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INFLUENCE OF FERMENTED ORGANIC MANURES ON GROWTH PARAMETERS, SOIL HEALTH, AND ECONOMICS OF BASIL (*OCIMUM BASILICUM*) UNDER TARAI REGION OF UTTRAKHAND, INDIA

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ABSTRACT

Basil thrives in warm tropical climates and belongs to the *Lamiaceae* family. Various parts of sweet basil, including its leaves and seeds, contain a diverse array of aromatic compounds that contribute to its distinctive flavor and fragrance. The field experiment was conducted at the Medicinal Plants Research and Development Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) during the Kharif season of 2019. The experiment comprised eight treatments:viz; T_1 [RDF (N_{120}:P_{60}:K_{40}) kg ha^{-1}], T_2 (FYM 15 t ha^{-1}), T_3 (Kunapajala @ 500 L ha^{-1}), T_4 (Kunapajala @ 1000 L ha^{-1}), T_5 (Kunapajala @ 500 L ha^{-1} +FYM @ 7.5 t ha^{-1}), T_6 (Jeevamrit @ 500 L ha^{-1}), T_7 (Jeevamrit @ 1000 L ha^{-1}) and T_8 (Jeevamrit @ 500 L ha^{-1} + FYM @ 7.5 t ha^{-1}). Among them the result found significantly higher growth parameter recorded under RDF (N_{120}:P_{60}:K_{40}) kg ha^{-1}followed by Jeevamrit @ 500 L ha^{-1} + FYM @ 7.5 t ha^{-1}.Similar results also observed for NPK content and uptake, whereas Net returns and B:C ratio observed under RDF (N_{120}:P_{60}:K_{40}) kg ha^{-1}that is similar to Jeevamrit @ 500 L ha^{-1} + FYM @ 7.5 t ha^{-1}.

***Keywords* :** Fermented organic manures, growth parameters, Soil health, Basil

Introduction

Basil, scientifically known as *Ocimum basilicum*, is an aromatic herb renowned for its culinary and medicinal uses. The word "basil" finds its roots in the Greek word "basilica," signifying the "royal plant" (Pushpagadan *et al*., 1995). An alternative etymology suggests that "basil" may have originated from the Latin term 'basilicus," meaning "dragon," which is also the root for "basilisk." However, this likely represents a linguistic adaptation from the Greek language (Sobti and Pushpangadan, 1982). Basil thrives in warm tropical climates and belongs to the Lamiaceae family. Various parts of sweet basil, including its leaves and seeds, contain a diverse array of aromatic compounds that contribute to its distinctive flavor and fragrance. The indiscriminate use of chemical fertilizers in agriculture has had adverse effects on soil quality, human health, and the environment. Integrated plant nutrient management practices have emerged as an alternative approach, promoting higher crop productivity by enhancing soil organic composition and nutrient availability. This is especially crucial in the context of energy constraints, escalating fertilizer costs, and the limited financial resources of farmers. In ancient Indian literature, a more scientifically and clinically formulated alternative to liquid biofertilizers is described under the generic name "*Kunapajala*," as presented by Surapala (Surapala, 1996) in '*Vrikshayurveda*' literature. *Kunapajala* promotes biological activities in the soil and enhances nutrient availability to crops (Kanali, 2016). Organic liquid manure, known as *"Jeevamrit*," is a rich bio-formulation containing a consortium of beneficial microbes (Pathak and Ram, 2013). *Jeevamrit* can also contribute to nitrogen availability in the soil through non-symbiotic nitrogen fixation. These natural approaches offer sustainable alternatives for cultivating healthy and productive crops, emphasizing the importance of environmentally friendly and biologically based farming practices.

Materials and Methods

The present field experimentation was conducted at the Medicinal Plants Research and Development Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand), during the *Kharif* season of 2019. The experiments conducted with eight treatments were replicated three times in a randomized complete block design.

Table 1 : Experimental treatments and details

Treatments	Details
T_1	(RDF (N_{120}:P_{60}:K_{40}) kg ha^{-1})
T_2	FYM 15 t ha^{-1}
T_3	(*Kunapajala* @ 500 L ha^{-1})
T_4	*Kunapajala* @ 1000 L ha^{-1}
T_5	Kunapajala @ 500 L ha^{-1} +FYM @ 7.5 t ha^{-1}
T_6	*Jeevamrit* @ 500 L ha^{-1}
T_7	*Jeevamrit* @ 1000 L ha-1
T_8	*Jeevamrit* @ 500 L ha^{-1} + FYM @ 7.5 t ha^{-1}

Jeevamrit was prepared as per the method developed by Palekar (2006), who is a strong promoter of natural farming, and *Kunapajala* was prepared by the method developed by Nene and Choudhary (2012), and treatment was given to plants six times (one pre and five post) at an interval of 15 days by the soil application method through water. After 20 days of transplanting, mulching (*acchadana*) was done to cover soil in T_3, T_4, T_6, and T_7 as an important component of natural farming described by Palekar (2006). Linseed crop residue is used as mulch material. Each experimental plot was 5 m long and 3.2 m wide with spacing.

Table 2 : Physico-chemical properties of the experimental soil (0-15 cm)

S.No.	Properties	Value
1.	Soil texture	Sandy clay loam
2.	Soil pH	6.3
3.	EC (dSm^{-1})	0.17
4.	Organic carbon (%)	0.68
5.	Available nitrogen(kg per ha)	186.60
6.	Available phosphorus(kg per ha)	18.90
7.	Available potassium(kg per ha)	201.23
8.	Bulk density of thesoil (g per cc)	1.57

Nutrient uptake by sweet basil: Nutrient uptake by sweet basil was calculated by the following formula:

Nutrient uptake (kg ha^{-1})=Nutrient content (%) x Yield (q ha^{-1})

Results and Discussion

The growth parameters were significantly affected by different treatments ($p \leq 0.05$). Among the treatments, T_1 recorded significantly higher growth parameters, including plant height, number of branches per plant, fresh weight, dry matter accumulation, and SPAD values. For instance, the plant height reached 109.67 cm, and the number of branches per plant was 21.81. These values were higher than those observed in other treatments, although T_1 was on par with T_8 and T_5, which had a plant height of 99.53 cm. Conversely, the lowest plant height, measuring 84.67 cm, was seen in treatment T_2.

The significantly higher growth parameters observed under the Recommended Dose of Fertilizer (RDF) treatment (N_{120}:P_{60}:K_{40} kg ha^{-1}) may be attributed to the increased nutrient uptake, which enhanced plant growth and development. Additionally, growth parameters were significantly higher under the application of Farmyard Manure (FYM) with liquid manures, leading to increased crop growth. This enhancement was particularly noticeable in terms of plant height, the number of branches, and the leaf-stem ratio per plant. This effect can be linked to the use of liquid manures, which are products of microbial consortia. When applied to the soil, these liquid manures stimulate microbial populations, accelerating the decomposition of FYM and promoting the mineralization of organic nitrogen in the soil. As a result, nutrients become more mobile in the soil, making them readily available to plants and facilitating the development of the plant system. The increase in growth-attributing characteristics such as plant height, the number of branches, and leaf-stem ratio, resulting from enhanced nutrient uptake, directly contributes to improved crop yield. This finding aligns with previous studies conducted by Mathur (2000) and Patel *et al*. (2018).

Therefore, it is evident that growth attributes, including plant height, the number of branches, and leaf-stem ratio per plant, can be increased by providing all the essential nutrients to the crop at critical growth stages. Similar trends in increased growth parameters were also observed in studies by Bhalla *et al.* (2006) in sword lilies (gladiolus) and by Singh *et al*. (2007) in tuberose (*Polianthes tuberosa*). Furthermore, a study conducted by Kumbar *et al.* (2016) highlighted the positive effect of jeevamrit application on the increased yield and yield-attributing characteristics of French beans. Similarly, Ankad *et al.* (2017) found similar results in *Withania somnifera,* where kunapajala treatments resulted in higher leaf area index, and total leaf area, chlorophyll a, b, and carotenoids.In contrast, soil application of farmyard manure showed lower yield attributes compared to the various doses of liquid manures. This finding is consistent with the results of Swain et al. (2015), who demonstrated that plant height, the number of branches, and yield can be increased by applying a bio-enhancer at intervals of 10 days in chili crops. Similar results were reported by Kumar *et al.* (2022) in Bramhi, where the application of jeevamrit at 5000 liters per hectare, combined with FYM at 2.5 tons per hectare, resulted in the highest shoot length, the number of shoots, and the number of leaves per square meter. Ultimately, this increased dry matter accumulation and enhanced biomass yield.

Table 3: Effect of Fermented Organic Liquid Manures on growth parameters

Treatments	Plants height(cm)	Branches per plant	Fresh weight	Dry matter accumulation(g/plant)	SPAD values
T_1	109.67	21.81	615.74	116.71	32.23
T_2	84.67	16.00	449.66	92.17	26.70
T_3	91.56	17.98	476.57	95.87	29.33
T_4	93.06	18.67	517.98	100.57	29.50
T_5	99.53	19.37	551.18	108.9	30.70
T_6	92.22	18.08	494.14	96.76	29.30
T_7	98.10	18.83	533.49	105.63	29.70
T_8	104.56	20.50	578.36	110.67	31.27
S.Em±	3.95	0.84	24.01	2.75	0.68
CD at 5%	11.55	2.46	70.24	8.04	1.99

Effect of Fermented Organic Liquid Manures on content and uptake of N, P, K

The N, P, and K content show significantly ($p \leq 0.05$) influenced by varied treatment. Among the varied treatments T_1 (1.88, 0.48 and 1.63) recorded significantly higher N,P and K content in plants compared to other treatments but it was on par with T_8. Lowest N, P and K content observed under T_2 (1.39, 0.41, 1.50) respectively.

Similar observations also recorded for N, P, and K uptake among different treatment. Highest N, P, and K uptake observed underT_1 treatments and lowest uptake recorded under the T_2 treatment. Plant nutrient status has been found to boost due to the addition of different treatments alone or in combination with FYM. Organic manure in combination with fermented liquid manures (jeevamrit or kunapajala) results in a high microbial population in the soil, which improves soil physical conditions and makes the plant root proliferate, resulting in higher utilization and uptake of nutrients. It also helps bring nutrients from the deeper layers to the top layer. Similar research was done by Kumar (1996). In general, it is reported that sweet basil removes 115, 21.5, and 98.8 kg per ha of nitrogen, phosphorus, and potassium, respectively, to achieve a good yield (Singh *et al*., 2014). The different NPK contents in plants due to different treatments may be attributed to the slow release of complex nutrients in the soil throughout the crop's growth.

Table 5 : Effect of Fermented Organic Liquid Manures on content of NPK

Treatments	N (%)	P (%)	K (%)
T_1	1.88	0.48	1.63
T_2	1.39	0.41	1.50
T_3	1.47	0.35	1.43
T_4	1.59	0.36	1.49
T_5	1.70	0.42	1.51
T_6	1.52	0.36	1.44
T_7	1.64	0.38	1.49
T_8	1.78	0.43	1.56
S.Em±	0.11	0.02	0.04
CD at 5%	0.23	0.07	0.10

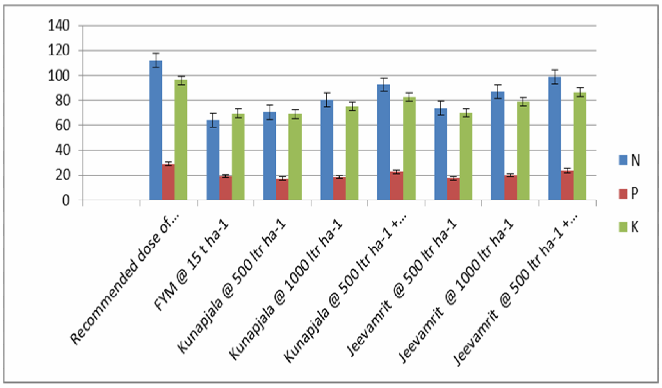

Fig. 1 : Effect of Fermented Organic Liquid Manures on content of NPK

The Economics of Sweet Basil:

The application of Recommended dose of fertilizers (N_{120}:P_{60}:K_{40}) kg ha^{-1} to basil proved economically beneficial with highest net returns (2, 54,810/ha). This could be ascribed to the fact that addition of chemical fertilizerthat might be higher growth and yield attributes in tulsi. This treatment also produced significantly higher benefit: cost ratio (4.21) over other treatments.

Table 4: Economics of the crop as influenced by different treatments

Treatments	Gross returns (Rs/ha)	Net returns (Rs/ha)	B: C ratio
T_1	315333	254810	4.21
T_2	221614	140094	1.72
T_3	227401	171711	3.08
T_4	255791	199096	3.51
T_5	284845	215405	3.10
T_6	241966	186293	3.35
T_7	272556	215896	3.81
T_8	304788	235365	3.39

Conclusion

Based on the findings presented, it can be concluded that the recommended dose of fertilizers resulted in the highest values for growth attributes, NPK content and uptake, net returns, and the benefit-to-cost (B:C) ratio. However, a similar positive outcome was observed with the use of Jeevamrit at 500 Lha^{-1} in combination with FYM at 7.5t ha^{-1}. This alternative approach is also beneficial for farmers, primarily due to its lower cost and high net returns.

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