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Studies on integrated use of nutrients and organic growth stimulants on growth and quality of palak (*Beta vulgaris* var. *bengalensis*) cv. Arka Anupama

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Abstract
An experimental field study titled "Studies on integrated use of nutrients and organic growth stimulants on growth and quality of palak (*Beta vulgaris* var. *bengalensis*) Cv. Arka Anupama" was conducted during the 2022-23 *rabi* season at the Medicinal and Aromatic Plants Unit, Saidapur Farm, University of Agricultural Sciences, Dharwad. The research encompassed nine distinct treatments, each replicated three times, aimed at assessing the combined effects of fertilizers and organic materials. These materials included Farmyard Manure (FYM) at 50%, Vermicompost at 25%, and organic growth stimulants, specifically Vermiwash at 5%, Panchagavya at 3%, and Humic acid at 0.2%. The application of these organic growth stimulants was carried out in conjunction with manure as a foliar spray at 20 and 40 days after sowing. Notably, treatment T_5, which involved the combination of recommended dose of fertilizer at 75%, Vermicompost at 25% of recommended dose of nitrogen and Panchagavya at 5 % as a foliar spray, demonstrated the highest performance in the plant height (14.95, 24.41, 29.01 and 47.67 cm respectively at 30, 45, 60 and 75 days after sowing), leaf area (326.52, 384.61, 424.98 and 351.42 cm^2 respectively at 30, 45, 60 and 75 days after sowing), chlorophyll content (44.14 SPAD units) and ascorbic acid content (69.84 mg 100 g^{-1}). The maximum root length (20.50 cm) was observed in treatment T_8 receiving 50% RDF + 50% FYM (equivalent to N) + panchagavya 3% and maximum shelf life (6.33 days) was recorded with treatment containing 75% RDF + 25% vermicompost (equivalent to N) + humic acid at 0.2% (T_6).

Keywords: Growth, integrated, organic growth stimulants, palak, panchagavya, quality

Introduction
Palak, scientifically known as *Beta vulgaris* var. *bengalensis*, and commonly referred to as Indian spinach, is a member of the chenopodiaceae family with its origins believed to trace back to the Indo-China region. This leafy green vegetable is not only highly nutritious but also a rich source of vitamins and minerals, boasting calcium, iron, vitamin A, vitamin C, vitamins B_1 and B_2, essential amino acids and antioxidants such as flavones, carotene, indoles, and isothiocyanates. Beyond its nutritional prowess, Palak is also known for its medicinal attributes and enjoys widespread cultivation in India and worldwide.

To bolster its rapid growth and abundant leaf production, farmers often stick to the use of inorganic fertilizers, known for their rapid nutrient solubility. However, the overuse of these chemical fertilizers poses threats to the environment and human health, contributing to soil degradation and water pollution. In response to these concerns, organic manure, biofertilizers, and biostimulants are emerging as sustainable alternatives. Organic manure, originating from natural sources like plant and animal waste, enhances soil quality, moisture retention, and microbial activity, while gradually supplying essential nutrients to plants. Notably, Farmyard Manure (FYM), Vermicompost, and biostimulants containing beneficial microorganisms such as Azospirillum and Phosphate Solubilizing Bacteria (PSB) are gaining popularity for their role in improving soil health, nutrient accessibility, and crop productivity. An understanding of the impact of these organic approaches on Palak cultivation is vital for fostering sustainable and economically viable agricultural practices.

Materials and Methods
The current investigation was carried out at the Medicinal and Aromatic Plants Unit, Saidapur Farm, University of Agricultural Sciences, Dharwad, Karnataka, during the *rabi* season of 2022-23 season. The research aimed to examine the effects of an integrated approach involving nutrient application and organic growth stimulants on the yield and economic

aspects of Palak (*Beta vulgaris* var. *bengalensis* Hort.).

Palak variety Arka Anupama was used for the present study. This was developed at IIHR by crossing IIHR 10 X IIHR 8 followed by pedigree method of selection. It has medium-large, dark green, succulent, crinkle and attractive leaves. It is a late bolter with vigorous initial growth and regenerates at a faster rate. Leaves become ready for first cutting in three to four weeks' time and subsequent cuts are taken at fortnightly intervals. It is rich in chlorophyll, carotene, vitamin-C and iron. The leaves are crisp and possess good taste even when eaten raw as salad (Hazra and Banerjee, 2005) [3]. The seeds were sown in first fortnight November month of 2022 and final harvest of leaves was carried out by second fortnight of January 2023.Total four harvests were procured. First harvest was done at 30 days after sowing and subsequent harvests were carried out at fifteen days interval after the first harvest.

The experimental design employed was a Randomized Complete Block Design (RCBD) with nine distinct treatments, each replicated three times, by utilizing a plot area of 4.41 square meters. Treatment one, the control group, involved the application of the recommended dose of fertilizers (50:25:50 N: P2O5:K2O kg/ha) along with 30 tons/ha of Farmyard Manure (FYM). In contrast, treatment two consisted of 75% of the recommended dose of nitrogen combined with 25% Vermicompost. Treatment three featured a combination of 50% Recommended Dose of Fertilizers (RDF) and 50% FYM, equivalent to the recommended dose of nitrogen. Treatments four through nine were created by individually blending treatments two and three with foliar spray of Vermiwash (5%), Panchagavya (3%), and Humic acid (0.2%), at 20 and 40 days after sowing for exploring various integrated approaches to nutrient and growth stimulant application for Palak cultivation.

Table 1: Treatment details

T_1	RDF (50:25:50 N:P_2O_5:K_2O kg/ha+ 30 t/ha FYM)
T_2	75% RDF + 25% Vermicompost (equivalent to RDN)
T_3	50% RDF + 50% FYM (equivalent to RDN)
T_4	T_2 + Vermiwash 5%
T_5	T_2 + Panchagavya 3%
T_6	T_2 + Humic acid 0.2%
T_7	T_3 + Vermiwash 5%
T_8	T_3 + Panchagavya 3%
T_9	T_3 + Humic acid 0.2%

Results and Discussion

Growth parameters

At 30, 45, 60 and 75 days after sowing plant height (21.45, 28.32, 38.97 and 60.54 cm respectively) of palak was increased significantly for different combination of nutrient source. Minimum plant height (14.95, 24.41, 29.01 and 47.67 cm respectively) was recorded with treatment T_1 receiving recommended dose of fertilizers through inorganic source alone. In this study the treatment T_5 consisting 75% RDF + 25% vermicompost (equivalent to N) + panchagavya at 3% produced higher plant height at different stages of plant growth. This might be due to slow decomposition of organic manures and presence of phytoharmones and growth promoting enzymes present in panchagavya which facilitated cell division and multiplication (Patil *et al.*, 2012) [5] which has facilitated in enhancing the plant height.

The different combination of nutrient source significantly influenced leaf area at 30, 45, 60 and 75 days after sowing. The treatment T_5 (75% RDF + 25% vermicompost (equivalent to N) + panchagavya at 3%) produced maximum leaf area (326.52, 384.61, 424.98 and 351.42 cm^2) and minimum leaf area (280.16, 325.45, 365.36 and 306.20 cm^2) was recorded in treatment T_1 receiving recommended dose of fertilizers. The use of combined source of nutrients might have increased the nutrient availability in soil, in turn improving the leaf size which is in alignment with Sunanda *et al*. (2014) [10] in Kasurimethi. These results are in agreement with findings of Somasundaram *et al*. (2007) [9] and Tharmaraj *et al*. (2011) [11] who reported that plants sprayed with panchagavya invariably tend to produce bigger sized leaves and develop denser canopy.

The significant difference was observed in root length by the application of different combination of nutrient sources. Higher root length (20.50 cm) of palak at 75 days after sowing was observed with treatment T_8 receiving 50% RDF + 50% FYM (equivalent to N) + panchagavya 3%. The minimum root length (12.50 cm) was recorded in treatment T_1 receiving recommended dose of fertilizers. This might be due to application of FYM in major proportion which may have helped in better root growth by providing aeration and nutrients instantly and also in long run. Panchagavya also improves the soil physical, chemical and biological properties (Sailaja *et al.* (2014)) [8] which may have contributed to better root growth. It is in agreement with Amalraj et al., 2013 [1].

Quality parameters

The maximum shelf life (6.33 days) was observed in treatment T_6 containing 75% RDF + 25% vermicompost (equivalent to N) + humic acid at 0.2%. Significantly lower shelf life (4 days) was observed in treatment T_1 receiving recommended dose of fertilizers through inorganic source alone. This might be due to combined application of inorganic nutrients, organic manure and bio stimulants which helped in reducing of respiration and also would be due to reduced moisture content as moisture level reduces, the physiological loss of weight also reduces this may be the reason for results observed. Similar results were obtained by Revathi *et al.* (2014) who reported that use of organic manure along with biofertilizers helped in reduction of respiration rate and improving the shelf life of palak.

The chlorophyll content of leaves (SPAD units). The highest content of chlorophyll (44.14) was observed in the treatment T_5 (75% RDF + 25% vermicompost (equivalent to N) + panchagavya at 3 %). The treatment T_3 receiving 50% RDF + 50% FYM (equivalent to N) recorded the lowest chlorophyll content (37.13). The balanced nutrient supply, better leaves growth and development and availability of enhanced micronutrient availability might be the reason for the results observed. These results are in line with Narkhede *et al.* (2011) [4] who reported that application of vermicompost increased chlorophyll content in chilli and Rakesh *et al*. (2017) [6] who reported that use of panchagavya at 3% increased the chlorophyll content in brinjal.

The ascorbic acid content of palak was significantly increased by application of different combination of nutrient sources. The highest ascorbic acid (69.84 mg 100 g^{-1}) was found in treatment receiving 75% RDF + 25% vermicompost (equivalent to N) + panchagavya at 3% (T_5). The treatment T_1 receiving recommended dose of fertilizers through inorganic source alone recorded the lowest ascorbic level (59.10 mg 100 g^{-1}). This could be due to growth promoting enzymes and

phytohormones present in panchagavya would have helped in increased chlorophyll production in turn increasing photosynthesis activity resulting in accumulation of photosynthates inturn increased ascorbic acid content. The similar results were obtained by Amareswari and Sujathamma (2014) [2] in French bean.

Table 2: Plant height as influenced by integrated use of nutrients and organic growth stimulants in palak (*Beta vulgaris* var. *bengalensis* Hort.) Cv. Arka Anupama

Treatment	Plant height (cm)			
	30 DAS	45 DAS	60 DAS	75 DAS
T_1- RDF (50:25:50 N:P_2O_5:K_2O kg/ha+ 30 t/ha FYM)	14.95	24.41	29.01	47.67
T_2- 75% + 25% Vermicompost (equivalent to RDN)	17.66	25.07	31.48	56.07
T_3- 50% RDF + 50% FYM (equivalent to RDN)	16.99	24.49	32.13	52.08
T_4- T_2 + Vermiwash 5%	19.21	25.75	32.00	56.64
T_5- T_2 + Panchagavya 3%	21.45	28.32	38.97	60.54
T_6- T_2+ Humic acid 0.2%	20.23	27.58	34.47	58.79
T_7- T_3 + Vermiwash 5%	18.57	25.41	30.60	56.15
T_8- T_3 + Panchagavya 3%	19.40	27.10	34.13	58.50
T_9- T_3 + Humic acid 0.2%	19.22	26.15	32.82	57.61
Mean	18.63	26.03	32.85	56.01
S.Em±	0.63	0.75	1.77	2.42
CD @ 5%	1.89	2.26	5.29	7.28

Note: DAS: Days after sowing, FYM: Farmyard manure, RDF: Recommended dose of fertilizers, RDN: Recommended dose of nitrogen

Table 3: Leaf area as influenced by integrated use of nutrients and organic growth stimulants in palak (*Beta vulgaris* var. *bengalensis* Hort.) Cv. Arka Anupama

Treatment	Leaf area (cm^2)			
	30 DAS	45 DAS	60 DAS	75 DAS
T_1- RDF (50:25:50 N:P_2O_5:K_2O kg/ha+ 30 t/ha FYM)	280.16	325.45	365.36	306.20
T_2- 75% + 25% Vermicompost (equivalent to RDN)	289.32	347.97	379.26	315.15
T_3- 50% RDF + 50% FYM (equivalent to RDN)	283.94	335.89	369.23	310.37
T_4- T_2 + Vermiwash 5%	304.16	356.65	395.53	325.98
T_5- T_2 + Panchagavya 3%	326.52	384.61	424.98	351.42
T_6- T_2+ Humic acid 0.2%	320.10	365.68	408.38	344.63
T_7- T_3 + Vermiwash 5%	297.38	353.10	383.90	320.88
T_8- T_3 + Panchagavya 3%	304.49	361.87	405.02	338.16
T_9- T_3 + Humic acid 0.2%	314.55	361.83	397.16	329.84
Mean	302.29	354.78	392.09	326.96
S.Em±	9.09	10.65	11.91	9.69
CD @ 5%	21.26	21.82	25.32	26.28

Note: DAS: Days after sowing, FYM: Farmyard manure, RDF: Recommended dose of fertilizers, RDN: Recommended dose of nitrogen

Table 4: Root length and uality parameters as influenced by integrated use of nutrients and organic growth stimulants in palak (*Beta vulgaris* var. *bengalensis* Hort.) Cv. Arka Anupama

Treatment	Root length (cm)	Shelf life (days)	Chlorophyll (SPAD units)	Ascorbic acid (mg 100 g^{-1})
T_1- RDF (50:25:50 N:P_2O_5:K_2O kg/ha+ 30 t/ha FYM)	12.50	4.00	41.37	59.10
T_2-75% + 25% Vermicompost (equivalent to RDN)	15.30	5.00	38.95	63.91
T_3- 50% RDF + 50% FYM (equivalent to RDN)	19.10	4.50	37.13	62.00
T_4- T_2 + Vermiwash 5%	16.40	6.00	43.17	64.45
T_5- T_2 + Panchagavya 3%	16.50	6.17	44.14	69.84
T_6- T_2+ Humic acid 0.2%	17.50	6.33	41.34	66.75
T_7- T_3 + Vermiwash 5%	19.40	5.33	38.06	63.97
T_8- T_3 + Panchagavya 3%	20.50	5.50	40.43	65.95
T_9- T_3 + Humic acid 0.2%	19.70	5.83	38.75	65.65
Mean	17.43	5.41	40.37	64.62
S.Em±	0.50	0.2	1.46	1.87
CD @ 5%	1.52	0.63	4.39	5.61

Note: DAS: Days after sowing, FYM: Farmyard manure, RDF: Recommended dose of fertilizers

Conclusion

The parameters like plant height, leaf area, chlorophyll content and ascorbic acid content was found superior in treatment T_5 (75% RDF + 25% vermicompost (equivalent to N) + panchagavya at 3%). Maximum root length was observed in treatment T_8 receiving 50% RDF + 50% FYM (equivalent to N) + panchagavya 3% and maximum shelf life was recorded with treatment containing 75% RDF + 25% vermicompost (equivalent to N) + humic acid at 0.2% (T_6).

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Appendix I: Monthly meteorological data during crop growth period (2022-2023) at the Main Agricultural Research Station, UAS, Dharwad

Month	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Rainy days
	Maximum	Minimum	Maximum	Minimum		
October 2022	28.9	18.6	85.6	67.8	208.6	8
November 2022	29.6	16.5	72.8	45.6	2.81	1
December 2022	29.6	15.6	76.6	44.2	3.2	1
January 2023	28.2	13.2	78.2	51.9	0.0	0
February 2023	32.0	15.1	61.8	32.9	0.0	0
March 2023	34.2	18.9	66.1	36.7	48.8	6
April 2023	34.8	21.1	75.7	52.5	114.4	8
May 2023	32.1	21.4	84	61.5	125.8	6