PLANT SCIENCE TODAY
ISSN 2348-1900 (online)
Vol x(x): xx–xx
https://doi.org/10.14719/pst.2124

HORIZON
e-Publishing Group
HePG

RESEARCH ARTICLE

Influence of integrated nutrient management on physiological parameters of lentil (*Lens culinaris* Medik.)

Alluri Vinay Chowdary, Neha Saini*, Atin Kumar, Sandeep Kumar, Jayanti Ballabh, Siddharth Shankar Bhatt, Amit Bhatt, Sunil Prakash & Aditya Patel

School of Agriculture, Uttaranchal University, Dehradun, 248007, India

*Email: neha.saini783@gmail.com

OPEN ACCESS

ARTICLE HISTORY

Received: 20 October 2022
Accepted: 15 February 2023
Available online
Version 1.0 : 24 June 2023

Check for updates

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc
See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

CITE THIS ARTICLE

Chowdary A V, Saini N, Kumar A, Kumar S, Ballabh J, Bhatt S S, Bhatt A, Prakash S, Patel A. Influence of integrated nutrient management on physiological parameters of lentil (*Lens culinaris* Medik.). Plant Science Today (Early Access). https://doi.org/10.14719/pst.2124

Abstract

During the rabi season of 2021, a field experiment was conducted in the North Western plains of Uttarakhand at Crop Research Centre, School of Agriculture, Uttaranchal University, Dehradun to examine the impact of integrated nutrient management (INM) on lentil growth, yield, and economics (*Lens culinaris* Medik.). The experiment was laid in Randomized Block Design with seven treatments i.e. T_1 (Control, 100% RDF (Recommended Dose of Fertilizers), T_2 (75 % NPK (Nitrogen, Phosphorus, Potassium) + 25 % FYM (Farm Yard Manure), T_3 (50 % NPK + 50 % FYM), T_4 (75 % NPK + 25 % *Azotobacter*), T_5 (50 % NPK + 50 % *Azotobacter*), T_6 (75 % NPK + 25 % (Vermicompost + *Azotobacter*)) & T_7 (50 % NPK+ 50 % (Vermicompost + *Azotobacter*)). The treatments T_7 with the combination of 50 per cent NPK and 50 per cent vermicompost plus *Azotobacter* showed maximum LAI (Leaf Area Index) (0.25), NAR (Net Assimilation Rate) (0.0020), chlorophyll content (3.05), dry matter (4.44 g), and protein content (26.99 %) in contrast to other six treatments.

Keywords

Azotobacter, Growth, INM, Vermicompost, Yield.

Introduction

India is the world's largest producer of pulses, accounting for one-fourth of global production and close to one-third of the world's total land planted with them. Despite being the world's greatest producer, India must import roughly 25 million tones of pulses annually to suit its domestic needs. This is partly because pulses are essential components and one of the most accessible and affordable sources of nutritional protein in the nation's vegetarian diet. This, together with a growing focus on environmental sustainability, economic consideration, and soil health, has sparked a paradigm shift in cropping systems that has led to the expansion of pulse in non-traditional regions (1).

Lentils are a significant component of impoverished nations' diets. Lentils have almost double protein content of cereal. It also has lysine, an amino acid that lacks in cereals. Lentils have the highest protein-to-calorie ratio of any legume, second only to soybeans. Due to significant levels of protein (20-30%), minerals (2-5%), and vitamin B_9, lentils give a range of necessary ingredients to a person's diet. Lentil is frequently high in micronutrients, notably iron (Fe), zinc (Zn), and selenium (Se), and can help meet dietary requirements (Se) (2).

Fertilizer management contributes maximum (27%) to main production component to enhance lentil output. Significant amounts of nitrogen, phosphate, and potassium are needed to boost crop output. One of the most important and expensive of these elements is nitrogen. Its impact on plant growth is strongest and fastest. Inadequate nitrogen can significantly lower productivity and degrade the quality of produce. Depending on the species or type, healthy plants might contain anywhere from 1 to 5 per cent nitrogen. It plays a significant structural role in cells and even the cell wall (5 % nitrogen). As a result, it boosts the protein content of dietary grains and promotes growth and development of all living tissues (3).

Phosphorus, an important macronutrient, is among the most needed elements for crop production in most tropical soils, which tend to be deficient in phosphorus availability. Legume crops are phosphorus loving, as they require higher amount of phosphorus to develop their root system, plant growth, pods and seed since low phosphorus availability limits the root nodulation, nitrogen fixation, potassium uptake, plant growth, flowering, pod development and grain yield. Under adequate phosphorus availability, nodulation increases because of properly developed root system.

Potassium is one of the luxury consumed element essentially required for growth and development of crop. Its deficiency may lead to different physiological disorder and unavailability of other essential elements. It also take part in ascent of sap and mobility of different chemical compounds.

Integrated nutrient management (INM) is a technique for increasing nutrient availability and maintaining high yields without exposing soil native nutrients or polluting the environment. It involves using the minimum effective dose of sufficient and balanced amounts of organic and inorganic fertilizers in combination with specific microorganisms. Moreover, utilizing integrated nutrient management can also result in a number of advantages. (4).

Because maintaining soil organic matter in tropical nations like India is challenging, employing organic wastes is crucial for maintaining fertility levels. Soil organic matter, according to Loveland and Webb (5), has a significant influence on both agronomic yields and ecological services (6). Despite the fact that the world is facing the challenge of climate change as a result of rapidly rising CO_2 levels in the atmosphere, soil organic matter accumulation and, as a result, carbon sequestration have garnered attention since the 1990s as a climate change mitigation option at both the global and regional levels (7).

Materials and Methods

A field experiment was conducted during the rabi season of 2021, at the Crop Research Centre, School of Agriculture, Uttaranchal University, Dehradun on the North Western Plains of Uttarakhand, for efficacy of integrated nutrient management on growth and yield in lentil (*Lens culinaris* Medik.). The experiment was designed with a random block design and seven treatments that were replicated three times. Each plot net area was 3m x 3m in size. In the therapy, the specified dosages of phosphorus via DAP (Di-ammonium Phosphate), potassium by muriate of potash and nitrogen via urea were employed when applied in combinations as follows, (T_1) Control RDF, (T_2) 75% NPK + 25 % FYM, (T_3) 50 % NPK + 50 % FYM, (T_4) 75 % NPK + 25 % *Azotobacter*, (T_5) 50 % NPK + 50 % *Azotobacter*, (T_6) 75 % NPK + 25 % (Vermicompost + *Azotobacter)*, (T_7) 50% NPK + 50% (Vermicompost + *Azotobacter)*. After harvesting, seeds were separated from each net plot and sun-dried for three days. Dry matter accumulation (g/plant) and other growth variables were manually recorded on five sample plants chosen at random from each plot of each replication. Following that, the seed yield per hectare was computed, cleaned, and represented in tones per hectare. After thorough drying in the sun for 10 days, the yield from each net plot was reported and represented in tones per hectare. The data was calculated and analyzed using the Gomez & Gomez statistical technique (8). After evaluating the price value of seed with Stover the benefit-to-cost ratio was computed.

Growth parameters

Leaf Area Index (LAI)

To fill in any gaps caused by seedling moratality, replanting was carried out five days after the first transplant. This was done to maintain a typical plant population and hill-to -hill distance.

$$LAI = \text{Leaf Area}/\text{Ground Area}$$

Net Assimilation Rate (NAR)

Net Assimilation Rate was calculated using the following formula: NAR = $(W2-W1)/(T_2-T_1)$ (L_2-L_1), Where L_1 and W_1 are the leaf area and dry weight respectively of the plant at time T_1, and L_2 and W_2 are the leaf area and dry weight respectively of the plant at time T_2.

Chlorophyll Content

250 mg of leaf samples from distinct plant species were extensively macerated in a pestle and mortar with some sand and 80% acetone. The macerated material was suspended in acetone and centrifuged for two minutes at 3000 rpm. The supernatant solution was poured into a volumetric flask and diluted with acetone to a volume of 25 ml. using a spectrophotometer the amount of total chlorophyll and chlorophyll A and B were measured, along with the colour intensity of the green pigment, at 645 nm and 652 nm, respectively.

$$\text{Chl-a mg/gm} = 12.7\ (A_{663})-2.69\ (A_{645}) \times V/1000 \times W$$

$$\text{Chl-b mg/gm} = 22.9\ (A_{645})-4.69\ (A_{663}) \times V/1000 \times W$$

$$\text{Chl-(a+b) mg/gm} = A_{652}/34.5 \times 1000\ V/1000\ W$$

Where,

A = Absorbance at specific wavelengths

V = Final volume of chlorophyll extract in 80% acetone

W = Weight of the fresh tissues extracted

Dry Matter

At 30 days interval, the dry matter accumulation was measured three times during crop growth. The plants that were chosen at random were removed from each plot. The weight of the above plant samples were recorded after they were dried in an oven at 60°C for 72 hours.

Quality Attributes

Protein content

Protein content in seed was calculated by the multiplying nitrogen content in seed with a factor 6.25 (9).

Results and discussion

Effect on growth parameters

Leaf Area Index

Integrated nutrient management raised the leaf area index at the later phases of plant growth, despite the fact that the study of the leaf area index was statistically significant in all growth intervals. At 60 DAS (Days after Showing), a maximum leaf area index of 0.25 m^2 was recorded with the treatment 50% NPK + 50% Vermicompost + *Azotobacter*, whereas treatments 50% NPK + 50% *Azotobacter*, 50% NPK + 50% FYM, and 75% NPK + 25% Vermicompost + *Azotobacter* were statistically equivalent to 50% NPK + 50% (Vermicompost + *Azotobacter*). Different fertility treatments applied to the crop at different growth stages had a substantial impact on the leaf area index (LAI). Regarding LAI, all integrated nutrient management therapies were found to be noticeably better than RDF treatments. (10-11) both observed similar findings in which they found highest leaf area index when treated with vermicompost and *Azotobacter*. (Fig.1)

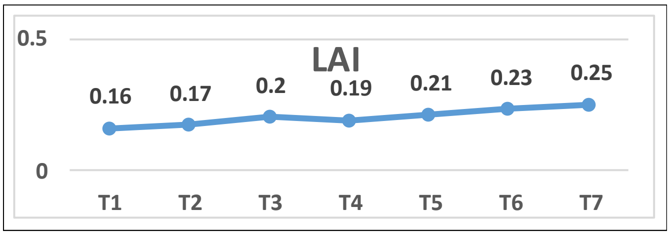

Fig. 1. Graphical representation of 60 DAS Leaf area index

Net Assimilation Rate

The treatment with the highest net assimilation rate (0.0020) between 45 and 60 DAS was 50% NPK + 50% Vermicompost + *Azotobacter*, but therapy with 25% NPK + 25% Vermicompost + *Azotobacter* is statistically equivalent to treatment with 50% NPK + 50% Vermicompost + *Azotobacter*. Different interventions at both stages of observations had a considerable impact on the net assimilation rate. In comparison to the control treatment at both stages, each integrated nutrient management treatment had a considerable impact on the net absorption rate (10-12) all reported results that were comparable (Fig.2).

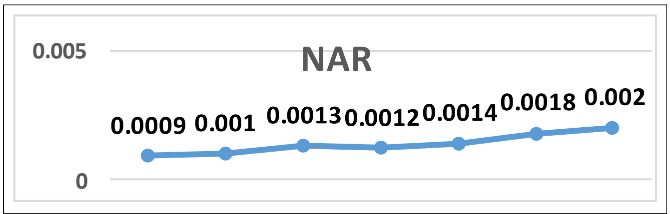

Fig. 2: Graphical representation of 60 DAS Net assimilation rate

Chlorophyll content

The data showed that chlorophyll content of plant was found to be significant at 45 DAS. At 45 DAS highest chlorophyll content was recorded with treatment 50 % NPK+ 50 % Vermicompost + *Azotobacter*. However, 75 % NPK + 25 % Vermicompost + *Azotobacter*, 50 % NPK + 50 % *Azotobacter* were found to be statistically at par with 50 % NPK+ 50 % Vermicompost + *Azotobacter*. The treatment in combination with application of NPK along with Vermicompost and *Azotobacter* increase the photosynthesis process which resulted the improvement of lentil growth performance. Similar results were also reported (10-12) (Fig.3).

Dry Matter

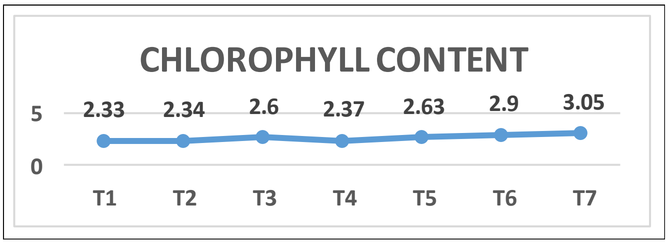

Fig. 3. Graphical representation of 45 DAS Chlorophyll

At flowering stage highest dry matter 4.44 was recorded with the treatment 50 % NPK+ 50 % Vermicompost + *Azotobacter*, whereas treatment 75 % NPK + 25 % Vermicompost + *Azotobacter*, 50 % NPK + 50 % *Azotobacter* are found to be statistically at par with the treatment 50 % NPK+ 50 % Vermicompost + *Azotobacter*. The dry matter partitioning of lentil increased significantly with integrated nutrient management along with vermicompost and *Azotobacter*. RDF was significantly outscored by every therapy. However, with the application of 50% NPK+ 50% Vermicompost + *Azotobacter*, dry matter accumulations in all plants were much greater. (10-12) all found similar findings (Fig.4).

Quality Attributes

Protein content

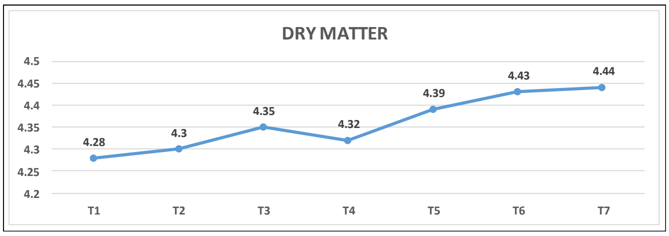

Fig. 4. Graphical representation of 60 DAS Dry matter

Significant and highest protein content (26.99%) was recorded in treatment 50 % NPK+ 50 % Vermicompost + *Azotobacter*. However, treatments Control + RDF (24.42%) recorded lowest protein content (Fig.5).

Conclusion

The treatment T_7 (50% NPK + 50 % Vermicompost + 50 %

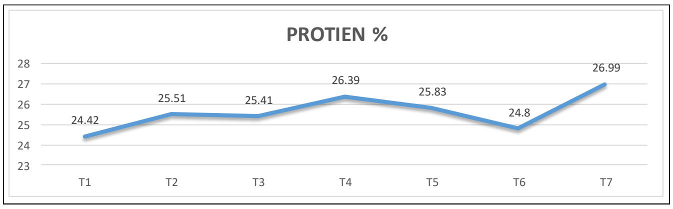

Fig. 5. Graphical representation of Protein percentage.

Azotobacter) was observed as significant in all growth and quality parameters. Treatment recorded LAI (0.25 m^2), NAR (0.0020), chlorophyll content (3.05 mg/100 g), dry matter (4.44 g), and protein content (26.99 %), which may be more preferable for farmers since it is economically more profitable and also achieved statistical parity with control RDF and can therefore be recommended to the farmers.

Acknowledgements

The authors are indebted to Uttaranchal University for providing research facilities for conductance of this experiment.

Authors contributions

NS & AV carried out the research work and data collection. SK, JB, SP and AK participated in writing and arrangement of the manuscript. SSB and AB performed the statistical analysis. AP has collected the references. All authors approved the final manuscript.

Compliance with ethical standards

Conflict of interest: There is no conflict of interest among authors in relation to conductance and writing of this manuscript.

Ethical issues: None.

References

1. Maheshwari A, Sharma M, Sharma D. Hydro Chemical Analysis of Surface and Ground Water Quality of Yamuna River at Agra, India. J. Mater. Environ. Sci. 2011;2(4):373-78.
2. Megan Migliozzi, Dil Thavarajah, Pushparajah Thavarajah, Powell Smith. Lentil and Kale: Complementary Nutrient-Rich Whole Food Sources to Combat Micronutrient and Calorie Malnutrition. Nutrients. 2015;7(11):9285–98. https://doi.org/10.3390/nu7115471
3. Hafez M, Elbarbary T A, Ibrahim I, Abdel-Fatah Y. *Azotobacter vinelandii* evaluation and optimization of Abu Tartur Egyptian phosphate ore dissolution. Saudi J Pathol Microbiol. 2016;1:80–93. https://doi.org/10.21276/sjpm.2016.1.3.2
4. Selim MM. Introduction to the Integrated Nutrient Management Strategies and Their Contribution to Yield and Soil Properties. International Journal of Agronomy. 2020;14. https://doi.org/10.1155/2020/2821678
5. Loveland P, Webb J. Is There Critical Level of Organic Matter in the Agricultural Soils of Temperate Regions: Review. Soil Tillage Research. 2003;70:1-18. http://dx.doi.org/10.1016/S0167-1987(02)00139-3
6. Tiessen H, Cuevas E, Chacon P. The role of soil organic matter in sustaining soil fertility. Nature . 1994;371:783–85.
7. Hitz S, Smith JB. Estimating Global Impacts from Climate Change. Global Environment Change. 2004;14(3):201-18. https://doi.org/10.1016/j.gloenvcha.2004.04.010
8. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research (2 ed.). John wiley and sons, New York. 1984. 680p.
9. AOAC (Association of Official Analytical Chemists). Official Methods of Analysis (14th ed). VA, USA: Arlington. 1984.
10. Singh SB, Singh ON, Singh SK, Yadav SS, Rajput PK. Effect of fertility levels, PSB and Vermi-compost on growth, yield and quality of large seeded lentil. J. Food Legumes. 2007;20(1):52-54.
11. Hossain MM, Suman M. Effect of biofertilizer and nitrogenous fertilizer on growth, yield and N-uptake of lentil (*Lens culinaris* Medik.). International J.Sust. Agril. Tech. 2005;1(6): 76-81.
12. Kumar RP, Singh ON, Singh Y, Sachchidanand D, Singh JP. Effect of integrated nutrient management on growth, yield, nutrient uptake and economics of French bean (*Phaseolus vulgaris*). Indian J Agril Sci. 2009;79(2): 122-28.