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Study on the effect of integrated nutrient management on growth & yield of Palak (*beta vulgeris* var. Bengalensis)

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Abstract
The experiment was entitled "Studies on the effect of Integrated Nutrient Management practices on growth, leaf yield and quality of palak" (*Beta vulgaris* var. bengalensis) was investigated at School Studies of Agricultural Science, Vikram University Ujjain (Madhaya Pradesh) during the *rabi* season of 2024-2025. The total 11 different treatment with three replication T_1- Control,T_2-30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM, T_3-30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC, T_4 -60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM,T_5-60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM, T_6-60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC, T_7 -90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM,T_8 -90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM,T_9 90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC, T_{10}-100% RDF through inorganic fertilizers (80:40:50 NPK ha^{-1}) and T_{11}-100% RD through organic manure (33.3% VC+ 33.33% FYM+ 33.3%PM).
Application of integrated nutrient management was recorded in treatment T_{11} 100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM). produced best results in terms of characters like plant height (cm), leaf area, number of leave per plant, fresh leaves weight, dry leaf weight, The highest leaf yield (576.67 q ha-1), dry matter production, highest total dry matter production, maximum protein content (3.68 g 100 g-1), maximum ascorbic acid (72.78 g 100 g 1), highest net return (₹2183330) The maximum benefit cost ratio (3.07) were recorded.

Keywords: Palak integrated nutrient management growth, leaf yield and quality

Introduction
The chenopodiaceae family includes the Palak (Beta vulgaris var. bengalensis), which is most likely indigenous to the Indo-Chinese area. Other names for it include Indian spinach, spinach beetroot and palak. It is often cultivated in the winter. On a tiny, thick stem, this herbaceous annual yields rosette-shaped, succulent, soft edible leaves that are picked and prepared as a vegetable. In addition to its various therapeutic benefits, the herbaceous portions provide a slight laxative effect. Its leaves are used to treat liver and spleen disorders, as well as inflammation, paralysis, headaches, and earaches.
The preventive food value of leafy greens is strong. Since leafy vegetables are valuable commodities, they may contribute significantly to economic growth. Due to a growing understanding of their nutritional significance, interest in growing leafy vegetables has grown significantly in recent years. High-yielding leafy greens offer additional jobs, foreign currencies, nutritional security, and income (Chadda, 2004) [2].
The majority of farmers exclusively apply urea as fertiliser, often in excess of the prescribed amount. Their knowledge of management techniques and the use of biofertilizer and other fertilisers is inadequate. Possibly these are the main causes of poor yield and soil health deterioration. Additionally, an increase in N fertiliser raised the crop tissues' nitrate content without appreciably raising output. (Sunitha *et al*., 2024) [9]. It has become necessary to use unconventional fertilisers as supplements or replacements for chemical fertilisers because the increased use of chemical fertilisers has increased the cost of producing vegetables, polluted their agricultural environment, and reduced soil fertility.In the same respect, (Ahmadi *et al*., 2010) [1] reported that, total yield, number of leaves/plant and nitrate content in leaves were increased by increasing chemical fertilizer NPK, while different fertilizer levels had no

significant effect on petiole length.

Materials and Methods

The experiment was conducted at the field of Horticulture, School of studies in agricultural sciences, Vikram University, Ujjain (M.P.). Ujjain is situated at 23.17650 N latitude and 75.78850 E longitudes at an altitude of 494 m Mean Sea Level. The experiment was laid out at the crop cafeteria of the section Horticulture. Seed rate used during experiment 10-12 kg and tested variety Pusa vilayti palak.

Results and Discussion

Growth parameters

Data examine in Table 1 to 5 indicate that application of integrated nutrient management practices brought about a significant variation in growth parameters as *viz*., maximum plant height (12.65, 27.54 and 34.65 cm) respectively, recorded at 15, 30 and 45 DAS, maximum leaf area (112.44, 332.43 and 376.88), number leave per plant (11.65, 14.89 and 15.66) and dry leaf weight (2.81, 2.75 and 2.67 g) at 15, 30 and 45 DAS were recorded with T_{11} (100% RD through organic manure (33.3% VC + 33.3% FYM + 33.3% PM).Among the various nutrients, nitrogen plays a very important role in plant growth and development. As it is not only directly as a constituent of proteins but also indirectly by changing the phytohormone balance in the plant. In the current study, in addition to applying fertilisers at the 100% recommended dosage, the application of inorganic fertilisers in combination with vermicompost, FYM, poultry manure, and biofertilizers significantly impacted growth characteristics like plant height, leaf number, leaf area, fresh and dry leaf weight, and dry matter production. The current study's findings showed that applying the necessary dosage of fertilizer—a mix of inorganic and organic manures such as vermicompost, FYM, chicken manure, and bio-fertilizers—had a substantial impact on plant height. A rapid rate of increase in plant height was observed from 15 DAS to harvest during crop growth period. Among all the treatments T_{11} (100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM), Highest plant height with the application of poultry manure was also recorded in palak (Phadnis *et al.*, 2007) [8].

Yield parameter

A glance of the data represented in Table 5 to 7 that there was significant effect of integrated nutrient management practices on yield, he maximum fresh leaves weight (38.43, 37.97 and 36.11 g) were recorded at 15, 30 and 45 DAS and highest leaf yield (576.67 q ha^{-1}) were recorded with T_{11} (100% RD through organic manure (33.3% VC + 33.3% FYM + 33.3% PM). Increased vegetative development, a balanced C/N ratio, and the direct or indirect involvement of co-enzymes in controlling several physiological processes inside the plant may have contributed to the treatment's highest yield. These characteristics of inorganic nutrients, biofertilizers, and micronutrient sprays may have improved root growth, improved plant nutrient translocation, and hastened the synthesis of carbohydrates, all of which would have improved leaf output. Tosic *et al*. (2016) [10] observed similar findings. The use of inorganic nutrients and biofertilizers, such as Azotobacter and PSB, which have improved the availability of N and P in soil as essential plant nutrients, may be the cause of the yield increase. The yield improvement may be attributed to higher yield attributing components such as increased vegetative and yield parameters which were positively affected by the foliar application of micronutrients as reported by Diana and Nehru (2014) [5].

Poultry manure application resulted in significantly higher yield in chilli, similar results were reported by (Paudel *et al.* 2004) in lettuce, (Geetha kumar *et al.,* 2005) [6] in amaranthus (Phadnis *etal.,* 2007) [8] in palak. The reduced leaf yield with 100% organic source of nutrients might have lead to reduction in leaf area and less uptake of nutrients.

Economics

The use of integrated nutrient management strategies in palak had a substantial impact on net return and the B-C ratio, according to the data (Table 8). T_{11} (100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM) were recorded highest gross return (₹288333), highest net return (₹2183330), maximum benefit cost ratio (3.07). Similar results were reported by (Madhavi *et al*., 2009) in spinach. To obtain more returns, it is preferable to have a higher monetary worth and lower cultivation costs. The current market price of output and inputs is taken into consideration while calculating the economics of various treatment combinations, which include land configuration and fertiliser level. These results are very close to the finding of (Chaudhary *et al*., 2011) [4].

Table 1: Effect of integrated nutrient management on plant growth of palak

Sr. No.	Treatments	Plant height (cm)		
		15DAS	30DAS	45DAS
T_1	Control	7.65	16.77	26.44
T_2	30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM	8.65	21.54	29.76
T_3	30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC	8.43	20.43	29.54
T_4	60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM	8.34	18.60	28.65
T_5	60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM	8.78	21.65	30.11
T_6	60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC	9.33	21.86	31.33
T_7	90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM	9.65	22.33	32.32
T_8	90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM	10.04	22.76	33.65
T_9	90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC	10.65	23.65	34.11
T_{10}	100% RDF through inorganic fertilizers (80:40:50 NPK ha-1)	9.87	22.65	33.54
T_{11}	100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM)	12.65	27.54	34.65
	SEm±	0.12	0.27	0.45
	C.D at5%	0.35	0.80	1.34

Table 2: Effect of integrated nutrient management on leaf area of palak

Sr. No.	Treatments	Leaf area (cm^3)		
		15DAS	30DAS	45DAS
T_1	Control	86.44	287.54	320.65
T_2	30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM	96.76	312.43	345.54
T_3	30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC	97.87	305.65	335.65
T_4	60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM	91.30	294.65	327.87
T_5	60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM	102.22	316.44	347.66
T_6	60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC	103.43	321.43	349.98
T_7	90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM	104.54	322.43	353.98
T_8	90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM	106.65	325.32	364.87
T_9	90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC	110.44	329.43	368.90
T_{10}	100% RDF through inorganic fertilizers (80:40:50 NPK ha-1)	105.22	323.54	359.98
T_{11}	100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM)	112.44	332.43	376.88
	SEm±	1.54	2.96	12.11
	C.Dat5%	4.53	8.74	35.72

Table 3: Effect of integrated nutrient management on number of leaf of palak

Sr. No.	Treatments	Number of leaves		
		15DAS	30DAS	45DAS
T_1	Control	6.54	9.53	11.66
T_2	30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM	8.45	12.65	13.65
T_3	30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC	8.23	12.54	13.22
T_4	60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM	7.98	10.66	12.65
T_5	60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM	8.67	13.54	14.12
T_6	60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC	9.12	13.65	14.35
T_7	90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM	9.23	13.87	13.54
T_8	90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM	10.76	14.54	15.30
T_9	90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC	10.87	14.23	15.22
T_{10}	100% RDF through inorganic fertilizers (80:40:50 NPK ha-1)	9.65	13.88	14.65
T_{11}	100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM)	11.65	14.89	15.66
	SEm±	0.14	0.25	0.19
	C.D at 5%	0.41	0.75	0.55

Table 4: Effect of integrated nutrient management on fresh leaf weight of palak

Sr. No.	Treatments	Fresh leaf weight (g $plant^{-1}$)		
		15DAS	30DAS	45DAS
T_1	Control	28.66	27.65	29.76
T_2	30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM	34.65	33.65	32.66
T_3	30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC	32.65	33.43	32.54
T_4	60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM	31.54	30.55	31.54
T_5	60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM	34.78	34.86	33.54
T_6	60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC	34.69	35.54	34.54
T_7	90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM	34.23	35.66	34.33
T_8	90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM	36.54	37.65	35.33
T_9	90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC	37.54	37.90	35.88
T_{10}	100% RDF through inorganic fertilizers (80:40:50 NPK ha-1)	35.11	36.22	35.54
T_{11}	100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM)	38.43	37.97	36.11
	SEm±	0.59	0.54	0.51
	C.Dat5%	1.74	1.61	1.51

Table 5: Effect of integrated nutrient management on dry leaf weight of palak

Sr. No.	Treatments	Dry leaf weight (g $plant^{-1}$)		
		15DAS	30DAS	45DAS
T_1	Control	2.73	2.42	2.32
T_2	30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM	2.66	2.51	2.27
T_3	30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC	2.77	2.68	2.36
T_4	60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM	2.46	2.39	2.33
T_5	60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM	2.36	2.33	2.43
T_6	60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC	2.50	2.44	2.46
T_7	90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM	2.12	2.14	2.34
T_8	90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM	2.04	2.22	2.54
T_9	90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC	2.20	2.17	2.45
T_{10}	100% RDF through inorganic fertilizers (80:40:50 NPK ha-1)	1.86	2.32	2.17
T_{11}	100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM)	2.81	2.75	2.67
	SEm±	0.02	0.04	0.03
	C.Dat5%	0.07	0.10	0.10

Table 6: Effect of integrated nutrient management on leaf yield of palak

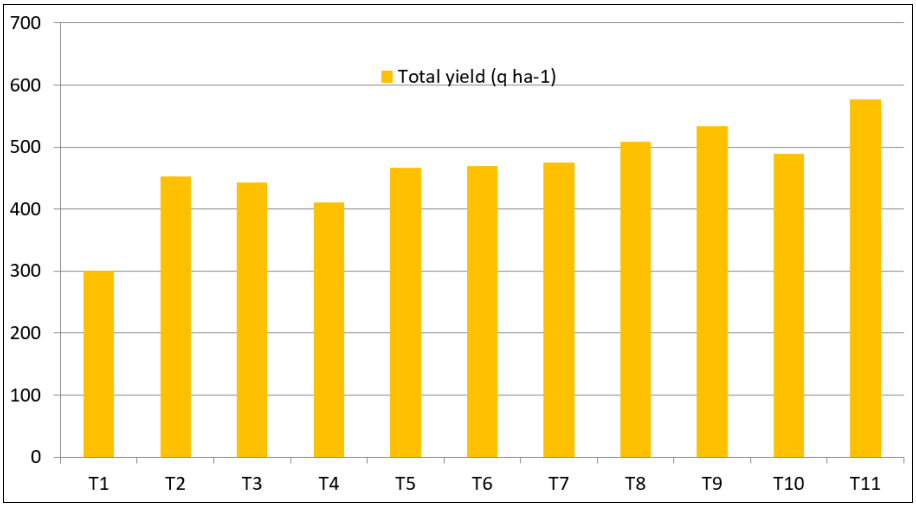
Sr. No.	Treatments	Fresh leaf yield (kg)		
		15DAS	30DAS	45DAS
T_1	Control	2.43	3.44	3.12
T_2	30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM	4.56	4.80	4.23
T_3	30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC	4.43	4.70	4.15
T_4	60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM	3.54	4.65	4.12
T_5	60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM	4.65	5.10	4.25
T_6	60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC	4.68	5.14	4.26
T_7	90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM	4.73	5.17	4.35
T_8	90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM	4.85	5.76	4.65
T_9	90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC	5.65	5.82	4.53
T_{10}	100% RDF through inorganic fertilizers (80:40:50 NPK ha-1)	4.78	5.45	4.43
T_{11}	100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM)	5.76	6.87	4.67
	SEm±	0.07	0.08	0.05
	C.D at 5%	0.22	0.23	0.16

Table 7: Effect of integrated nutrient management on leaf yield of palak

Sr. No.	Treatments	Leaf yield (kg plot^{-1})	Total yield (q ha^{-1})
T_1	Control	8.99	299.67
T_2	30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM	13.59	453.00
T_3	30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC	13.28	442.67
T_4	60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM	12.31	410.33
T_5	60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM	14.00	466.67
T_6	60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC	14.08	469.33
T_7	90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM	14.25	475.00
T_8	90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM	15.26	508.67
T_9	90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC	16.00	533.33
T_{10}	100% RDF through inorganic fertilizers (80:40:50 NPK ha-1)	14.66	488.67
T_{11}	100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM)	17.30	576.67
	SEm±	2.65	2.23
	C.Da t 5%	7.25	6.54

Table 8: Effect of integrated nutrient management on economics of palak

Sr. No.	Treatments	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Benefit Cost ratio
T_1	Control	149833.2	99833.18	2.00
T_2	30% RDF through inorganic fertilizers + 70% RD of nitrogen through PM	226499.8	166499.80	2.77
T_3	30% RDF through inorganic fertilizers + 70% RD of nitrogen through VC	221333.1	161333.10	2.69
T_4	60% RDF through inorganic fertilizers + 40% RD of nitrogen through FYM	205166.5	145166.50	2.42
T_5	60% RDF through inorganic fertilizers + 40% RD of nitrogen through PM	233333.1	173333.10	2.89
T_6	60% RDF through inorganic fertilizers + 40% RD of nitrogen through VC	234666.4	174666.40	2.91
T_7	90% RDF through inorganic fertilizers + 10% RD of nitrogen through FYM	237499.8	177499.80	2.96
T_8	90% RDF through inorganic fertilizers + 10% RD of nitrogen through PM	254333.1	192333.10	3.10
T_9	90% RDF through inorganic fertilizers + 10% RD of nitrogen through VC	266666.4	201666.40	3.10
T_{10}	100% RDF through inorganic fertilizers (80:40:50 NPK ha-1)	244333.1	184333.10	3.07
T_{11}	100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM)	288333	218330.12	3.12



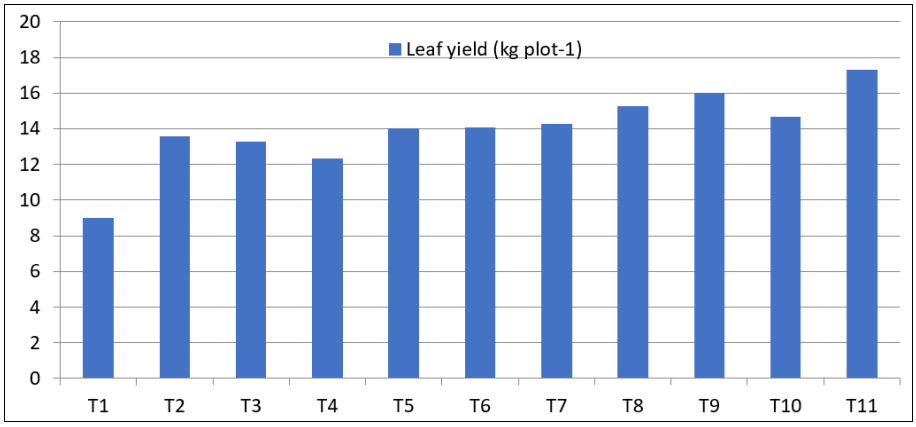


Fig 1: Effect of integrated nutrient management on leaf yield of palak

Conclusion

It may be concluded that for higher growth leaf yield and quality of palak in 100% RD through organic manure (33.3%VC+33.3%FYM+33.3% PM should prefer over other combination. The observations are based on one season data, to get more precise information, it is suggested that the experiment.

It can be concluded that the we can suggest to farmer use of 100% RD through organic manure (33.3% VC + 33.3% FYM + 33.3% PM) in integrate nutrient management and improved soil nutrient status.

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