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Integrated Nutrient Management For Spinach

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Abstract:

The field experiment was conducted at Horticulture farm No.16, College of Agriculture, Nagpur and analytical work was carried out at Post Graduate Laboratory, Soil Science and Agricultural Chemistry section, College of Agriculture, Nagpur. The experiment was laid out in randomized block design with 15 treatments and 3 replications. application of 50 % RDN + 50 % N through VC + 10 kg P +15 kg K(T_{12}) was found significantly superior all over rest of treatments and Treatment T_7 and T_8 was at par with T_{12}. Treatment T_{12} which increased yield, nutrient content, uptake and also improved quality of spinach in terms of protein ascorbic acid and chlorophyll. Similarly residual soil fertility status was also increased due to application of 50 % RDN + 50 % N through VC + 10 kg P +15 kg K (T_{12}). As the results are based on only one year of study, the experiment should be reported for better conclusion and recommendation.

Introduction:

Spinach (*Spinaciaoleracea)* is a member of the *Chenopodiaceae* (Goosefoot family). Among the leafy vegetable, spinach is one of the most important leafy vegetables. It is commonly known as "palak" and is having a high nutritional value and is extremely rich in antioxidants, especially when consumed fresh, steamed, or quickly boiled. It is a rich source of vitamin A (especially high in lutein), vitamin C, vitamin E, vitamin K, magnesium, manganese, folate, Betaine, iron, vitamin B_2, calcium, potassium, vitamin B_6, folic acid, copper, protein, phosphorus, zinc, niacin, selenium and omega-3 fatty acids. Recently, opioid peptides called rubiscolins have also been found in spinach **(Anonymous 2013)**.Spinach contain 86.49 % moisture, 0.7 g fiber, 3.4 g protein, 2.29 g mineral, 6.5 g carbohydrates, 0.5 g Riboflavin, 380 mg Calcium, 16.2 mg Iron, 0.29 mg thiamine, 977 mg Vitamin A, Vitamin C 70 mg 100 g^{-1} of edible portion, **(Yawalkar and Ram, 2004).**It also contains high quantity of iron and 100 g of leaf supply as much as essential amino acids as compared to many non-vegetarian foods like meat and fish. Spinach is

cultivated for its fresh and green leaves which become ready for harvest in about 40-45 days after sowing.

In term of production India is the second largest producer of vegetables in the world, next to China, with an estimated production of about 50.09 million tons from an area of 4.5 million hectares and at an average yield of 11.3 tons per hectare. India shares about 12 % of the world output of vegetables from about 2.0 % of cropped area in the country. The per capita consumption in India is only about 140 gm which is far below the minimum dietary requirement of 280 g per day per person. At present major growing states of spinach are Utter Pradesh, Madhya Pradesh, West Bengal, Punjab, Gujarat and Maharashtra. In Maharashtra area under Indian Spinach is 1874 hectares with total production of 10,871 tons with an average yield of 5.80 tons per hectare. Long term food security requires a balance between increasing crop production, for vegetable growth, yield and better quality as well as maintaining soil health and environmental sustainability. INM is also important for marginal farmers who cannot afford to supply crop nutrients through costly chemical fertilizers. This experiment summarizes the results of research work carried out to investigate the role of INM in harnessing economically enhancing nutritive quality of the spinach, improving soil health.

Material and Methods:

The field experiment was conducted at Horticulture farm No.16, College of Agriculture, Nagpur and analytical work was carried out at Post Graduate Laboratory, Soil Science and Agricultural Chemistry section, College of Agriculture, Nagpur. The experiment was laid out in randomized block design with 15 treatments and 3 replications. The experimental plot was ploughed and subsequent harrowing was given for clod crushing and also to ensure fine tilth and moisture conservation. Stalk and stubbles were removed. Treatment wise application of organic manure (FYM and Vermicompost) was done 20 days prior to sowing. A small furrow was made by drawing a straight line with stick and the seeds were sown evenly along the line and covered with soil carefully. Two hand weeding operations were taken up to keep the experimental plot clean and free from weeds. The first irrigation was given immediately after sowing the seeds. Then some protective irrigation were given as per requirement till the harvest.

The application of both manures was done on the basis of nitrogen content in organic manures. The fertilizers (inorganic) were applied as per the treatments details. Dose of nitrogen,

phosphorus and potassium were applied through urea, single super phosphate and potassium sulphate respectively. Five plants were selected from each plot 30 DAS and after harvest. The leaves of selected plants were washed with distilled water and dried at 30^0C and homogenized using grinder. The processed samples were preserved in brown paper bags with appropriate labels and used for further chemical analysis. In order to evaluate the effect combinations of organic and inorganic on residual soil fertility yield and quality of spinach.

Results and Discussion:

Among the different minerals required by plant N. P, K, Ca and Fe are of high important. They influence the quality of spinach and also involved in many physiological and biochemical processes in plants. Nitrogen aids in proper vegetative growth, phosphorous in root development and potassium in transport of nutrients and improving quality of leaf. The nutrient content of spinach was studied at 30 DAS and at harvesting.

Effect of INM on Nutrients content of spinach leaves at 30 DAS:

The data regarding Nutrient content at 30 DAS and at harvesting is presented in table the data on nutrient content presented in table 1 indicate significant effect of different organic and inorganic sources on content of N, P, K, Ca and Fe.

Content of nitrogen in spinach leaves at 30 DAS:

From the data it can be observed that, maximum N content (1.98) was found in plant receiving 50 % RDN +50 % N through VC + 10 kg P +15 kg K in treatment T_{12} followed by plants (1.95 %) receiving 50 % RDN +50 % N through FYM + 10 kg P +15 kg K (T_7) and in treatment T_8 with application of 50 % RDN +50 % N through FYM + 10 kg P +30 kg K. T_7, T_8, T_{14}, T_6 andT_{15} were at par with T_{12}. The minimum content of N was found in treatment T_2 receiving (100 % RDN +10 Kg P +15 kg K). The highest Nitrogen content in T_{12} was may be due better supply and utilization of nitrogen from inorganic and organic sources. The results are in conformity, **Misarirambi (2012)**.

Content of P in spinach leaves at 30 DAS:

The data regarding P content in spinach leaves at 30 DAS show significant variation. The treatment T_{12} (50 % RDN +50 % N through VC + 10 kg P +15 kg K) proved significantly superior recording 0.547 % of P content at 30 DAS, this treatment was followed by T_7, T_{14}, T_9 and T_4. The lowest P recorded was T_1 with application (100 % RDN) the highest p content in T_{12} may be due to solubilizing

and increased availability of P through vermicompost and inorganic P source. Similar results were observed by **Roy *et al.* (2009).**

Content of K in spinach leaves at 30 DAS:

The data pertaining to K content in spinach leaves in table 5 indicated significant effect of different treatment combinations from the data of K content at 30 DAS it is observed that, application of 50 % RDN + 50 % N through VC + 10 kg P + 15 kg K in treatment T_{12} proved significantly superior by recording 0.640 % K content in spinach leaves. The treatment T_7 receiving 50 % RDN + 50 % N through FYM + 10 kg P +15 kg K stood second by recording 0.638% content of potassium followed by T_8, T_9,T_2,T_{10} and T_{15}. Similar results were observed by **Roy *et al.* (2009).**

Content ofCa in spinach leaves at 30 DAS:

The data regarding to Ca content in spinach leaves at 30 DAS table 1 indicated significant effect of different nutrient combinations. It is observed that plant receiving 50 % RDN + 50 % N VC + 10 kg P + 15 kg K (T_{12}) increased Ca content (0.359 %) significantly over all other treatment. This treatment is followed by treatment T_7, T_8 and T_6. While the minimum Ca content (0.344 %) was recorded in T_1 receiving (100 % RDN).

Table 1: Effect of integrated nutrient management on nutrient content (%) of spinach at 30 DAS

Treatment		N	P	K	Ca	Fe
T_1	100 % RDN	1.73	0.431	0.628	0.344	0.049
T_2	100 % RDN + 10 kg P + 15 kg K	1.64	0.441	0.632	0.349	0.048
T_3	100 % RDN + 10 kg P + 30 kg K	1.68	0.478	0.630	0.346	0.050
T_4	100 % RDN + 20 kg P + 15 kg K	1.77	0.514	0.625	0.349	0.051
T_5	100 % RDN + 20 kg P + 30 kg K	1.66	0.462	0.630	0.345	0.052
T_6	50 % RDN + 50 % N FYM	1.82	0.437	0.620	0.355	0.057
T_7	50 % RDN + 50 % N FYM + 10 kg P + 15 kg K	1.95	0.530	0.638	0.358	0.059
T_8	50 % RDN + 50 % N FYM + 10 kg P + 30 kg K	1.93	0.489	0.636	0.357	0.058
T_9	50 % RDN + 50 % N FYM + 20 kg P + 15 kg K	1.69	0.515	0.633	0.347	0.056
T_{10}	50 % RDN + 50 % N FYM + 20 kg P + 30 kg K	1.67	0.473	0.631	0.345	0.055
T_{11}	50 % RDN + 50 % N VC	1.75	0.507	0.629	0.354	0.054
T_{12}	50 % RDN +50 % N VC +10 kg P + 15 kg K	1.98	0.547	0.640	0.359	0.060
T_{13}	50 % RDN + 50 % N VC +10 kg P + 30 kg K	1.79	0.498	0.630	0.352	0.051
T_{14}	50 % RDN + 50 % N VC + 20 kg P + 15 kg K	1.92	0.520	0.627	0.353	0.046
T_{15}	50 % RDN + 50 % N VC + 20 kg P + 30 kg K	1.82	0.505	0.631	0.351	0.047
F-test		Sig	Sig	Sig	NS	Sig
SE (m)		0.043	0.012	0.003	0.002	0.002
CD @ 5%		0.122	0.034	0.009	-	0.005

Content of Fe in spinach leaves at 30DAS:

From the data it is revealed that there is significant variation in Fe contain at 30 DAS. Among the 15 treatment T_{12} which received 50 % RDN + 50 % N VC + 10 kg P + 15 kg K showed highest Fe contain (0.060 %). This statement was followed by treatment T_7 (0.059 %), T_8 (0.056 %) and then T6 (0.57 %). Treatment T_7, T_8 and T_6 were found at par with T_{12}. From this it can be seen that, adding of organic manures along with inorganic sources increased Fe content in spinach leaves. Similar results were observed by **Roy *et al.* (2009).**

Effect of INM on Nutrient content of spinach leaves at harvesting:

The data presented in table no 2 significant effect of different combination on nutrient content in spinach leaves at harvest.

Content of N in spinach leaves at harvest:

The data pertaining N content in spinach leaves at harvesting is presented in table no.2. Showed highest N contains range from (2.06 % to 2.3 1%). Among the 15 treatment T_{12} which received 50 % RDN + 50 % Vermicompost + 10 kg P +15 kg K showed highest N contain (2.24 %). This treatment was followed by T_7 with application of 50 % RDN + 50 % FYM +10 kg P +15 kg K and recorded 2.23 % of N content. In general, order of N content in as per ranking can be described as $T_{12}>T_7>T_8>T_{11}$. The lowest N content (2.06 %) was observed in plant receiving 100 % RDN +10 kg P +15 kg K in treatment T_2.

Comparing values of N content from table 5 and 6, it can be concluded that, there is increase in nitrogen content from 30 DAS to harvesting. The results are in conformity with **Choudhary*et al.* (2011)**.

Table 2: Effect of integrated nutrient management on nutrients content (%) of spinach at harvest

Treatment		N	P	K	Ca	Fe
T_1	100 % RDN	2.12	0.581	0.634	0.351	0.053
T_2	100 % RDN + 10 kg P + 15 kg K	2.06	0.582	0.639	0.352	0.048
T_3	100 % RDN + 10 kg P + 30 kg K	2.08	0.602	0.658	0.354	0.050
T_4	100 % RDN + 20 kg P + 15 kg K	2.13	0.594	0.633	0.355	0.051
T_5	100 % RDN + 20 kg P + 30 kg K	2.10	0.585	0.649	0.357	0.052
T_6	50 % RDN + 50 % N FYM	2.16	0.589	0.660	0.349	0.047
T_7	50 % RDN + 50 % N FYM + 10 kg P + 15 kg K	2.23	0.631	0.675	0.361	0.059

T_8	50%RDN+50%NFYM+10kgP+30kgK	2.21	0.627	0.670	0.359	0.058
T_9	50%RDN+50%NFYM+20kgP+15kgK	2.15	0.616	0.661	0.350	0.049
T_{10}	50%RDN+50%NFYM+20kgP+30kgK	2.18	0.624	0.667	0.347	0.053
T_{11}	50%RDN+50%NVC	2.20	0.621	0.641	0.349	0.054
T_{12}	50%RDN+50%NVC+10kgP+15kgK	2.24	0.635	0.678	0.362	0.060
T_{13}	50%RDN+50%N VC+10kgP+30kgK	2.16	0.622	0.662	0.352	0.051
T_{14}	50%RDN+50%N VC+20kgP+15kgK	2.19	0.624	0.640	0.347	0.046
T_{15}	50%RDN+50%N VC+20kgP+30kgK	2.18	0.626	0.664	0.358	0.057
F test		Sig	Sig	Sig	Sig	Sig
SE (m)		0.020	0.009	0.010	0.003	0.002
CD @ 5%		0.058	0.025	0.029	0.008	0.006

Content of P in spinach leaves at harvest:

There is increased in P content in spinach from 30 DAS to at the time of harvesting the content of P in spinach leaves was increased from (0.581 % to 0.635 %). The highest P content (0.635 %) was recorded in plant receiving 50 % RDN +50 % N VC +10 kg P + 15 kg K in treatment T_{12}. While, the lowest content of N was observed in treatment T_1 with application of 100 % RDN. Treatment T_7 and T_8 recorded (0.631 %) and (0.627 %) P content respectively.**Roy *et al.* (2009)** also founded there is increased P content in spinach when supplied with combination of organic and inorganic sources.

Content of K in spinach leaves at harvest:

The data present in table.2 indicate significant variation in K content of spinach leaves at harvest. The maximum K content (0.678 %) in spinach leaves at harvest recorded in Treatment T_{12} which received 50 % RDN + 50 % Vermicompost +10 kg P + 15 kg K. This treatment was followed by T_7 with application of 50 % RDN + 50 % FYM +10 kg P +15 kg K and in treatment T_8 which received 50 % RDN + 50 % FYM +10 kg P + 30 kg K. While the plot receiving 100 % RDN (T_1) recorded 0.616 % K content which was the lowest one. The results are in conformity with **Rani and Padmaja (2014).**

Content of Ca in spinach leaves at harvest:

Significant change due to different treatment combination was seen on Ca content in spinach at harvested. The Ca content at harvested range from (0.347 % to 0.362 %). Among the 15 treatment T_{12} which received 50 % RDN +50 % Vermicompost +10 kg P +15 kg K showed highest Ca contain (0.362 %). While, the treatment T_7 receiving 50 % RDN +50 % FYM +10 kg P +15 kg K stood second by recording 0.361 % Ca content. Treatment T_7, T_8 and T_{15} were at par with T_{12}.The

lowest Ca content was recorded in Treatment T_1 with application of 100 % RDN. **Kansal*et al.* (1981)** also found increase in Ca with combined application of inorganic and organic. Similarly were published by **Roy *et al.* (2009).**

Content of Fe in spinach leaves at harvest :

Fe content in spinach leaves was significantly influenced by different combinations of treatment. It ranged from (0.048 % to 0.060 %). Comparing value of Fe content from table 1 and 2. It can be seen that there is slight increase in Fe content from 30 DAS to harvesting. The maximum Fe content (0.060 %) in spinach leaves at harvested was recorded in Treatment T_{12} receiving 50 % RDN + 50 % Vermicompost + 10 kg P +15 kg K. This treatment was followed by T_7 receiving 50 % RDN + 50 % FYM +10 kg P +15 kg K (0.659 %). Treatment T_7, T_8 and T_{15} were at with T_{12}. **Roy *et al.* (2009)** also found that the Fe content with application of organic and inorganic sources.

Conclusion:

From the study undertaken on INM in spinach it can be concluded that combination of inorganic and organic sources significantly increased the yield and quality of spinach in general than inorganic alone. Specifically application of 50 % RDN + 50 % N through VC + 10 kg P +15 kg K(T_{12}) was found significantly superior all over rest of treatments and Treatment T_7 and T_8 was at par with T_{12}. Treatment T_{12} which increased yield, nutrient content, uptake and also improved quality of spinach in terms of protein ascorbic acid and chlorophyll. Similarly residual soil fertility status was also increased due to application of 50 % RDN + 50 % N through VC + 10 kg P +15 kg K (T_{12}). As the results are based on only one year of study, the experiment should be reported for better conclusion and recommendation.

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