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Performance and correlation studies on nutritional uptake and nutritional content by various organic and inorganic fertilizers on Spinach

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Palak or spinach beet (*Beta vulgaris* Var. *bengalensis* Hort.) is one of the most popular leafy vegetables of tropical and sub-tropical region and is grown widely in India. Its tender soft succulent leaves are used as vegetable. Wonderful green leafy vegetable spinach is often recognized as one of the functional food for its nutritional, antioxidants and anti-cancer constituents. Its tender, crispy, dark green leaves are favourite ingredients of chefs all around the planet. Palak is highly nutritious contains higher fibrous matter, which provides necessary roughage in the diet, rich in Vitamin A and Vitamin K. There is little work on the nutritional uptake and its contents aspects of this crop. In order to study the nutritional uptake and nutritional content by various organic and inorganic fertilizers of the spinach an experiment was conducted. The correlation study among various growth and yield parameters was studied. This will help in the further crop improvement of palak by breeder or an agronomist.

An experiment was conducted at the Horticultural Research Farm, University of Agricultural Sciences, GKVK, Bangalore, the experimental unit is situated at $12^0$58' North latitude and $77^0$35' East longitudes with an altitude of 930m above MSL. The crop was grown under irrigated conditions "To study the Nutrition of palak (*Beta vulgaris* var. *bengalensis* Hort.) through organic and inorganic nutrient sources." The palak variety "All Green" released by IARI, New Delhi was used. It is suitable for multi-cutting (6-7 times) with a yield potential of 125 q ha^{-1}. The experiment was laid out in RCBD with sixteen treatments with various combinations of organic and inorganic doses of nutrients (Table 1), having three replications. All agronomic package practices were followed in addition to treatments case study.

The soils were sandy loam with low in available soil nitrogen (156.00 kg/ha), phosphorus (16.54 kg/ha) and potassium (136.62 kg/ha) with normal pH (6.7). The nitrogen was applied in three equal spits while, P_20_5 and K_20 were applied as basal at the time of sowing. Composites of surface soil samples to a depth of 31.5 cm were collected at before sowing and after harvest of the crop.

The crop observations are recorded to investigate the parameters such as green leaf yield, plant height at harvest (cm), no. of leaves at harvest, leaf area at harvest (cm^2), leaf area index, leaf area duration 20-30 DAS (dm^2/day), dry weight per plant at harvest (g), chlorophyll content at 20 DAH (mg/g), net assimilation rate (g/m^2/week), crop growth rate (g/m^2/week), N uptake by plant at harvest (kg/ha), P uptake by plant at harvest (kg/ha) and K uptake by plant at harvest (kg/ha). These parameters are represented as X1, X2 ,X3, X4, X5, X6, X7, X8, X9, X10, X11, X12 and X13 respectively.

Significant differences were recorded among different treatments regarding crop growth of main and ratoon crop of palak (Table 2). For crop growth, yield and green leaf yield per hectare treatment T_{12} was recorded highest and on par with the treatment T_2, T_5 and T_{13}. Significant differences were obtained with respect to green leaf yield per hectare of main and ratoon crop of palak due to influence of varying levels of organic manures and inorganic fertilizers. Green leaf yield increase linearly as organic manures and inorganic fertilizers levels increased. In main crop highest green leaf yield was in T_{12} (157.20 q/ha) and lowest was in T_1 (59.89 q/ha) with an increased yield of 97.31 q/ha which was about two and half times higher over the control. In the first ratoon crop green leaf yield was highest in treatment T_{12} (143.75 q/ha) and the lowest was in T_1 (49.06 q/ha), which was almost three fold increase in the yield over control. In the second ratoon crop highest green leaf yield was in treatment T_{12} (131.45 q/ha) and lowest was in T_1 (31.16 q/ha) with an increase in yield of 92.29 q/ha, which was about three folds increase over the control. The increase

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Table 1. Treatments conducted for the experiments

Treatments	N ($Kgha^{-1}$)	P_2O_5 ($Kgha^{-1}$)	K_2O ($Kgha^{-1}$)	Agri magic ($Kgha^{-1}$)	FYM (t ha^{-1})
T_1	0.0	0.0	0.0	0	0.0
T_2	150.0	100.0	100.0	0	20.0
T_3	75.0	50.0	50.0	0	10.0
T_4	112.5	75.0	75.0	0	15.0
T_5	150.0	100.0	100.0	280	0.0
T_6	112.5	75.0	75.0	280	0.0
T_7	112.5	75.0	75.0	560	0.0
T_8	75.0	50.0	50.0	280	0.0
T_9	75.0	50.0	50.0	560	0.0
T_{10}	0.0	0.0	0.0	560	0.0
T_{11}	150.0	100.0	100.0	0	0.0
T_{12}	150.0	100.0	100.0	Agrimagic equilent to FYM on nitrogen basis (8.87 t ha^{-1})	0.0
T_{13}	150.0	100.0	100.0	27Kg of fulvic liquid + seed line granular+ two post plant spray	0.0
T_{14}	112.5	75.0	75.0	27 Kg of fulvic liquid +seed line granular+two post plant spray	0.0
T_{15}	112.5	75.0	75.0	36Kg of fulvic liquid+seed line granular+two post plant spray	0.0
T_{16}	75.0	50.0	50.0	36Kg of fulvic liquid + seed line granular+two post plant spray	0.0

Table 2. Effect of organic manures and inorganic fertilizers on crop growth rate (g/m^2/week), green leaf yield / plot and estimated yield/ha of main crop, ratoon crop I & II

Treatments	Main crop		Ratoon crop I		Ratoon crop II	
	g/m^2/week	Estimated yield/ha	g/m^2/week	Estimated yield/ha	g/m^2/week	Estimated yield/ha
T_1	0.0024	59.89	0.0014	49.06	0.0009	39.16
T_2	0.0157	149.99	0.0142	138.33	0.0109	125.16
T_3	0.0059	105.20	0.0058	90.72	0.0045	85.22
T_4	0.0091	117.70	0.0091	109.37	0.0079	106.65
T_5	0.0120	141.25	0.0107	123.74	0.0094	118.12
T_6	0.0092	120.62	0.0083	96.97	0.0067	95.41
T_7	0.0091	123.22	0.0087	106.45	0.0067	103.22
T_8	0.0069	106.35	0.0049	85.93	0.0034	75.31
T_9	0.0062	112.29	0.0053	87.81	0.0038	80.60
T_{10}	0.0031	68.75	0.0019	53.95	0.0014	44.58
T_{11}	0.0127	136.45	0.0082	112.61	0.0043	87.60
T_{12}	0.0174	157.20	0.0157	143.75	0.0137	131.45
T_{13}	0.0135	140.62	0.0106	116.51	0.0082	110.62
T_{14}	0.0100	125.51	0.0079	95.41	0.0059	87.91
T_{15}	0.0106	128.19	0.0057	95.62	0.0063	93.01
T_{16}	0.0069	110.19	0.0043	84.78	0.0028	75.31
SEM	0.0011	5.76	0.0012	3.65	0.0011	2.533
CD (P=0.05)	0.0033	16.64	0.0033	10.54	0.0032	7.31
C.V.%	21.03	8.41	26.12	6.35	31.77	4.81

Table 3. Correlation coefficients between various characters of main crop of palak as influenced by application of organic manures and inorganic fertilizers

	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13
X1	0.963**	0.872**	0.845**	0.965**	0.967**	0.965**	0.935**	0.978**	0.950**	0.959**	0.946**	0.962**
X2		0.916**	0.880**	0.947**	0.950**	0.966**	0.889**	0.946**	0.940**	0.959**	0.953**	0.964**
X3			0.906**	0.932**	0.924**	0.953**	0.894**	0.891**	0.940**	0.960**	0.960**	0.956**
X4				0.919**	0.911**	0.921**	0.907**	0.842**	0.891**	0.920**	0.913**	0.926**
X5					0.995**	0.992**	0.973**	0.969**	0.983**	0.990**	0.981**	0.990**
X6						0.989**	0.977**	0.965**	0.979**	0.983**	0.973**	0.985**
X7							0.965**	0.973**	0.987**	0.996**	0.991**	0.999**
X8								0.945**	0.963**	0.960**	0.948**	0.964**
X9									0.980**	0.967**	0.961**	0.970**
X10										0.986**	0.987**	0.987**
X11											0.992**	0.997**
X12												0.993**

*= Significant at 5% **= Significant at 1%

X1= Green leaf yield
X2= Plant height at harvest (cm)
X3= No. of leaves at harvest
X4= Leaf area at harvest (cm^2)
X5= Leaf area index
X6= Leaf area duration 20-30DAS (dm^2 day)
X7= dry weight per pant at harvest (g)
X8= Chlorophyll content at 20 DAH (mg/ g)
X9= Net assimilation rate (g/m^2/week)
X10= Crop growth rate (g/m^2/week)
X11= N uptake by plant at harvest (kg/ha)
X12= P uptake by plant at harvest (kg/ha)
X13= K uptake by plant at harvest (kg/ha)

in yield may be attributed to better nutritional source for vegetative growth as indicated by increase in plant height, increased number of leaves per pant and increased leaf area and dry matter production in plant which might have enhanced the yield. These results are in accordance with the research findings of Ramachandra and Timmaraju (1983), Panda *et.al.* (1991) in Amaranthus, Kumaran *et.al* (1998) and Duraiswamy *et.al* (1999) in tomato.

Data pertaining to correlation coefficients between growth parameters, yield components with yield of main crop, are presented in Table 3. From these data, it shows a positive and significant association with all most all the traits. Correlation values of growth parameters and yield components like plant height, number of leaves per plant, leaf area per plant, leaf area index, leaf area duration, dry weight of the plant, chlorophyll content in leaf, net assimilation rate, crop growth rate and uptake of NPK by plant at harvest with yield indicates true relationship and direct solution of agronomic practices through these traits for better crop.

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