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Effect of Bio-enhancers on Growth and Yield of Palak (*Beta vulgaris* var. *bengalensis*) under Shade Net conditions

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ABSTRACT: An experiment was carried out at School of Agriculture, ITM university, Gwalior, Madhya Pradesh, India, during February, 2023, to investigate how various bio-enhancers impact the growth and yield of palak var. Arka Anupama under shade net conditions. The study followed a completely randomized design with eight treatments and three replications. The treatments were labeled as T_1= Panchgavya 100%, T_2= Jeevamrita 100 %, T_3= Jeevamrita (Saptdhaan) 100 %, T_4=Panchgavya 50%+ Jeevamrita 50%, T_5=Panchgavya 50% + Jeevamrita (Saptdhaan) 50%, T_6=Panchgavya 34% + Jeevamrita 33%+ Jeevamrita (Saptdhaan) 33%, T_7= RDF 100 % and T_8=Control. The soil was sandy loam and having 7.7 pH and 6.2 g kg^{-1} organic carbon According to the experiment's results, treatment T_6 exhibited the most favorable outcomes, with the highest plant height, the highest number of leaves per plant, the longest leaf length, and the longest root length at the time of harvest. Additionally, treatment T_6 showed the highest yield per plant and yield per bag at the time of harvest. On the other hand, treatment T_8 had the lowest yield per plant and yield per bag among all the treatments. Consequently, an increasing multitude of farmers are embracing the transition to organic farming. In this context, the identification of novel organic fertilizers that are both cost-effective and environmentally benign assumes paramount significance. As of our current understanding, comprehensive insights into the utilization of organic fertilizers to ameliorate the nutritional quotient of Palak remain conspicuously absent. Thus, the present endeavor hypothesized that the integration of organic inputs would fortify growth and yield characteristics of Palak. In light of this, the current study was undertaken to discern the influence of bio-enhancers, namely panchagavya, jeevamrita, and jeevamrita (saptdhaan), growth attributes, and yield of Palak (*Beta vulgaris* var. *bengalensis*) cultivation.

Keywords: Bio-enhancers, jeevamrita, panchagavya, saptdhaan, jeopardy, ameliorate, organic fertilizer.

INTRODUCTION

Palak, scientifically known as *Beta vulgaris* var. *bengalensis*, belongs to the Chenopodiaceae family and is a popular leafy vegetable in tropical and subtropical regions. Its high market demand is attributed to its medicinal properties, rich nutrient content, and pleasant taste. The leaves are abundant in dietary fiber, essential minerals like calcium, phosphorus, and iron, as well as antioxidants such as carotene, vitamin C, and folic acid (Vethamoni and Thampi 2018). Palak can be enjoyed raw in salads or cooked, steamed, and sautéed, complementing various dishes like potatoes, cauliflower, paneer, and chicken, making it a versatile option for both vegetarians and non-vegetarians. Green leafy vegetables, including palak, have long been recognized as excellent sources of protein, vitamins, and minerals (Solanki *et al.*, 2018). The presence of antioxidant vitamins like ascorbic acid and phenols in palak is essential for human diets as they act as anti-cancer agents. In today's world, natural farming of vegetables is gaining importance due to increasing health consciousness among the population. Concerns over pesticide residues in conventionally grown vegetables available in local markets have led to a growing need for organic cultivation (Ramesh Kumar 2014).

Chemical fertilizers are rich in nitrogen salts, and their absorption by plants results in rapid depletion of soil moisture. Overusing inorganic fertilizers has detrimental effects on crop yield, leading to reduced fruit production, delayed fruit setting, and ripening, as well as excessive vegetative growth (Abdou *et al.*, 2017). Bio enhancers, which are natural substances produced through the fermentation of animal products and plant residues, play a vital role in enhancing soil health and promoting microbial growth (Devakumar *et al.*, 2008). Cow urine, for instance, possesses anti-fungal properties and serves as an excellent source of plant nutrients, making it a traditional choice in crop

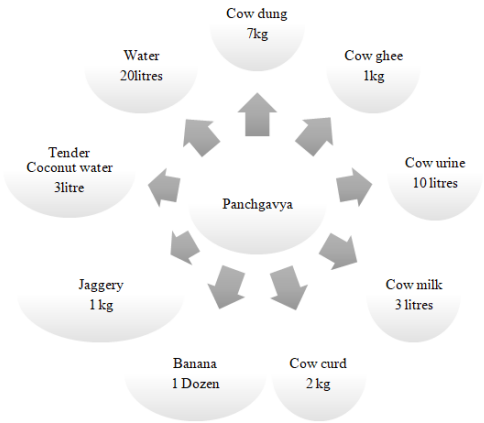
production Chadha *et al.* (2021). Various forms of organic agriculture hold the potential to gain acceptance among farmers (Sreenivasa *et al.*, 2010); Natarajan, 2007). To fully understand their impact, it is crucial to evaluate how bio-enhancers, when combined with inorganic fertilizers, affect the growth and yield of tomatoes. Additionally, bio-chars can serve as beneficial soil amendments to enhance soil properties and crop yield, while also providing a means for long-term carbon sequestration when stored in soils (Glaser *et al.* 2002). The primary objective of this study is to propose innovative strategies for maintaining or enhancing soil fertility and increasing palak productivity by incorporating Bio-enhancers. The aim is to explore alternative solutions that can contribute to better agricultural practices and improved crop yields while utilizing these natural substances.

MATERIAL AND METHODS

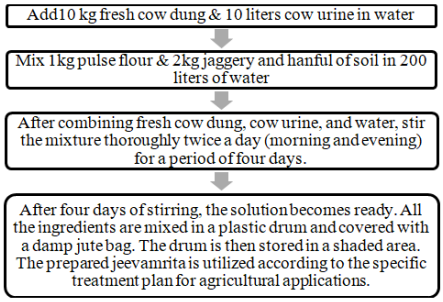
In February 2023, an experiment was conducted at the School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India, to examine the effects of various bio-enhancers on the growth and yield of palak var. Arka Anupama under shade net conditions. The study employed a completely randomized design (CRD) with eight treatments and three replications. The treatments consisted of different combinations of bio-enhancers, including Panchgavya, Jeevamrita, and Jeevamrita (Saptdhaan), as well as a control and recommended dose of fertilizer (RDF). Palak seeds were sown individually in grow bags, and proper care was taken for their growth. Harvesting occurred between 45 to 60 days after sowing (DAS), and various plant parameters were measured and analyzed, such as plant height, number of leaves, leaf length, root length, yield per plant, and yield per bag.

To compare the data means, OPSTAT and Excel were employed, using Analysis of Variance (ANOVA) at a significance level of 5%, aiming to identify significant differences among the collected data sets.

Preparation of panchgavya. For the preparation of Panchgavya, a mixture of five components – cow dung, cow urine, cow milk, cow curd, and cow ghee – was combined. This blend is believed to have growth-boosting and immunity-enhancing properties when applied to plants system.



Preparation of Jeevamrita:



Preparation of Jeevamrita (Saptdhaan). To prepare Jeevamrita (Saptdhaan), a similar method was followed as in Jeevamrita, but instead of pulse flour, saptdhaan components were used, including linseed, green gram, black gram, cowpea, Turkish gram, wheat seeds, and chickpea. This concoction is intended to have beneficial effects on plant growth and health.

RESULT

There were significant variations observed among the treatments in terms of various plant parameters, as outlined in Table 1-3.

A. Plant height (cm)

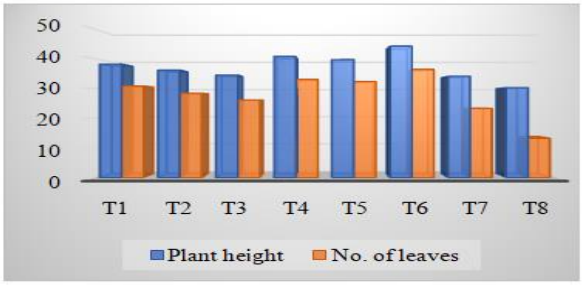
At the time of harvest, notable differences were evident in terms of plant height (Table 1). The treatment T_6 had the tallest plants, measuring 44.09 cm, which was on par to T_4. Conversely, T_8 displayed the shortest plants at 12.33 cm, was on par to T_3.

B. Number of leaves (cm)

The number of leaves per plant also exhibited substantial differences among treatments, as detailed in Table 1. T_6 had the highest number of leaves per plant (36.34 cm), aligning with T_5, T_4 and T_1. Conversely, T_8 recorded the lowest number of leaves per plant, measuring 13.26 cm.

Table 1: Effect of Bio-enhancer and inorganic fertilizers on plant height and number of leaves.

Treatment	Plant height (cm)	No. of leaves
T_1	38.09	30.76
T_2	36.09	28.34
T_3	34.42	26.09
T_4	40.67	33.01
T_5	39.59	32.26
T_6	44.09	36.34
T_7	34.01	23.26
T_8	30.17	13.26
SD	4.384	7.210
SEm±	1.550	2.549
CD (0.05)	3.793	6.237



C. Leaf length (cm)

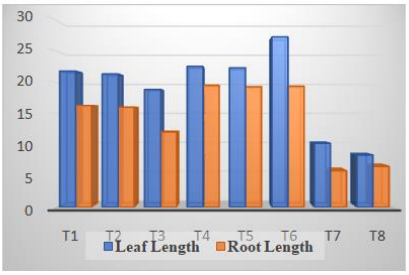
In terms of leaf length at harvest (Table 2), the treatments demonstrated significant distinctions. T_6 showcased the lengthiest leaves (27.22 cm), on par to T_4, T_5 and T_1. In contrast, T_8 had the shortest leaf length at 8.33 cm, on par to T_7.

D. Root length (cm)

Root length was notably affected by different treatments (Table 2). T_6 exhibited the longest root length (19.34 cm), on par to T_4, T_5, T_1 and T_2. On the contrary, T_7 displayed the shortest root length of 5.83 cm, on par to T_8.

Table 2: Effect of Bio-enhancer and inorganic fertilizers on leaf length and root length Yield per plant (gm).

Treatment	Leaf Length (cm)	Root Length (cm)
T_1	21.76	16.26
T_2	21.30	16.01
T_3	18.83	12.01
T_4	22.51	19.51
T_5	22.26	19.26
T_6	27.22	19.34
T_7	10.2	5.83
T_8	8.33	6.51
SD	6.489	5.63
SEm±	2.294	1.99
CD (0.05)	5.613	4.87



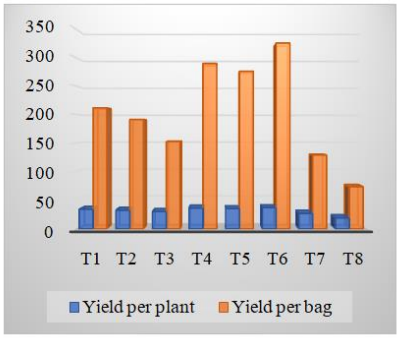
Yield per plant also displayed significant variations among treatments (Table 3). T_6 achieved the highest yield per plant (37.22 gm), was on parT_4, T_5, T_1 and T_2. Conversely, T_8 demonstrated the lowest yield per plant, measuring 13.29 gm.

E. Yield per Bag (gm)

Yield per bag at harvest exhibited noteworthy differences across treatments (Table 3). T_6 attained the highest yield per bag (324.4 gm), whereas T_8 had the lowest yield per bag (74.00 gm), was on par withT_7.

Table 3: Effect of Bio-enhancer and inorganic fertilizers on Yield per plant and yield per bag.

Treatment	Yield per plant (gm)	Yield per bag (gm)
T_1	34.44	211.3
T_2	32.89	191.2
T_3	30.56	152.6
T_4	36.53	288.8
T_5	35.56	275.2
T_6	37.22	324.4
T_7	27.19	129.2
T_8	19.29	74.00
SD	6.015	86.259
SEm±	2.127	30.497
CD (0.05)	5.204	74.623



DISCUSSION

Plant height was higher in treatment T_6 characterized by the combination of Panchagavya (3%), Jeevamrita (5%), and Jeevamrita (Saptdhaan) (5%), potentially due to higher nutrient availability from soil and foliar sources. This boost in nutrients, particularly nitrogen, likely contributed to the plant's increased height. Additionally, substances like indole acetic acid (IAA) and gibberellic acid (GA), provided through Panchagavya and Jeevamrita, played a role in promoting plant growth, as seen in similar findings by Naga (2013), Prabhavathi (2014), and Manohar (2017). The positive effect of panchgavya and jeevamrita was also reported by Ram and Pathak (2016) or Yadav and Tripathi (2013) who reported that plant height and no. of leaves significantly increased with the application of Panchgavya. Foliar application of panchagavya @ 3% found to be equally effective to NPK @ 1% in improving growth parameters The similar results were also observed by Mohan (2008), Chadha et al. (2012), Tharmaraj et al. (2011) and (Bhawariya *et al.*, 2022).

Treatment T_6, characterized by the combination of Panchagavya (3%), Jeevamrita (5%), and Jeevamrita (Saptdhaan) (5%), led to more leaves and longer leaf length, likely due to elevated nutrient availability and Ram and Pathak (2016) as well as Yadav and Tripathi (2013) documented the beneficial impact of Panchgavya and Jeevamrita. They observed a significant increase in both plant height and the number of leaves as a result of applying Panchgavya and Jeevamrita. Gram flour and saptdhaan contributed to greater photosynthate production, metabolic activities, and cell division, ultimately enhancing the photosynthetic area and chlorophyll content. Panchagavya foliar spray supplied nutrients and growth-promoting substances, facilitating rapid cell division and expanding the photosynthetic area, as also supported by Ayub *et al.* (2010); Reddy *et al.* (2011); (Naga, 2013). Bharadwaj and Omanwar (1994) found that using bio-enhancers led to an increased number of leaves per plant, attributed to the enhanced availability of nutrients in the soil. Organic farmers cultivating vegetable cluster beans, employing a farming technique involving the application of farmyard manure (FYM) coupled with the use of Jeevamrutha, Panchagavya has been identified as an effective method. This approach has demonstrated the potential to increased plant growth (Tharun Kumar *et al.*, 2022). The utilization of Panchagavya and farmyard manure (FYM) possibly

played a role in enhancing the vegetative growth of plants. This enhancement could have led to an increase in photosynthate production, effective partitioning of nutrients, and improved translocation. These factors collectively might have contributed to the augmentation of yield attributes and overall crop yield (Kumawat *et al.*, 2022).

Higher root length and root volume would facilitate the plant in exploring a larger rhizosphere area and accessing a higher quantity of nutrients. The treatment with the most notable root length and root volume was T_6, characterized by the combination of Panchagavya (3%), Jeevamrita (5%), and Jeevamrita (Saptdhaan) (5%). The augmentation in root length and root volume could be attributed to the substantial presence of organic matter, organic carbon, as well as macro and micro nutrients, particularly phosphorus. This, in turn, fostered root development and subsequently improved soil physical attributes such as bulk density, soil aeration, and moisture retention capacity. Additionally, it contributed to positive soil biological properties, as mentioned by Ansari *et al.* (2019), and elevated nutrient levels, as supported by the current study's findings. These collective enhancements in soil conditions created a favorable environment for robust root development. Similar outcomes have also been documented by Somasundaram *et al.* (2003); Saritha *et al.* (2013); Makkar *et al.* (2017). Panchagavya and humic acid can serve as alternatives to synthetic fertilizers in the cultivation of cluster beans. These alternatives have the capacity to uphold soil productivity and safeguard environmental quality (Ali *et al.*, 2019).

Higher yield per plant and yield per bag (Table 3) were observed in treatment T_6, characterized by the combination of Panchagavya (3%), Jeevamrita (5%), and Jeevamrita (Saptdhaan) (5%), attributed to swift nutrient supply that enhanced growth parameters. This led to increased photosynthate synthesis, successful transport from root to leaves, and elevated yield parameters. Similar outcomes were reported by Naga (2013); Prabhavathi (2014); Rawat *et al.* (2015). Panchagavya, Jeevamrita, and Jeevamrita (saptdhaan) applications improved soil properties, enriched microbial life, and boosted nutrient uptake, contributing to higher yield, aligning with Rajpoot *et al.* (2006); Manohar *et al.*, (2018); Patel *et al.* (2018). Organic farmers cultivating vegetable cluster beans, employing a farming technique involving the application of farmyard manure (FYM) coupled with the use of Jeevamrutha, Panchagavya has been identified as an effective method. This approach has demonstrated the potential to yield increased harvests and improved financial returns (TharunKumar *et al.*, 2022).

CONCLUSIONS

In conclusion, this study delved into the Impact of Bioenhancers on the growth and yield of palak (*Beta vulgaris* var. *bengalensis*) under shade net conditions. The findings result collectively underscore the remarkable potential of bioenhancers in bolstering palak cultivation. Notably, they contribute to enhanced growth, nutrient levels, soil vitality, and microbial activity. Among the treatments, T_6, characterized by the combination of Panchagavya (3%), Jeevamrita (5%), and Jeevamrita (Saptdhaan) (5%) emerged as particularly effective, positive outcomes in plant yield and development. These findings accentuate the significance of bioenhancers and offer valuable direction towards harnessing them for sustainable agricultural practices. By leveraging bioenhancers, agricultural productivity can be improved, and soil management can be enhanced.

FUTURE

To validate these findings comprehensively, further research and field trials on a larger scale and across diverse agro-climatic conditions are recommended. This endeavor will yield practical recommendations for farmers, facilitating the widespread adoption of bioenhancers in palak cultivation. Ultimately, these practices can contribute to sustainable and ecologically-friendly agricultural approaches.

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