www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(4): 93-97

www.thepharmajournal.com
Received: 10-02-2022
Accepted: 12-03-2022

Navaneetha Gowda KN
Department of Horticulture, College of Agriculture, UAS, Dharwad, Karnataka, India

Mantur SM
Agricultural Research Station, Mugad, University of Agricultural Sciences, Dharwad, Karnataka, India

Biradar MS
Department of Horticulture, College of Agriculture, UAS, Dharwad, Karnataka, India

Gurudatt M Hegde
AICRP on Wheat and Barley, Main Agricultural Research Station, UAS, Dharwad, Karnataka, India

Corresponding Author
Navaneetha Gowda KN
Department of Horticulture, College of Agriculture, UAS, Dharwad, Karnataka, India

Effect of integrated nutrient management of spinach on quality attributes under shade net condition

Navaneetha Gowda KN, Mantur SM, Biradar MS and Gurudatt M Hegde

Abstract
The experiment was conducted at Hi-tech Horticultural Unit, MARS, Saidapur Farm, UAS, and Dharwad during summer, 2021 to study "Integrated nutrient management of spinach under protected condition". The treatments comprised of recommended dose of fertilizers (100, 75 and 50% RDF), recommended dose of nitrogen (100, 75 and 50% RDN) applied through farm yard manure (FYM), vermicompost and neem cake (NC) and biofertilizers (*Azotobacter* and PSB). The chlorophyll content found highest initially at 45 days after transplanting with 100% RDF + FYM (38.99 SPAD value) and later at 60 days after transplanting it was found highest in 50% RDF + 50% RDN through FYM and vermicompost (2:1) + *Azotobacter* and PSB (37.72 SPAD value). The quality parameters like oxalate, iron and carotenoid content were found best in 50% RDF + 50% RDN through FYM, vermicompost and NC (2:2:1) + *Azotobacter* and PSB with values of 328.65 mg/100g, 7.23 mg/100g and 3.98 mg/100g, respectively. While, calcium (365.30 mg/100g) and magnesium content (91.44 mg/100g) was found highest with 100% RDN through organic manures + *Azotobacter* and PSB.

Keywords: Nitrogen, Spinach, Biofertiliser, Nutrient management, Organic

Introduction
Spinach, also called as spinach beet or palak (*Beta vulgaris* var. *bengalensis*) belonging to Chenopodioideae family with chromosome number 2n=2x=18 is a wonderful leafy vegetable of Indo-China origin. It has laxative property and also rich in vitamin A and iron content. Spinach is commonly grown in all soil types and 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.

Spinach responds well to nutrient and fertilizer application. Extensive use of the chemical fertilizers will help in higher production of spinach but also show detrimental effect on soil-living organisms which are useful and hence even decrease soil health, ecology and also natural resources over years. 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. The use of bio fertilizers, organic manure *etc*., are the other sources of plant nutrients which apart from acting as manure also improves overall productivity of soil. Nurturing the soil will help in getting healthy diet for consumption.

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 (Sharma *et al*., 2016). The combined use of chemical fertilizers, organic manures and bio-fertilizers will help in improving the quality traits of vegetables for better health.

The main objectives of INM are to increase the nutrient use, to maintain quality of soil like physical, chemical and biological properties of the soil, and even to maintain the soil and nutrient balance between the applied nutrients and nutrient removed from plants, to improve soil health. Use of organic manures like FYM, vermicompost and neem cake along with bio fertilizers with reduced levels of chemical fertilizers plays a vital role in achieving above said aspects. The effect of both organic and inorganic sources of nutrients associated with microbial population through inoculation with biofertilizer helping in mobilizing phosphorus and nitrogen fixation into soluble form in the soil, there by higher release of both nutrient forms, this is in turn promoted in growth, increased the rate of absorption, increased the photosynthesis productivity and better accumulation of macronutrients and Fe content and

ascorbic acid and folic acid content in spinach (Alderfasi *et al.*, 2010) [1].

Materials and Methods

The experiment on "Effect of integrated nutrient management on quality attributes of spinach" was carried out in Hi-Tech Horticulture unit, Main Agricultural Research Station, Saidapur Farm, University of Agricultural Sciences, Dharwad in the summer season of 2021.

The experiment composed of 14 treatments and 2 replications which was laid out in the randomized block design. The spinach variety All-green was taken for present investigation.

Treatments details

Treatments details	
T_1	100% RDF and FYM (Control)
T_2	75% RDF + 25% RDN through FYM and neem cake (2:1)
T_3	75% RDF + 25% RDN through FYM and neem cake (2:1) + *Azotobacter* + PSB
T_4	75% RDF + 25% RDN through vermicompost and neem cake (2:1)
T_5	75% RDF + 25% RDN through vermicompost and neem cake (2:1) + *Azotobacter* + PSB
T_6	50% RDF + 50% RDN through FYM and neem cake (2:1)
T_7	50% RDF + 50% RDN through FYM and neem cake (2:1) + *Azotobacter* + PSB
T_8	50% RDF + 50% RDN through vermicompost and neem cake (2:1)
T_9	50% RDF + 50% RDN through vermicompost and neem cake (2:1) + *Azotobacter* + PSB
T_{10}	75% RDF + 25% RDN through FYM, vermicompost and neem cake (2:2:1)
T_{11}	75% RDF + 25% RDN through FYM, vermicompost and neem cake (2:2:1)+ *Azotobacter* + PSB
T_{12}	50% RDF + 50% RDN through FYM, vermicompost and neem cake (2:2:1)
T_{13}	50% RDF + 50% RDN through FYM, vermicompost and neem cake (2:2:1) + *Azotobacter* + PSB
T_{14}	100% RDN through FYM, vermicompost and neem cake (2:2:1) + *Azotobacter* + PSB

The main field was brought to fine tilth by repeated ploughing followed by harrowing. The land was thoroughly dug to a depth of 30 cm and weeds and stubbles were removed. Finally, it was levelled and replications were demarcated using bund former. Each replication was further divided into plots and a total of 28 plots were laid out. These experiment was carried out in shade-net house covered using 35 per cent shade net of white colour. The structure was well-situated, at 10 feet height from ground ventilated and good for crop growth.

Recommended dose of FYM applied to all treatments commonly. The entire calculated dose of FYM, vermicompost and neem cake as per treatments were combined and applied to individual plots two weeks before transplanting of seedlings by broadcasting method and was thoroughly, mixed with soil.

The entire calculated dose of nitrogen, phosphorous and potassium as per treatment were applied as basal dose before transplanting. The source of fertilizers was urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O). Bio-fertilizers were applied as per treatment to the specified plots as per recommendation. They were mixed with organic fertilizers and applied as broadcasting and thoroughly mixed with soil.

The 35 days old healthy seedlings of palak were transplanted on 1st April, 2021 in at a spacing 45 x 30 cm in paired row system on a raised bed of 1 m width with 50 cm path between two beds prepared. The plants were watered for a week with rose can and later with drip irrigation. Gap filling was carried out one week after transplanting. Harvesting of green leaves was done weekly once or twice based on leaf yield and made into bunches.

The analysis of spinach leaves for its quality attributes has been conducted in laboratory using standard methods. The chlorophyll content readings were taken using SPAD meter (Minolta chlorophyll meter SPAD-502) at 45 and 60 days after transplanting. Calcium and magnesium content were analyzed by Versanate EDTA titration method with digested sample using diacid mixture (Sparks, 1996) [11]. Total carotene content was estimated by the method of Ranganna (1997) [9]. It was calculated by testing digested sample in atomic absorption spectrophotometer (Tandon, 1987) [12]. The oxalate analysis was done by titration method standardized by Baker, 1954.

Results and Discussion

1. Chlorophyll content

The chlorophyll content in leaves of spinach is significantly influenced with integrated nutrient management and results revealed the effect as follows (Table 1). At 45 days after transplanting the chlorophyll content resulted highest in Treatment T_1, applied with 100 per cent RDF + FYM (38.99) followed by T_{13} (35.82). The minimum values were recorded at T_{10} (30.07) and which is on par with T_{14} (30.71) and T_5 (31.53). At 60 days after transplanting the chlorophyll content resulted highest in Treatment T_7, receiving combination of 50 per cent RDF + *Azotobacter* and PSB + 50 per cent RDN through FYM and neem cake in the ratio of 2:1 (37.72) and which is on par with T_8 (37.51) and T_{11} (37.16). The minimum values are recoded at T_5 (32.88) and which is on par with T_{10} (33.08).

The greater amount of nitrogen was supplied for plants in the above combination, as the organic and inorganic nutrients are supplied together. They help in building up of chlorophyll molecule, and the biofertilizers help in efficiently utilization of nutrients. Bharad *et al*. (2013) [4] and Padmanabha *et al*. (2002) also reported that the FYM and vermicompost along with urea increased chlorophyll content.

2. Oxalate content

The significantly lowest oxalate content was found in treatment T_{13}, receiving combination of 50 per cent RDF + *Azotobacter* and PSB + 25 per cent RDN through FYM, vermicompost and neem cake (328.65 mg/100g) followed by T_{12} (382.00 mg/100g). The highest values were recorded at T_1 (628.47 mg/100g) followed by T_3 (593.78 mg/100g). The table 2 shows the values of oxalate content. The use of only inorganic manures yielded highest amount of oxalate content which was found less with the integrated use of organic, inorganic and biofertilizers. The accumulation of nitrate would have direct effect on oxalate content which reduce upon application of organics. The similar results reported by

Zhang *et al.* (2005) [13] and Castelli *et al.* (2010) [5] in spinach.

3. Iron content

The table 2 shows the significant results of iron content in spinach leaves. It was found significantly highest in treatment T_{13}, comprising combination of 50 per cent RDF + *Azotobacter* and PSB + 25 per cent RDN through FYM, vermicompost and neem cake (7.23 mg/100g) followed by T_{14} (7.03 mg/100g). The minimum values were found in control T_1 (5.12 mg/100g) on par with T_2 (5.22 mg/100g). The organic manures applied are in mineralized form which are rich sources of proteinaceous and carbonaceous compounds and also micro-nutrients resulted in enhanced soil fertility and quality and availability of these nutrients as mentioned in nutrient management in spinach by Baravaliya *et al.* (2018) [3].

4. Carotenoid content

The carotenoid content of spinach (table 2) was significantly influenced with integrated nutrient management and found highest in treatment T_{13}, containing 50 per cent RDF + 50 per cent RDN through FYM, vermicompost and neem cake (2:2:1) + *Azotobacter* and PSB (3.98 mg/100g) which is on par with T_{14} (3.89 mg/100g) and T_9 (3.86 mg/100g). The minimum values were found in control T_1 (1.56 mg/100g) followed by T_2 (1.78 mg/100g). The organic fertilizer along with inorganic and biofertilizer showed good amount of carotene content than organics or inorganics alone. Solubilization of nutrients applied through organic and inorganic manures improves uptake of minerals which help in contributing improvement in carotenoid content. These results found in agreement with findings of Revati *et al.* (2011) and Maji *et al.* (2018) [7] in spinach.

5. Calcium content

The calcium content of spinach was significantly influenced with integrated nutrient management and results were tabulated in table 2. It was found highest in treatment T_{14}, 100 per cent RDN through FYM, vermicompost and neem cake (2:2:1) + *Azotobacter* + PSB + *Azotobacter* + PSB (365.30 mg/100g) followed by T_{13} (343.35 mg/100g), whereas minimum values were found in T_{10} (155.75 mg/100g) which is on par with T_7 (157.30 mg/100g) and T_4 (159.50 mg/100g).

6. Magnesium content

The magnesium content of spinach was found highest in treatment T_{14}, comprising application of 100 per cent RDN through FYM, vermicompost and neem cake (2:2:1) + *Azotobacter* and PSB (91.44 mg/100g) followed by T_{13} (81.34 mg/100g), whereas minimum values were found in T_{10} (25.40 mg/100g) which is on par with T_7 (26.74 mg/100g). the significant influence on magnesium content was tabulated in table 2.

According to Baravaliya *et al*. (2018) [3] the organic manures contain nutrients in mineralized form, which allows the maximum accumulation of nutrients than inorganic nutrients. The similar findings reported in other studies by Baravaliya *et al*. (2018) [3] and Madhavi *et al*. (2007) in spinach.

Table 1: Chlorophyll content (SPAD value) of plant as influenced by integrated nutrient management in spinach

Treatments	Chlorophyll content	
	45 DAT	60 DAT
T_1- 100% RDF and FYM (Control)	38.99	33.39
T_2- 75% RDF + 25% RDN through FYM and neem cake (2:1)	32.79	33.43
T_3- T_2 + *Azotobacter* + PSB	34.65	35.51
T_4- 75% RDF + 25% RDN through vermicompost and neem cake (2:1)	32.97	33.19
T_5- T_4 + *Azotobacter* + PSB	31.53	32.88
T_6- 50% RDF + 50% RDN through FYM and neem cake (2:1)	33.07	33.64
T_7- T_6 + *Azotobacter* + PSB	34.50	37.72
T_8- 50% RDF + 50% RDN through vermicompost and neem cake (2:1)	34.19	37.51
T_9- T_8 + *Azotobacter* + PSB	33.29	35.68
T_{10}- 75% RDF + 25% RDN through FYM, vermicompost and neem cake (2:2:1)	30.07	33.08
T_{11}- T_{10} + *Azotobacter* + PSB	35.64	37.16
T_{12}- 50% RDF + 50% RDN through FYM, vermicompost and neem cake (2:2:1)	33.47	35.27
T_{13}- T_{12} + *Azotobacter* + PSB	35.82	35.00
T_{14}- 100% RDN through FYM, vermicompost and neem cake (2:2:1) + *Azotobacter* + PSB	30.71	35.51
Mean	33.69	34.88
S.Em ±	0.626	0.671
CD @ 5%	1.911	2.050

DAT: Days after transplanting

Table 2: Nutrient content in spinach as influenced by integrated nutrient management

Treatments	Nutrient content (mg/100 g)				
	Oxalate	Iron	Carotenoid	Calcium	Magnesium
T_1- 100% RDF and FYM (Control)	628.47	5.12	1.56	284.20	64.86
T_2- 75% RDF + 25% RDN through FYM and neem cake (2:1)	550.72	5.22	1.78	250.45	55.48
T_3- T_2 + *Azotobacter* + PSB	593.78	5.50	2.58	239.65	49.75
T_4- 75% RDF + 25% RDN through vermicompost and neem cake (2:1)	516.95	5.30	3.39	159.50	33.05
T_5- T_4 + *Azotobacter* + PSB	588.80	5.95	2.92	196.45	36.06
T_6- 50% RDF + 50% RDN through FYM and neem cake (2:1)	544.70	6.53	2.53	342.90	79.38
T_7- T_6 + *Azotobacter* + PSB	534.00	6.01	3.22	157.30	26.74
T_8- 50% RDF + 50% RDN through vermicompost and neem cake (2:1)	469.99	6.38	3.71	260.55	61.25
T_9- T_8 + *Azotobacter* + PSB	439.85	6.61	3.86	223.00	43.52
T_{10}- 75% RDF + 25% RDN through FYM, vermicompost and neem cake (2:2:1)	443.85	5.27	1.89	155.75	25.40

T_{11}- T_{10} + *Azotobacter* + PSB	391.25	5.41	2.27	282.50	62.54
T_{12}- 50% RDF + 50% RDN through FYM, vermicompost and neem cake (2:2:1)	382.00	6.04	3.44	325.95	71.79
T_{13}- T_{12} + *Azotobacter* + PSB	328.65	7.23	3.98	343.35	81.34
T_{14}- 100% RDN through FYM, vermicompost and neem cake (2:2:1) + *Azotobacter* + PSB	424.30	7.03	3.89	365.30	91.44
Mean	488.38	5.95	2.92	256.20	55.90
S.Em ±	3.209	0.033	0.046	1.697	0.710
CD @ 5%	9.804	0.100	0.139	5.185	2.170

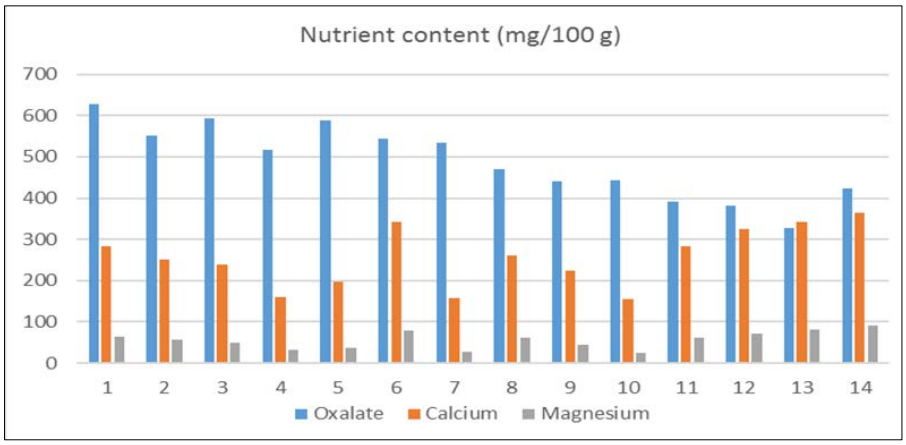

Fig 1: The effect of integrated nutrient management on oxalate, calcium and magnesium content of spinach

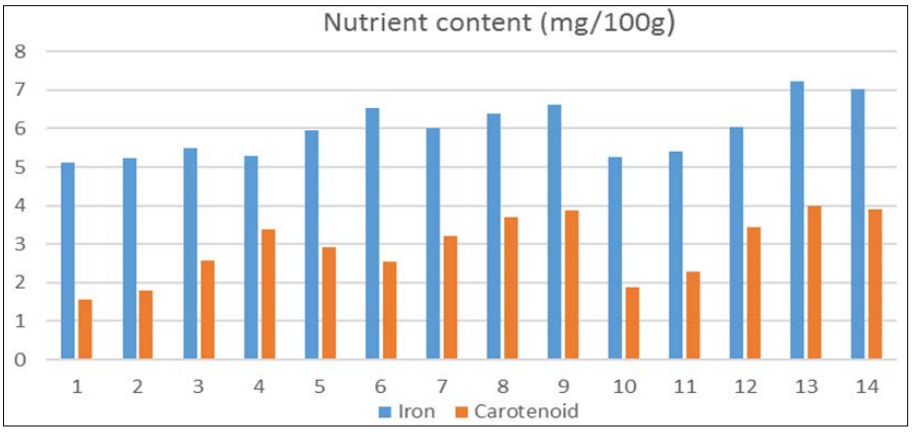

Fig 2: The effect of integrated nutrient management on iron and carotenoid content of spinach

Conclusion

The quality parameters like oxalate, iron and carotenoid content found good at treatment 13, receiving 50 per cent RDF + 50 per cent RDN applied through FYM, VC and NC at 2:2:1 ratio + *Azotobacter* and PSB. The calcium and magnesium content was found better with treatment T_{14} containing FYM, VC and NC in 2:2:1 ratio to equalize 100 per cent RDN along with biofertilizers.

References

1. Alderfasi AA, Moftah AE, Ajuaed AM. Prospective study influences of using bio-organic farming system on growth, nitrate, oxalate and ascorbic acid contents in spinach. World Applied Sciences Journal. 2010;9(1):49-54.
2. Baker CJL. The determination of oxalate in fresh plant material. Analyst. 1952;77:340.
3. Barvaliya MM, Italiya AP, Patel DP, Patel TPH. Effect of FYM, Zn and *Trichoderma* spp. on growth, yield and soil properties after harvest of the spinach beet grown in cadmium contaminated soil. Journal of Pharmacognosy and Phytochemistry. 2018;7(6):544-549.
4. Bharad SG, Snehal K, Pravina S, Baviskar MN. Effect of organic manures and number of cuttings on growth and quality of Indian spinach. Asian Journal of Horticulture. 2013;8(1):60-64.
5. Castelli I, Logegaray V, Diana F. Spinach quality: Reduction of oxalate content in leaves through different Phosphorous levels in nutrient solution. Advances in Horticultural Science. 2010;24(2):145-148.
6. Madhavi Y, Goud PV, Reddy KM, Saidulu A. Effect of different levels of vermicompost, castor cake, poultry manure and biofertilizers on dry matter production, nutrient uptake and economics of Indian spinach. The Orissa Journal of Horticulture. 2008;36(1):53-58.
7. Maji S, Nayak PK. Response of nutrient and cutting management for quality and green yield of palak (Beta vulgaris var. bengalensis). Journal of Crop and Weed. 2018;14(1):126-129.
8. Padmanabha K, Umesh MR, Krishnappa KS. Effect of different organic and inorganic sources of nutrients on nutrient content and nutrient uptake in palak (Beta vulgaris var. bengalensis Hort.). Asian Journal of Horticulture. 2008;3(2):256-258.
9. Ranganna S. Manual of analysis of fruit and vegetable products. 9th Edition, Tata Mc Graw Hill, New Delhi, 1997.
10. Sharma VK, Kumawat C, Yadav RK. Integrated nutrient

management: concepts and components, 2016.
11. Sparks DL. Methods of Soil Analysis Part 3: Chemical Methods. Soil Science Society of America, American Society of Agronomy, Madison, 1996.
12. Tandon HU. Fertilizer recommendation for horticultural crops: A guidebook. Fertilizer development and consultation organization, New Delhi, 1987, 10-14.
13. Zhang Y, Xianyong L, Shao JZ. Effects of nitrogen levels and nitrate/ ammonium ratios on oxalate concentrations of different forms in edible parts of spinach. Journal of Plant nutrition. 2005;28(11):2011-2025.