Effect of integrated nutrient management on growth and yield of Palak

ABSTRACT

Aims: A field experiment was conducted to assess the "Effect of integrated nutrient management on growth and yield of Palak *(Beta vulgaris var. bangalensis)*".
Study design- The experiment laid out in Randomized Complete Block Design with 4 replication.
Place and Duration of Study: The experiment was conductedduring *Rabi* 2022 at Polyhouse of Dr. B.R. Ambedkar university of social science Mhow, Indore (M.P.).
Methodology- The experiment comprised of 6 treatments viz. **T_1**–75% RDF (inorganic fertilizers) + 25% RDF (Vermicompost), **T_2** – 75% RDF + 25% RDF (FYM), **T_3** – 50% RDF + 50% RDF Vermicompost, **T_4**– 50% RDF + 50% RDF (FYM), **T_5**– 100% RDF (80-40-50 Kg NPK ha^{-1}), T_6 – Control (Without any fertilizers). All observations were recorded at 30, 45 and 60 days after sowing (DAS).
Results- The results shows that the highest value of all the yield and growth parameters (plant heigh, number of leaves $plant^{-1}$, leaf width, leaf length, no. of leaf $plant^{-1}$, length of petiole, dry and fresh weight) were recorded with the application of T_5 which was significant over T_1 and T_2 and at par with T_3 at 30, 45 and 60 DAS. Similarly maximum yield (95.87, 95.48 and 90.20 q ha^{-1}) was recorded with the application of T_5 which was significant over T_1 and T_2 and at par with T_3. Application of T_3 was also found significant over T_4, T_1 and T_2 with the values of 94.84, 94.00 and 88.77 q ha^{-1} at 30, 45 and 60 DAS.
Conclusion: Among all treatment application of T_3 (50% RDF + 50% RDF Vermicompost) gave maximum yield which not only increase yield but also save cost of 50% RDF.

Keywords: Recommended doses of fertilizers (RDF), Vermicompost and Farmyard manure, Integrated nutrient management

1. INTRODUCTION

Fruits and vegetables are rich source of vitamins and minerals that help strengthen the human immune system which in return and responsible for fighting against diseases. Such a plant with Vitamin and mineral rich vegetable, widely grown and consumed is spinach *(Spinacia oleracea L.)* [3]. Vegetables play a significant role in Indian vegetarian diets. Palak is one of the most popular leafy vegetables with good nutritive value. It is a commonly grown leafy vegetable throughout the tropical and subtropical regions in all types of soils [12]. It contains 268.60 mg nitrogen, 49.68 mg phosphorus, 141.68 mg potash, 368.00 mg calcium, 42.32 mg iron, 50.24 mg ascorbic acid and 52.00 µg carotene content per 100 g of edible portion. Thus, it is called as "Mines of Minerals" [2]. The price of chemical fertilizers is high and hence farmers also adopting use of alternate resources of nutrients to reduce depending on use of chemical fertilizers and start better conservation and utilization of natural resources [2]

Organic manure plays an important role in quality production of vegetable cropsgrown products are high in quality [6,7]. The organic forms of nutrients must first be

mineralized into plant-available forms such as nitrate and ammonium. The FYM contains all the nutrients needed for crop growth including trace elements but in small quantities. The rate of mineralization is variable and depends on soil type, moisture, temperature, and manure composition. Vermicompost is a nutrient rich microbiologically active organic amendment which results from the interactions between earthworms and microorganisms by the breakdown of organic matter. It is a stabilized, finely divided peat-like material with a low C: N ratio and high water-holding capacity that constitutes a source of plant nutrients which are released gradually, through mineralization, as the plants need them. Vermicompost work as a 'slow-release organic fertilizer'. With their continued application the 'organic nitrogen' & other nutrients in compost tends to be released at constant rate from the accumulated 'humus' and the net overall efficiency of NPK over a period of years is considerably greater than 50% of that of chemical fertilizers. In years to come, utilization of organic manure to meet crop nutrient requirement will be an unavoidable practice to enhance sustainable agriculture, this is because the physical, chemicaland biological properties of soil is generally improved by the addition of organic manures which in turn enhances crop productivity and maintains the quality of crop produce [8]. Although, in comparison to inorganic fertilizers, organic manures contain smaller quantities of plant nutrients. The use of inorganic fertilizer to increase yield has been found to be effective as a short-term solution but demands consistent use on a long-term basis. The high cost of inorganic fertilizers makes it uneconomical and out of reach to poor farmers and it is also undesirable due to its hazardous environmental effects [9]. Therefore, it is essential to investigate the use of locally sourced organic materials which are environment friendly, cheapand probably an effective way of improving and sustaining the productivity of soils and crops [1]. The integrated use of organic and inorganic fertilizers not only increase mutual efficiency but also helps in the substitution of costly chemical fertilizers [7]. The concept of Integrated Nutrient Management (INM) is defined as adjustment or maintenance of soil fertility and supply of nutrient to plants up to an optimum level for sustaining the desired crop productivity through optimized utilization of all possible resources of plant nutrients in an integrated manner [10]. Thus, the integration of organic and inorganic sources may improve and sustain crop yields without degrading soil fertility status This study was therefore carried out to determine the effect of organic and inorganic fertilizers and their combinations on the grain yield of Palak.

2. MATERIAL AND METHODS

A research trial was taken up during Rabi season of 2021-2022 at polyhouse of Dr. B.R. Ambedkar university of social science at Mhow, Indore (M.P.). The experiment comprised of 6 treatments viz. T_1 –75% RDF (inorganic fertilizers) + 25% N (Vermicompost), T_2 – 75% RDF + 25% N (FYM), T_3 – 50% RDF + 50% N Vermicompost, T_4 – 50% RDF + 50% N (FYM), T_5 – 100% RDF (80:40:50 Kg NPK ha^{-1}), T_6 – Control (Without any fertilizers) formed were laid out in a Randomized Complete Block Design with 4 replication. The total number of plot 24. The experimental site was well prepared, cultural practices include thinning, weeding, irrigation and manure application were followed for the healthy growth of crop. The organic manures were applied as basal dose and seed treatment respectively. Control plot was maintained without any organic and bio inputs. Palak growth and yield parameters were noted at 30, 45 and 60 days after sowing (DAS). Five plants taken for each plot. The fresh weight of the plant was noted using electrical balance for each treatment separately. For dry weight of plant was oven dried at 60^{o}C for 24 hours then the dry weight of shoot was noted using electrical balance for each treatment separately. Then the average dry weight (g) was

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measured.Data were analyzed using SPSS for analysis of variance and Fisher's LSD multiple range test was employed for the means comparisons.Data on growth, yield and quality parameters were collected and discussed below.

3. RESULTS AND DISCUSSION

3.1 Plant height

The data presented in table shows that the application of all the treatments were found significant over control. The highest plant height (20.16, 29.77 and 44.69 cm) was recorded with the application of T_5 which was significant over T_1 and T2 and at par with T_3 with the plant height of 19.62, 28.86 and 41.87 cm at 30, 45 and 60 DAS. Increase in plant height with increasing levels of NPK due to more availability of nutrient like nitrogen, ~~which increases proportion of protoplast to cell wall and deal several consequences, one of them being increase in size of cell which express morphologically in increase plant height. Phosphorous affects the cell elongation and root development and potassium is involved in many physiological processes, photosynthesis assimilates and enzyme activation which can~~ direct consequent on crop growth (Majhi et al., 2018). Increase in plant height in inorganic source may be due to inorganic fertilizer might have resulted in maximum nutrient uptake, leading to increased protein synthesis, cell division and cell enlargement which in turn are elaborated into protoplast and thereby protein is left available for cell wall formation materials, which is expressed morphologically in terms of increased plant height (Kumar and Satyavan, 2017).

3.2 Maximum leaf width

The maximum leaf width (4.83, 4.91 and 8.58 cm) was recorded with the application of T_5 which was significant over T_1 and T2 and at par with T_3 with the value of 4.35, 3.47 and 7.23 cm at 30, 45 and 60 DAS. ~~Higher LAI~~may be due to presence of microorganisms in the VC and FYM that colonize in the rhizosphere and stimulate the vegetative growth and biochemical contents, influenced physicochemical properties that imparts favorable soil structure for root growth and enhancing mineral uptake by the roots which enhanced leaf area. Increase in leaf area is a function of cell multiplication and cell enlargement, nitrogen forms a major source of cell division and cell enlargementand it is an internal part of chlorophyll which is the primary absorber of light energy needed for photosynthesis. Phosphorous fertilization also improves the metabolic and physiological processes and thus known as "energy currency" which is subsequently used for vegetative and reproductive growth through ~~phosphorylation and sufficient.~~Potassium is responsible for maintaining proper water potential, turgid pressure and promoting cell elongation in the leaves. Which results in the higher leaf area index.

3.3 Leaf length

The highest leaf length (9.48, 22.10 and 23.24 cm) was recorded with the application of T_5 which was significant over T_1 and T_2 and at par with T_3. Application of T_3 with the value of 8.10, 20.04 and 22.23 cm was also found significant over T_4, T_1 and T_2 at 30, 45 and 60 DAS. ~~Increases number of grains per spike of INM treatment due to greater the nutrient availability from inorganic fertilizer and organic manures, increase the beneficial enzymatic activities, increased population of beneficial microorganisms or the presence of biologically active plant growth influencing substances such as plant growth regulators or plant hormones which provide efficient translocation of food material into grain.~~

3.4 Length of petiole

The maximum length of petiole 6.56, 9.27 and 10.89 cm was found with the application of T_5 which was significant over T_1 and T_2 and at par with T_3. Application of T_3 was also found significant over T_4, T_1 and T_2 with the value of 5.99, 8.44 and 9.17 at 30, 45 and 60 DAS. The integrated use of inorganic and organic nutrient sources resulted in synergy and

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improved the conservation and synchronization of nutrient release and crop demand, which led to increased fertilizer efficiency and greater yield, use of organic fertilizer could increase the efficiency of inorganic fertilizer.

3.5 No. of leaf plant^{-1}

The maximum no. of leaf plant^{-1} (12.58, 23.35 and 43.32 cm) was recorded with the application of T_5 which was significant over T_1 and T_2 and at par with T_3. Application of T_3 was also found significant over T_4, T_1 and T_2 at 30, 45 and 60 DAS. Nitrogen is a structural element of chlorophyll and protein molecules, and thereby affects formation of chloroplasts and accumulation of chlorophyll in plants (Tucker, 2004). Application of higher nitrogen favored the optimum plant growth and extensive root system resulting in higher feeding power and nutrient absorption by the plant (Chaudhary, 2016). Potassium is associated with absorption of water, nutrients, synthesis, and translocation of carbohydrates within the plant. These roles of K stimulate growth of plants. It activates more than 60 plant enzymes regulating many metabolic processes including essential processes of photosynthesis. All these functions with role in resistance against pests and diseases result in increased growth, availability and uptake of nutrients which is finally results in increase in maximum no. of leaf plant^{-1}.

3.6 Fresh weight

The maximum fresh weight (17.97, 37.27 and 78.36 g) was recorded with the application of T_5 which was significant over T_1 and T_2 and at par with T_3. Application of T_3 was also found significant over T_4, T_1 and T_2 at 30, 45 and 60 DAS. ~~The maximum fresh weight in T_5 may be due to the efficacy of vermicompost is supposed to be enhanced due to certain hormonal activity associated with it.~~ All these might have resulted in the vigorous vegetative growth of the plant which in turn leads to increased partition of the photo-assimilates to the fruits and thereby increase the dry matter accumulation in the fruits.

3.7 dry weight

The maximum dry weight (4.49, 9.32 and 19.59 cm) was recorded with the application of T_5 which was significant over T_1 and T_2 and at par with T3. Application of T_3 (3.79 cm) was also found significant over T_4, T_1 and T_2 at 30,45 and 60 DAS. However, the increase dry matter in integrated sources of nutrient due to continuous slow release of nutrient with the application of recommended dose of fertilizer in combination with organic manures enabled the leaf area duration to extend and provided an opportunity for the plants to increase the photosynthetic rate leading to higher accumulation of dry matter.

3.8 Yield

The maximum yield (95.87, 95.48 and 90.20 q ha^{-1}) was recorded with the application of T_5 which was significant over T_1 and T_2 and at par with T_3. Application of T_3 was also found significant over T_4, T_1 and T_2 at 30, 45 and 60 DAS. Better nutrition because ofsynergistic effect of combination of fertilizer manure and biofertilizer which might have added in higher root growth, development and enhanced the uptake and translocation of nutrients resulted higher plant growth and ultimately yield. Nitrogen is growth promoting nutrient. Nitrogen when absorbed during vegetative phase helps to synthesized the chlorophyll necessary for photosynthesis, promotes rapid leaf, stem and root growth as evidenced by an increase in number of tillers as well as an increase in the size of leaves. Nitrogen increases proportion of protoplast to cell wall and deal several consequences, one of them being increase in size of cell which express morphologically in increase plant height. P is known to promote root development, rapid plant maturity, seed production, improve BNF, water use efficiency, and resistance to diseases.

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4. CONCLUSION

~~As per~~The study revealed that, application of organic manures with inorganic source had positive impact on yield of ~~leafy vegetables~~palak ~~but also improve soil health~~. The use of inorganic fertilizer to increase yield has been found to be effective as a short-term solution but demands consistent use on a long-term basis. ~~And limitation of organic manures are limited raw materials, slowly mineralized and less quantity of nutrients. Thus, integrated source 50% inorganic + 50% RDN (through VC) gave maximum yield and also save cost of 50% inorganic fertilizers.~~

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REFERENCES

1. Adekiya AO, Ejue WS, Olayanju A. Different organic manure sources and NPK fertilizer on soil chemical properties, growth, yield and quality of okra. Sci. Rep. 2020;10, 16083.
2. Choudhury B, Rajendra R. Pusa Jyothi: A highly nutritive palak. Indian Horticulture. 1980;25(2):5-6
3. Chaudhary UC, Singh S, Ahlawat TR and Palagani N. Influence of nitrogen on growth parameters and Leaf nutrient composition of rose cv. Samurai under Protected conditions protected conditions. 2016 1377-1380.
4. Chokkara SL. Spinach and its health benefits: A review. The Pharma Innov. J. 2022; 11(8S): 1232-1239.
5. Gowda KN, Mantur SM, Biradar MS and Gurudutt M, Hegde. Response of spinach *(Beta vulgaris var. bengalensis)* to integrated nutrient management practices under protected condition J. Farm Sci. 2022;35(1): 136-139.
6. Hisch CF, Hsu KN. Effect of organic manures on growth and yield of sweet pepper. Bulletin of Taichung District Agricultural Improvement Station. 1994;(42):1-10
7. Hussain TI and. Ahmed MA,. EM Technology-A new looks for IPNM. In: Proc. Symp., Integrated Plant Nutrient Management, NFDC, Islamabad, Pakistan. 2000
8. Maheswarappa HP, Nanjappa, HV, Hegde MR & Prabhu SR. Influence of planting material, plant population and organic manures on yield of East Indian galangal *(Kaempferia galanga)*, soil physico-chemical and biological properties. *Indian J. Agron*. 44(3), 651–657 (1999).
9. Majhi S, Thakur R, Pal SK, Upasani RR, Puran AN Kujur AN. Long-term influence of nutrientmanagementon productivity and profitability of maize (Zeamays)–wheat (Triticum aestivum) cropping system. Indian J. Agron. 2018; 63 (1): 14–20.
10. Olowoake, AA. Influence of organic, mineral and organomineral fertilizers on growth, yield, and soil properties in grain amaranth (Amaranthus cruentus L.). J. Org. 2014; 1(1), 39–47.
11. Ray Tucker, M. 2004. Primary nutrients and plant growth, In: Essential Plant Nutrients, North Carolina Department of Agriculture. 2016;11(3): 1377-1380
12. Sharma VK, Kumawat C and Yadav RK, Integrated nutrient management: concepts and components. Biotech articles. 2016.
13. Sunil Kumar and Satyavan. Effect of Integrated Nutrient Management on Growth and Development of Wheat *(Triticum aestivum L.)* under Saline and Canal Water Irrigation, Int. J. Pure App. Biosci. 5 (6): 744-751 (2017)
14. Veeraragavathatham D. Vegetable culture. Suri Associates, 1998, 228-231.

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Table 1. Effect of integrated nutrient management on growth parameters at 30, 60 and 90 DAS

No.	Plant height (cm)			Leaf width(cm)			Leaf length (cm)			Petiole length (cm)		
	30	45	60	30	45	60	30	45	60	30	45	60
T1	17.42	26.36	35.66	3.12	3.85	6.00	6.73	19.87	19.23	4.25	6.42	7.41
T2	17.13	24.11	34.10	2.16	3.12	5.70	5.04	14.43	17.38	3.31	5.61	7.22
T3	19.62	28.86	41.87	4.35	3.47	7.23	8.10	20.04	22.23	5.99	8.44	9.17
T4	16.74	20.75	27.88	2.14	2.61	4.87	4.86	11.68	14.43	3.51	3.43	6.27
T5	20.16	29.77	44.69	4.83	4.91	8.58	9.48	22.10	23.24	6.56	9.27	10.89
T6	12.35	19.44	22.44	1.39	1.32	4.17	4.16	10.56	12.21	3.19	2.41	5.26
Mean	**17.24**	**24.88**	**34.44**	**3.00**	**3.21**	**11.20**	**6.39**	**16.45**	**18.12**	**4.47**	**5.93**	**7.70**
CD at 5%	**1.84**	**0.53**	**1.88**	**0.22**	**1.50**	**0.34**	**0.80**	**1.08**	**0.89**	**0.36**	**1.44**	**0.92**
SE mean	**0.61**	**0.18**	**0.63**	**0.07**	**0.50**	**5.70**	**0.26**	**0.36**	**0.29**	**0.12**	**0.48**	**0.30**

T1 - 75%RDF (Inorganics) + 25% RDN (VC), T2 - 75% RDF (Inorganics) + 25%RDN (FYM), T3 - 50% RDF (inorganics) + 50% RDN (through VC), T4 - 50% RDF (inorganics) + 50% RDN (inorganics + FYM), T5 - 100% RDF (inorganics), T6 – Control

Table 2. Effect of integrated nutrient management on growth parameters and yield at 30, 60 and 90 DAS

No.	No. of leaf/ plant			Fresh weight (g)			Dry weight (g)			Yield (q/ha)		
	30	45	60	30	45	60	30	45	60	30	45	60
T1	10.47	18.70	34.47	14.45	30.70	62.99	3.61	7.68	15.74	90.73	91.25	80.31
T2	9.13	17.35	25.80	12.86	29.73	53.02	3.21	7.43	13.25	80.35	80.12	79.47
T3	12.07	21.57	37.82	15.18	35.00	70.37	3.79	8.75	17.59	94.84	94.00	88.77
T4	8.77	16.31	22.51	9.91	28.73	47.01	2.48	7.18	11.75	74.38	75.44	74.32
T5	12.58	23.35	43.32	17.97	37.27	78.36	4.49	9.32	19.59	95.87	95.48	90.2
T6	8.41	16.32	20.47	9.49	21.38	42.18	2.37	5.35	10.67	70.7	70.12	70.15
Mean	**10.24**	**18.93**	**30.73**	**13.31**	**4.55**	**58.99**	**3.32**	**7.67**	**14.76**	**84.48**	**84.40**	**80.53**
CD at 5%	**1.24**	**1.06**	**3.69**	**1.29**	**0.70**	**14.36**	**0.32**	**0.52**	**1.22**	**0.97**	**29.47**	**0.48**
SE mean	**0.41**	**0.35**	**1.22**	**0.43**	**29.73**	**4.76**	**0.11**	**0.17**	**0.40**	**0.32**	**9.77**	**0.16**

T1 - 75%RDF (Inorganics) + 25% RDN (VC), T2 - 75% RDF (Inorganics) + 25%RDN (FYM), T3 - 50% RDF (inorganics) + 50% RDN (Inoganics + VC), T4 - 50% RDF (inorganics) + 50% RDN (inorganics + FYM), T5 - 100% RDF (inorganics), T6 – Control

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