant growth and highlighting the consistent benefits of using black plastic mulch and humic acid for moisture conservation, weed suppression, and nutrient efficiency, ultimately maximizing crop yield potential.

Acknowledgment

The authors express their deep gratitude to the parents, chairpersons (Dr. Maruthi Prasad, B. N.), and Advisory Committee, College of Horticulture in Bengaluru, for generously providing the necessary facilities that facilitated the successful execution of this research.

Conflict of interest

The authors declare that they have no conflicts of interest.

References

Abaas, I. S. (2014). Effect of biological competition of weeds on growth and volatile oil yield of marigold (*Calendula officinalis* L.) as medicinal plant used in herbal medicine of Iraq. *International Journal of Pharmacy and Pharmaceutical Sciences*, 6 (1), 217-219.

Akbari, G. A., Binesh, S., Ramshini, H., Soltani, E., Amini, F., Mirfazeli, M. S. (2019) Selection of basil (*Ocimum basilicum* L.) full-sib families from diverse landraces. *Journal of applied Research in Medicinal and Aromatic Plants*. 12, 66-72.

Ashrafuzzaman, M., Halim, M. A., Ismail, M. R., Shahidullah, S. M. & Hossain, M. A. (2011). Effect of plastic mulch on growth and yield of Chilli (*Capsicum annuum* L.). *Brazilian Archives of Biology and Technology*, 54 (2), 321-330.

Aytac, Z., Gulbandılar, A. & Kurkçuo glu, M. (2022). Humic acid improves plant yield, antimicrobial activity and essential oil composition of Oregano (*Origanum vulgare* L. subsp. hirtum (Link.) Ietswaart). *Agronomy*, 12, 2086.

Farooqi, A. A. & Sreeramu, B. S. (2004): *Cultivation of medicinal and aromatic crops*. University Press (India) Limited, Hyderabad.

Giri, P., Pandey, S. T., Prajapati, B. K. & Jena, N. K. (2021). Effect of weed management practices on nutrient uptake and economics of Sweet basil (Ocimum basilicum) cultivation in Tarai region of Uttarakhand. International *Journal of Phytomedicines and Related Industries*, 13 (3), 479-484.

Helaly, A. A., Goda, Y., El-Rehim, A. A. S., Mohamed, A. A. & El-Zeiny, O. A. (2017). Effect of polyethylene mulching type on the growth, yield and fruit quality of *Physalis pubescens*. *Advances in Plants and Agriculture Research*, 6 (5), 2-7.

Iqbal, R., Raza, M. A. S., Valipour, M., Saleem, M. F., Zaheer, M. S., Ahmad, S., Toleikiene, M., Haider, I., Aslam, M. U. & Nazar, M. A. (2020). Potential agricultural and environmental benefits of mulches-a review. *Bulletin of the National Research Centre*, 44, 1-16.

Jadhav, S. B., Katwate, S. M., Kakade, D. S. & Pawar, B. G. (2018). Effect of mulching on growth, yield and weed management in rose. *International Journal of Chemical Studies*, 6 (3), 2806-2808.

Macik, M., Gryta, A. & Frac, M. (2020). Chapter Two - Biofertilizers in agriculture: An overview on concepts, strategies and effects on soil microorganisms. *Advances in Agronomy*, 162, 31-87.

Muralidharan, A.& Dhananjayan, R. (2004). Cardiac stimulant activity of *Ocimum basilicum* Linn. Extracts. *Indian Journal of Pharmacology*, 36, 163-166.

Rajablariani, H. R., Hassankhan, F. & Rafezi, R. (2012). Effect of colored plastic mulches on yield of tomato and weed biomass. *International Journal of Environmental Science and Development*, 3 (6), 590-593.

Ramesh, B. & Satakopan, V. N. (2010). *In vitro* antioxidant activities of Ocimum species: *Ocimum basilicum* and *Ocimum sanctum. Journal of Cell and Tissue Research*, 10 (1),

Sarrou, E., Chatzopoulou, P., Koutsos, T. V. & Katsiotis, S. (2016). Herbage yield and essential oil composition of sweet basil (*Ocimum basilicum* L.) under the influence of different mulching materials and fertilizers. *Journal of Medicinal Plants Studies*, 4 (1), 111-117.

Sekeroglu, N., Cimen, G., Kulak, M. & Gezici, S. (2022). Plastic mulching or conventional cultivation of lavender flower: what influence on the yield, essential oil and their neuroprotective effects. *Trakya University Journal of Natural Sciences*, 23(1), 43-52.

Sindhu, P. V. & Beena, C. (2022). Effect of growing condition and mulching management for enhancing yield and quality of *Plectranthus vettiveroides* (K. C. Jacob) N. P. Singh and B. D. Sharma. *Journal of Crop and Weed*, 18(1), 50-54.

Solberg, S. O. & Dragland, S. (2014). The effects of dark colored plastic, fiber and paper mulches on yield and aver-wintering of perennial herbs. *Journal of Herbs, Spices and Medicinal Plants*, 12 (1), 13-23.

Thakur, M., Bhatt, V. & Kumar, R. (2019). Effect of shade level and mulch type on growth, yield and essential oil composition of damask rose (*Rosa damascena* Mill.) under mid hill conditions of Western Himalayas. *PLoS ONE*, 14 (4), 1-14.

Verrillo, M., Cozzolino, V., Spaccini, R. & Piccolo, A. (2021). Humic substances from green compost increase bioactivity and antibacterial properties of essential oils in Basil leaves. *Chemical and Biotrchnological Technologies in Agriculture*, 8, 28.

Publisher's Note: The ASEA remains neutral with regard to jurisdictional claims in published maps and figures.