Biological Forum – An International Journal **13(3a): 760-764(2021)**

ISSN No. (Print): 0975-1130
ISSN No. (Online): 2249-3239

Studies on Interspersed Nutrient Management on Uptake of Nutrients Seeds, Stover and Soil Biota Status of Fennel

Rajesh S. Kalasare[1*], Dinkar J. Gaikwad[2], P.P. Gaikwad[3], Sagar Maitra[4], Ashirbachan Mahapatra[5] and Manish Kumar Yadav[6]

[1]Associate Professor, Department of Agronomy and Agroforestry, Centurion University of Technology and Management, (Odisha), India.
[2]Assistant Professor, Department of Biochemistry and Plant Physiology, Centurion University of Technology and Management, (Odisha), India.
[3]Assistant Professor, Department of Agronomy, College of Agriculture, Selu, Parbhani, (Maharashtra), India.
[4]Professor, Department of Agronomy and Agroforestry, Centurion University of Technology and Management, (Odisha), India.
[5]Assistant Professor, Department of Agronomy and Agroforestry, Centurion University of Technology and Management, (Odisha), India.
[6]Assistant Professor, Department of Agricultural Entomology, Centurion University of Technology and Management, (Odisha), India.

(Corresponding author: Rajesh. S. Kalasare)*
(Received 27 July 2021, Accepted 30 September, 2021)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Crop nutrient management is always a tough task for farmers as most recommendations made for crops are not actually based on all the given localities. Proper and balanced nutrients help in good absorption and translocation of nutrients consequently facilitating proper growth and development of plant along with maintaining the soil health. In view of the above facts, the present experiment was executed at the Research Area of Farm of Agronomy, College of Agriculture, Anand Agricultural University, Anand, Gujarat to find out the effects of balanced and combined practices of nutrient managements on fennel crop. The research was laid out in Randomized Block Design comprising of twelve combinations of Integrated Nutrient Management treatments and three replications. The results revealed that the application of 100 % RDF (Recommended Dose of Fertilizer) with *Azospirillum* sp.+ Phosphate S. Bacteria + Vermi-compost @ 2 t ha^{-1} significantly increased the nutrient uptake of seed (N-42.71, P-8.12, K-13.77 kg^{-1}) and stover (N-28.49,P-9.18, K-16.10 kg^{-1}) as compared to the remaining treatments whereas the application of 50% RDF + *Azospirillum* + PSB + Vermi-compost@2t ha^{-1} maintained the highest soil micro-organism status after harvest of fennel crop against the control check. The experiment concluded that the combined use of fertilizers along with other sources like bio-fertilizer, composts and other organic sources of nutrients not only enhances the quality of the produce but also conserves the soil health maintaining a higher population of soil micro-organism.

Keywords: Fennel, *Azospirillum*, PSB, Vermicompost, RDF.

INTRODUCTION

The Fennel, (*Foeniculum vulgare*) being a member of the *Apiaceae* family and native to the Southern European regions and Mediterranean areas, is an important seed spice. India is the largest shareholder in fennel production as well as export worldwide. Gujarat, Rajasthan, Karnataka and Andhra Pradesh are the major fennel producing states in India (Kashyap and Agarwal, 2021; Sheoran *et al*., 2021). Among them, Gujarat is the highest producer contributing 82% of the total production in the country (SBI 2011). Fennel is a stout, aromatic and annual herb. Its seed is rich in protein (9.5%), fat (10.0%), carbohydrates (42.3%), fiber (18.5%) and minerals (13.4%) (Bhunia *et al*., 2005; Aslam *et al*., 2021; Kashyap and Agarwal, 2021). As far as climatic requirements are concerned, it is a cool season crop and if the crop gets dry and cool weather conditions during seed formation, it increases yield and quality of the seed. The crop can be well grown in all types of soils having adequate amount of organic matter. Organic fertilizer has nitrogen, phosphorus, potassium, organic carbon, enzymes and antibiotics which help to improve the quality and quantity of yield (Chaudhary *et al*., 2021; Devi *et al*., 2021). Farmyard manure (FYM) and vermicompost are the most important and extensively used bulky organic manures

(Desai *et al*., 2020). Bio-fertilizer or microbial fertilizer or more appropriately "microbial inoculations" are the preparations of live or latent cells of efficient strains of microorganisms which are nitrogen fixers (Singh *et al*., 2021; Brithal *et al*., 2021). These are used for seed or soil application with an objective of increasing the numbers of such microorganisms in soil or rhizosphere which subsequently improve the quantity of biologically fixed nitrogen for plant growth. *Azospirillum* is a nitrogen fixing, aerobic free-living bacteria, which does the job of making the atmospheric nitrogen available to various crops (Chandra *et al*., 2021; Sheoran *et al*., 2021; Dhavan *et al*., 2021; Madhukar *et al*., 2021). Nitrogen fixation in the *rhizosphere* is done through the action of various nitrogenase complex enzymes. The organic manures such as plant and animal wastes, FYM, vermicompost, neem cake, poultry manures supply maximum macro and micro nutrients along with improving the soil properties (physical, chemical and biological) (Mevada *et al*., 2017). The importance of plant nutrients from different organic sources is being popularized day by day for the growing concerns ecology and deteriorating innate soil fertility resulting multiple insufficiencies of essential plant nutrient (Kurichen *at al*., 2021; Malik & Dwivedi, 2021). The aim of integrated nutrient management practices is to use nutrients from soil, minerals and organic resources for getting higher production without damaging the biological properties (Shivran and Jat 2015). Therefore, an investigation has been proposed and executed to study the effect of integrated nutrient management with nutrients from different inorganic and organic sources and their combinations on seed and stover yield of fennel as well as on soil microbial population status.

MATERIAL AND METHODS

A field investigation was carried out at Agronomy Farm, B.A. College of Agriculture, Anand Agricultural University, Anand, Gujarat. The soil texture of the research site was loamy sand. Soil samples were taken from the field and analyzed for different chemical properties in which it was found that the soil was slightly alkaline (pH 7.9) having Electrical Conductivity 0.16 dsm^{-1}. The soil of the experimental site was medium in available nitrogen (246.72 kg ha^{-1}), high in available phosphorous (55.78 kg ha^{-1}) and potassium (308.20 kg ha^{-1}). The research was laid out in Randomized Block Design comprising of twelve combinations of Integrated Nutrient Management treatments (Table 1) replicated thrice. The average maximum and minimum temperature at the time of growth and development of the crop ranged from 25.3 - 40.9°C to 8.6 - 28.2°C.

In the research plot the *Gujarat Fennel-2* variety was sown during the second week of November with a sowing geometry of 45 cm × 15 cm and using a seed rate of 5 kg ha^{-1} and recommended fertilizer dose 90:30:0 kg NPK kg ha^{-1} with application of half of the dose of nitrogen and full dose of phosphorous at sowing and the rest amount of nitrogen at 30 days after sowing (DAS) in top dressing. The other nutrient components like Vermi-compost, NADEP, Humic acid were taken as per their quantity requirements according to the treatments and spread equally to the particular treatment plots during sowing. During the research, all the appropriate combinations of plant protection measures were followed.

For estimation of N, P and K content in seed and stover, representative samples were taken from each net plot after harvesting of crop. Estimation of N content in seed and stover was carried out by Micro Kjeldahl method (Jackson, 1973). The digestion of sample was done as per Jackson, (1973) by using nitric acid and perchloric acid and phosphorus was estimated by Olsen's method (Olsen *et al*., 1954) while, for the determination of potassium was done by the Flame Photometer method (Panse and Sukhatme, 1954). Soil microbial population analysis was done taking soil samples after harvest of the crop. Statistical analysis was carried out by using ANOVA.

RESULTS AND DISCUSSION

A. Effect of treatments on nutrient uptake by seed and stover

All the treatments significantly influenced the nutrient uptake (nitrogen, phosphorus and potassium) in seed and stover of fennel where the application of T_4 (100% RDF + *Azospirillum* sp. + PSB + Vermi-compost @ 2 t ha^{-1}) and T_2 (100 % RDF + *Azospirillum* sp.+ Vermi-compost @ 2 t ha^{-1}) were found at par and highest among all (Table 1 and 2). Since content and uptake of nutrients are functions of their concentration and yield, the augmentation in yield of seed and stover tied with higher nutrient concentration consequently augmented the total uptake of nitrogen, phosphorus and potassium with the supply of 100% RDF + *Azospirillum* sp.+ PSB + Vermi-compost and 100% RDF + *Azospirillum* sp.+ Vermi-compost @ 2 t ha^{-1}. The integrated approach of nutrient management in this treatment resulted in higher growth in plant eventually increasing the higher leaf area and higher photosynthesis. Higher photosynthesis and growth facilitates increased amount of photosynthates from shoot to root. These phenomena might have encouraged root growth as well as its functional activities ensuing in increased extraction of nutrients from rhizosphere and their translocation to aerial plant parts. This result may be due to the fact that the proper and balanced nutrition from various organic sources of plant nutrients outcomes in proper absorption, translocation and assimilation of those nutrients (Selim, 2020). Similar findings were also observed by Shivanna *et al.,* (2009); Uttam (2013); Patel *et al.,* (2013); Srujan *et al*., (2021); Kantwa *et al.,* (2021).

Table 1: Influence of different nutrient practices on NPK uptake of seed (Pooled basis).

Sr. No.	Treatments	N uptake seed (kg ha^{-1})	P uptake seed (kg ha^{-1})	K uptake seed (kg ha^{-1})
T_1	RDF 90:30:00 NPK kg/ha.	23.53	4.45	5.96
T_2	100% RDF + *Azospirillum* sp. + Vermi-compost @ 2 t ha^{-1}	40.75	7.72	12.78
T_3	50% RDF + *Azospirillum* sp. + Vermi-compost @ 2 t ha^{-1}	35.43	6.66	10.13
T_4	100%RDF + *Azospirillum* sp. + Phosphorus S. Bcacteria + Vermi-compost @ 2 t ha^{1}	42.71	8.12	13.77
T_5	50% RDF + *Azospirillum* sp.+ Phosphorus S. Bcacteria + Vermi-compost @ 2 t ha^{-1}	36.15	6.90	10.85
T_6	100% RDF + 2 spray of vermi-wash @ 50 lit ha^{-1} at 45 and 75 DAS	26.63	5.11	6.89
T_7	50 % RDF + 2 spray of vermi-wash @ 50 lit ha^{-1} at 45 and 75 DAS	22.60	4.19	5.41
T_8	100% RDF + 15 kg of Humic acid ha^{-1}	32.36	5.94	8.52
T_9	50% RDF + 15 kg Humic acid ha^{-1}	28.31	5.47	7.61
T_{10}	50 % RDF + NADEP @ 5 t ha^{-1}+ 15 kg Humic acid ha^{-1}	35.09	6.54	9.55
T_{11}	100% RDF+ NADEP @ 5 t ha^{-1}	39.32	7.41	12.10
T_{12}	50 % RDF + NADEP @ 5 t ha^{-1}	29.69	5.65	7.91
	S.Em. $\pm$	1.12	0.20	0.31
	C.D. (P = 0.05)	3.17	0.56	0.86
	C.V. %	9.69	9.04	9.30

Table 2: Influence of different nutrient practices on NPK uptake of stover (Pooled basis).

Sr. No.	Treatments	N uptake stover (kg ha^{-1})	P uptake stover (kg ha^{-1})	K uptake stover (kg ha^{-1})
T_1	RDF 90:30:00NPK kg/ ha.	17.33	4.24	9.29
T_2	100% RDF + *Azospirillum* sp. + Vermi-compost @ 2 t ha^{-1}	26.42	8.18	14.95
T_3	50% RDF + *Azospirillum* sp. + Vermi-compost @ 2 t ha^{-1}	24.16	7.14	13.16
T_4	100% RDF + *Azospirillum* sp. + Phosphorus S. Bcacteria + Vermi-compost @ 2 t ha^{1}	28.49	9.18	16.10
T_5	50% RDF + *Azospirillum* sp.+ Phosphorus S. Bcacteria + Vermi-compost @ 2 t ha^{-1}	24.69	7.71	13.80
T_6	100% RDF + 2 spray of vermi-wash @ 50 lit ha^{-1} at 45 and 75 DAS	17.63	4.40	9.50
T_7	50 % RDF + 2 spray of vermi-wash @ 50 lit ha^{-1} at 45 and 75 DAS	16.12	3.80	8.51
T_8	100% RDF + 15 kg of Humic acid ha^{-1}	21.11	5.73	11.65
T_9	50% RDF + 15 kg Humic acid ha^{-1}	19.56	4.88	10.68
T_{10}	50 % RDF + NADEP @ 5 t ha^{-1}+ 15 kg Humic acid ha^{-1}	22.86	6.43	12.49
T_{11}	100% RDF+ NADEP @ 5 t ha^{-1}	25.69	6.46	14.50
T_{12}	50 % RDF + NADEP @ 5 t ha^{-1}	20.82	5.39	11.35
	S.Em. $\pm$	0.78	0.25	0.43
	C.D. (P = 0.05)	2.19	0.69	1.21
	C.V. %	9.95	11.31	9.94

B. Effect of treatments on micro-organism status in soil after harvest of fennel

Data given in (Table 3) shows that, different integrated nutrient management treatments significantly influenced the available micro-organism status of soil. The highest available microbial population was observed under treatment, T5 (50% RDF + *Azospirillum* sp. + PSB + Vermi-compost @ 2 t ha^{-1}). This might be because of the increased leaching loss of the already composted vermicompost and inorganic fertilizers. The increased population of soil micro flora and fauna and the consequential increased availability of nutrients to plant increasing productivity of fennel were due to the integrated application of various sources of nutrients (organic and inorganic) along with application of bio-fertilizers (Bahadur *et al*., 2012; Shirin *et al*., 2021).

Table 3: Influence of different nutrient practices on microbial population status after harvesting of fennel.

Sr. No.	Treatments	Microbial population (X 10^5cfu/g soil)
T_1	RDF 90:30:00 NPK kg/ ha	6
T_2	100% RDF + *Azospirillum* sp. + Vermi-compost @ 2 t ha^{-1}	440
T_3	50% RDF + *Azospirillum* sp. + Vermi-compost @ 2 t ha^{-1}	6837
T_4	100% RDF + *Azospirillum* sp. + Phosphorus S. Bcacteria + Vermi-compost @ 2 t ha^{1}	750
T_5	50% RDF + *Azospirillum* sp.+ Phosphorus S. Bcacteria + Vermi-compost @ 2 t ha^{-1}	7362
T_6	100% RDF + 2 spray of vermi-wash @ 50 lit ha^{-1} at 45 and 75 DAS	6
T_7	50 % RDF + 2 spray of vermi-wash @ 50 lit ha^{-1} at 45 and 75 DAS	8
T_8	100% RDF + 15 kg of Humic acid ha^{-1}	5
T_9	50% RDF + 15 kg Humic acid ha^{-1}	6
T_{10}	50 % RDF+ NADEP @ 5 t ha^{-1} + 15 kg Humic acid ha^{-1}	59
T_{11}	100% RDF+ NADEP @ 5 t ha^{-1}	86
T_{12}	50 % RDF + NADEP @ 5 t ha^{-1}	267
	S.Em.+	149
	C.D. (P=0.05)	500
	C.V. %	4.81

CONCLUSION

Significantly higher nitrogen, phosphorus and potassium uptake of seed and stover was observed with the application of T4 (100% RDF + *Azospirillum* sp. + PSB + Vermi-compost @ 2 t ha^{-1}) which was found at par with the treatment T2 (100 % RDF + *Azospirillum* sp. + Vermi-compost @ 2 t ha^{-1}) over rest of the treatments. It shows that the combination of inorganic fertilizers, biofertilizer and vermicompost treatment gives highest nutrient uptake by seed and stover. The available micro-organism status after harvest of fennel was increased by different nutrient management practices. The highest available microbial population was observed under treatment T5 (50% RDF + *Azospirillum* sp. + PSB + Vermi-compost @ 2 t ha^{-1}).

Conflict of Interest. None

REFERENCES

Aslam, M. S., Xue, P. H., Bashir, S., Alfakhri, Y., Nurunnabi, M., & Nguyen, V. C. (2021). Assessment of rice and wheat production efficiency based on data envelopment analysis. *Environmental Science and Pollution Research*, *28*(29): 38522-38534.

Bahadur, L., Tiwari, D. D., Mishra, J., & Gupta, B. R. (2012). Effect of integrated nutrient management on yield, microbial population and changes in soil properties under rice-wheat cropping system in sodic soil. *J. Indian Soc. Soil Sci.*, *60*(4): 326-329.

Bhunia, S. R., Chauhan, R. P. S., & Yadav, B. S. (2005). Effect of nitrogen and irrigation on water use, moisture-extraction pattern, nutrient uptake and yield of fennel (*Foeniculum vulgare*). *Indian J. Agron.*, *50*(1): 73-76.

Birthal, P. S., Hazrana, J., Negi, D. S., & Pandey, G. (2021). Benefits of irrigation against heat stress in agriculture: Evidence from wheat crop in India. *Agricultural Water Management*, *255*, 106950.

Chandra, M. S., Naresh, R. K., Kumar, R., Yadav, S., Harish, J., Rajput, P., & Pathak, S. O. (2021). Water-scarcity footprints and water productivities indicate unsustainable rice-wheat production of sub-tropical eco-systems: A review, *10*(3): 323-334.

Chaudhary, A., Chhokar, R. S., Dhanda, S., Kaushik, P., Kaur, S., Poonia, T. M., & Punia, S. S. (2021). Herbicide Resistance to Metsulfuron-Methyl in *Rumex dentatus* L. in North-West India and its Management Perspectives for Sustainable Wheat Production. *Sustainability*, *13*(12): 6947.

Desai, S. S, Chaudhary, Patel, R.S., & Joshi, J. R. (2020). Effect of integrated nutrient management on growth, yield and economics of cumin (*Cuminum cyminum* L.). *Int. J. Current Microbiology App Sci.*, *9*(11): 3712-3719.

Devi, M., Kumar, J., Malik, D. P., & Mishra, P. (2021). Forecasting of wheat production in Haryana using hybrid time series model. *Journal of Agriculture and Food Research*, 100175.

Dhawan, G., Dheri, G. S., & Gill, A. A. S. (2021). Nitrogen budgeting of rice-wheat cropping system under long-term nutrient management in an Inceptisol of north India. *European Journal of Agronomy*, *130*: 126376.

Jackson, M. L. (1973). Soil chemical analysis. Prentice hall of India Pvt. Ltd., New Delhi, India. pp. 10-114.

Kantwa, C. R., Vyas, K. G., Patel, S. A., & Patel, B. J. (2021). Residual Effect of Wheat Varieties and Integrated Nutrient Management on Productivity and Profitability of Green Gram under North Gujarat Agro-climatic Condition. *Legume Research-An International Journal*, *1*, 8.

Kashyap, D., & Agarwal, T. (2021). Carbon footprint and water footprint of rice and wheat production in Punjab, India. *Agricultural Systems*, *186*, 102959.

Kashyap, D., & Agarwal, T. (2021). Temporal trends of climatic variables and water footprint of rice and wheat production in Punjab, India from 1986 to 2017. *Journal of Water and Climate Change*, *12*(4): 1203-1219.

Kuriachen, P., Devi, A., Sam, A. S., Kumar, S., Kumari, J., Suresh, A., & Jha, G. K. (2021). Wheat Yield Responses to Rising Temperature: Insights from North Indian Plains of India.

Madhukar, A., Dashora, K., & Kumar, V. (2021). Investigating historical climatic impacts on wheat yield in India using a statistical modeling approach. *Modeling Earth Systems and Environment*, *7*(2): 1019-1027.

Malik, A., & Dwivedi, N. (2021). An analytic study of Indian agriculture Crop with reference to wheat. *International Journal of Modern Agriculture*, *10*(2): 2164-2172.

Mevada, K. D., Gamar, P., Ombase, K. C., Bhadane, R. S., & Patel, P. D. (2017). Influence of Integrated Nutrient Management on Yield, Quality and Nutrient Status of Drilled rabi fennel (*Foeniculum vulgare* Mill.). *J. Pure Appl. Microbiol., 11*(3):1559-1565.

Olsen, S. R., Cole, C. W., Watanabe. F. S., & Dean, L.A. (1954). Estimation of available phosphorus in soil by extraction with $NaHCO_3$. Circular 939, United States Department of Agriculture Washington DC, USA.

Panse, V. G., & Sukhatme, P. V. (1954). *Statistical Methods for Agricultural Workers.* ICAR, New Delhi. pp. 359.

Patel, S. G., Amin, A. V., Patel, S. P. Agalodiya & Patel, S. M. (2013 a,b). Effect of different sources of organic manures and without bio fertilizers in cumin (*Cuminum cyminum* L.) *Int. J. Seed Spices, 3*(2).

SBI (2011). Statistics: Production of Major Spices. Spices Board of India, Ministry of Commerce and Industry, Government of India, New Delhi (*http://www.indianspices.com*).

Selim, M. M. (2020). Introduction to the integrated nutrient management strategies and their contribution to yield and soil properties. *International Journal of Agronomy*.

Sheoran, P., Basak, N., Kumar, A., Yadav, R. K., Singh, R., Sharma, R., & Sharma, P. C. (2021). Ameliorants and salt tolerant varieties improve rice-wheat production in soils undergoing sodification with alkali water irrigation in Indo–Gangetic Plains of India. *Agricultural Water Management*, *243*, 106492.

Sheoran, P., Kumar, A., Sharma, R., Prajapat, K., Kumar, A., Barman, A., & Sharma, P. C. (2021). Quantitative Dissection of Salt Tolerance for Sustainable Wheat Production in Sodic Agro-Ecosystems through Farmers' Participatory Approach: An Indian Experience. *Sustainability*, *13*(6): 3378.

Shirin, A., Hossain, M. D., Rashid, M. A., & Meah, M. B. (2021). Assessment of postharvest soil fungal population with special reference to Trichoderma in eggplants. *Progressive Agriculture*, *32*(1), 31-42.

Shivanna, M.B., Ramesh, G., & Santa Ram, A. (2009 a,b). Influence of organics and biofertilizers on the growth and yield of kalmegh (*Andrographis paniculata*).*J. Medicinal Aromat. Plants, 32*(3): 251-256.

Shivran, A. C., & Jat, N. L. (2015). Integrated nutrient management influenced growth, yield and economics of fennel (*Foeniculum vulgare*) under semi arid conditions. *Indian J. Agron., 60*(2): 318-323.

Singh, G., Singh, P., Sodhi, G. P. S., & Tiwari, D. (2021). Energy auditing and data envelopment analysis (DEA) based optimization for increased energy use efficiency in wheat cultivation (*Triticum aestium* L.) in north-western India. *Sustainable Energy Technologies and Assessments*, *47*, 101453.

Srujan, C. S., Patel, H. H., Lokesh, R., Madagoudra, Y. B., & Terin, P. (2021). The effect of irrigation and nitrogen levels on nutrient content and uptake in grain amaranth (*Amaranthus hypochondriacus* L.) and soil Nutrient status after harvest.

Uttam Vasoya J. (2013). Effect of Organic manure and Bio-fertilizer on growth and yield of Direct Seeded *Rabi* Fennel (*Foeniculum vulgare* Mill.). M.Sc., Thesis submitted to Junagadh Agricultural University, Gujarat.

How to cite this article: Kalasare, R.S., Gaikwad, D.J., Gaikwad, P.P., Maitra, S., Mahapatra, A. and Yadav, M.K. (2021). Studies on Interspersed Nutrient Management on Uptake of Nutrients Seeds, Stover and Soil Biota Status of Fennel. *Biological Forum – An International Journal*, *13*(3a): 760-764.