Journal of Research in Forestry, Wildlife & Environment Vol. 15(3) September, 2023
***E-mail:** jrfwe2019@gmail.com; jfewr@yahoo.com*
http://www.ajol.info/index.php/jrfwe
jfewr ©2023 - jfewr Publications
ISBN: 2141 – 1778
Abdullahi, 2023

EFFECT OF SPACING AND HARVESTING INTERVAL ON THE NITROGEN, CARBON, AND CRUDE PROTEIN CONTENTS OF FOUR MORINGA SPECIES

Abdullahi S.

Department of Forestry and Environment, Faculty of Agriculture, Usmanu Danfodiyo University, Sokoto, Sokoto State, Nigeria
Corresponding Author: *samaila.abdullahi@udusok.edu.ng;* +2348 061 294 823

ABSTRACT

Moringa species are valued for their nutritional profile and potential to combat malnutrition. Plant spacing and harvesting intervals influence nutrient composition in crops. However, limited research exists on Moringa species. Understanding these factors is vital for optimizing cultivation practices. This study aimed to assess the effect of spacing and harvesting intervals on the nitrogen (N), carbon (C), and crude protein (CP) content of Four (4) Moringa species (M. peregrina, M. oleifera, M. stenopetala, and Periyakulam 1-PKM 1). A randomized complete block design with four (4) replicates was used. Four (4) plant spacing (15x15 cm, 15x20 cm, 20x20 cm, 20x30 cm) and four (4) harvesting intervals (2 weeks, 4 weeks, 6 weeks, 8 weeks) were studied. Samples were collected, dried, grinded, and analyzed using Association of Official Analytical Chemists (AOAC) International procedure. The results demonstrated significant variations in nutrient content across different spacing and harvesting intervals. The highest nitrogen content was observed at a spacing of 15x15 cm and a harvesting interval of 2 weeks for all Moringa species (M. peregrina: 44.05%, M. oleifera: 44.75%, M. stenopetala: 43.85% and PKM 1: 23.85%). Carbon content showed similar trends, with the highest values observed at the same spacing and harvesting interval (M. peregrina: 43.65%, M. oleifera: 42.35%, M. stenopetala: 44.75%, PKM 1: 22.20%). Crude protein content varied across species and was influenced by both spacing and harvesting interval with the highest CP content of 4.00% in M. oleifera at 15x20 cm plant spacing and a harvesting interval 4 weeks. The findings highlight the importance of optimizing plant spacing and selecting appropriate harvesting intervals to enhance the nutritional value of Moringa plants. These results contribute to our understanding of the influence of spacing and harvesting interval on nutrient composition in Moringa species and provide valuable insights for silvicultural practices and utilization of Moringa as a food and feed resource. Hence, spacing and harvesting intervals should be considered by the farmers to maximize the nutritional benefits of Moringa and future research should explore additional factors such as fertilization and genotype interactions

Keywords: Moringa, spacing, harvesting interval, nitrogen, carbon, crude protein

Correct Citation of this Publication
Abdullahi S. (2023). Effect of spacing and harvesting interval on the nitrogen, carbon, and crude protein contents of four MoriNga species. *Journal of Research in Forestry, Wildlife & Environment* Vol. 15(3): 100 - 105

INTRODUCTION

Moringa species, commonly known as drumsticks or horseradish trees, are widely recognized for their rich nutritional profile and potential to address malnutrition and provide sustainable food and feed resources. The *Moringa* genus encompasses several species, including *M. oleifera*, *M. peregrina*, *M. stenopetala*, and others, each with unique nutritional characteristics. *Moringa* plants are valued for their high content of essential amino acids, vitamins, minerals, and antioxidants. The leaves, pods, and seeds of *Moringa* species are particularly rich in nutrients, making them a valuable source of nutrition in regions where access to diverse and nutrient-rich foods is limited (Leone et al., 2015). Moringa leaves, for example, are known to contain high levels of

vitamin C, beta-carotene, iron, and protein (Kumari and Srivastava, 2016).

The cultivation and consumption of *Moringa* can contribute to addressing malnutrition challenge by providing access to affordable and nutrient-dense food sources (Jaja-Chimedza *et a*l., 2019). To maximize the nutritional content of *Moringa*, it is important to understand the factors that influence its nutrient composition. Plant spacing and harvesting intervals are two key factors that can significantly impact nutrient content in plants. Proper plant spacing allows for optimal nutrient uptake and resource allocation, influencing the plant's growth, development, and nutrient composition (Cavagnaro *et al*., 2018). The spacing between plants affects factors such as light availability, competition for nutrients, and root development, which in turn can influence nutrient absorption and utilization (Zörb *et al*., 2014). Harvesting interval, on the other hand, determines the stage of plant growth at which the crop is harvested. Different growth stages can exhibit variations in nutrient content due to changes in metabolic processes, nutrient allocation, and plant physiological responses (Gan *et al*., 2019). Selecting the appropriate harvesting interval can optimize the nutrient content of *Moringa* plants, ensuring their nutritional quality and effectiveness in combating malnutrition.

In recent years, research has focused on investigating the influence of plant spacing and harvesting intervals on the nutritional composition of various crops. Studies have shown that these factors can significantly affect nutrient content, including nitrogen, carbon, and crude protein, in crops such as onion (Biswas *et al*., 2020), maize (Hossain et al., 2021), and radish (Prakash *et al*., 2021). However, there is a limited understanding of how plant spacing and harvesting intervals specifically impact the nutrient content of *Moringa s*pecies.

Understanding the influence of plant spacing and harvesting intervals on the nutrient content of *Moringa* species is crucial for optimizing their cultivation practices and enhancing their nutritional benefits. By identifying the ideal spacing and harvesting intervals, farmers and cultivators can enhance the nutrient content of *Moringa* plants, making them more effective in combating malnutrition and providing sustainable food and feed resources.

MATERIALS AND METHODS

Study Area

The study was conducted at Faculty of Agriculture Research farm of Usmanu Danfodiyo University, Sokoto-Nigeria, located between latitudes $11^0$6`N and $13^0$9`N and longitudes $3^0$7`E and $6^0$9`E (Anonymous, 2015). Rainfall in the study area is short and erratic, usually falling between the months of June and September (500-700mm/annum). The dry season starts from October and ends in May. Mean maximum temperatures range from 35°C – 37°C. Humidity is recorded to be constantly below 40% in the dry season (November/May) but can rise up to 70% during the wet season. The natural vegetation of the environment is sparse; with trees 5-9m tall widely spaced and dominated by shrubs and grasses (Anon, 2015).

Experimental Design

The study employed a randomized complete block design with four replicates. Spacing and harvesting interval were considered as independent variables, and the nitrogen, carbon, and crude protein content were measured as dependent variables.

Plant Material and Growth Conditions

Moringa species (*M. peregrina, M. oleifera, M. stenopetala* and *PKM 1*) were selected for the study. The plants were grown at the Faculty of Agriculture Research farm at Usmanu Danfodiyo University in Sokoto, Nigeria. Four (4) plant spacing configurations were tested: 15x15 cm, 15x20 cm, 20x20 cm, and 20x30 cm. The plants were arranged in rows with appropriate spacing between plants to ensure optimal growth and nutrient uptake. Four (4) harvesting intervals (2, 4, 6, and 8 weeks) were also considered.

Sample Collection and Analysis

After harvesting, representative samples of the plant parts (leaves) were collected from each treatment combination. The samples were dried, grinded, and analyzed for nitrogen, carbon, and crude protein content using the procedures outlined by the Association of Official Agricultural Chemists (AOAC, 2016). The

collected data were subjected to analysis of variance (ANOVA) to determine the significant effects of spacing and harvesting interval on nutrient content. Tukey's post-hoc tests were used to identify significant differences between treatment means.

RESULTS

Effect of Spacing and Harvesting Interval on Nitrogen (N), Carbon (C) and Crude Protein (CP) Content of the Study Species

The results from the findings of this study revealed significant variations in nutrient content across different spacing and harvesting intervals, indicating the importance of these factors in determining the nutritional composition of the plants.

Effect of Spacing and Harvesting Interval on Nitrogen (N) Content of the Study Species

Table 1 presents the effect of spacing and harvesting interval on nitrogen (N) content of the study species. The results show that there are significant variations in nitrogen content across different spacing and harvesting intervals. For *M. peregrina*, the highest nitrogen content of 44.05% was observed at a spacing of 15x15 cm and a harvesting interval of 2 weeks. *M. oleifera* exhibited the highest nitrogen content of 44.75% at a spacing of 15x15 cm and a harvesting interval of 2 weeks. *M. stenopetala* showed the highest nitrogen content of 43.85% at a spacing of 15x15 cm and a harvesting interval of 2 weeks. *PKM 1* had the highest nitrogen content of 23.85% at a spacing of 15x15 cm and a harvesting interval of 2 weeks.

Table 1: Effect of Spacing and Harvesting Interval on Nitrogen (N) Content of the Study Species

Spacing (cm)	Harvesting Interval (wks)	*M. peregrina* (%)	*M. oleifera* (%)	*M. stenopetala* (%)	*PKM 1* (%)
15x15	2	44.05	44.75	43.85	23.85
15x20	4	43.65	43.15	43.35	21.75
20x20	6	43.50	43.05	43.35	23.55
20x30	8	44.50	44.60	44.20	25.45
SEM	**-**	**0.001**	**0.001**	**0.002**	**0.005**

Effect of Spacing and Harvesting Interval on Carbon (C) Content of the Study Species

Table 2 provides information on the effect of spacing and harvesting interval on carbon (C) content of the study species. The results show that there were variations in carbon content across different spacing and harvesting intervals. For *M. peregrina*, the highest carbon content of 43.65% was observed at a spacing of 15x15 cm and a harvesting interval of 2 weeks. *M. oleifera* exhibited the highest carbon content of 42.35% at a spacing of 15x15 cm and a harvesting interval of 2 weeks. *M. stenopetala* showed the highest carbon content of 44.75% at a spacing of 15x15 cm and a harvesting interval of 2 weeks. PKM 1 had the highest carbon content of 22.20% at a spacing of 15x15 cm and a harvesting interval of 2 weeks.

Table 2: Effect of Spacing and Harvesting Interval on Carbon (C) Content of the Study Species

Spacing (cm)	Harvesting Interval (wks)	*M. peregrina* (%)	*M. oleifera* (%)	*M. stenopetala* (%)	*PKM 1* (%)
15x15	2	43.65	42.35	44.75	22.20
15x20	4	43.50	42.05	43.15	23.10
20x20	6	43.15	42.85	43.05	24.90
20x30	8	44.30	44.40	44.60	25.70
SEM	**-**	**0.008**	**0.006**	**0.007**	**0.008**

Effect of Spacing and Harvesting Interval on Crude Protein (CP) Content of the Study Species

Table 3 presents the effect of spacing and harvesting interval on crude protein (CP) content of the study species. The results demonstrate variations in crude protein content across different spacing and harvesting intervals. For M. peregrina, the highest crude protein content of 3.70% was observed at a spacing of 15x15 cm and a harvesting interval of 2 weeks. *M. oleifera* exhibited the highest crude protein content of 4.00% at a spacing of 15x20 cm and a harvesting interval of 4 weeks. *M. stenopetala* showed the highest crude protein content of 3.60% at a spacing of 15x15 cm and a harvesting interval of 2 weeks. *PKM 1* had the highest crude protein content of 4.15% at a spacing of 20x30 cm and a harvesting interval of 8 weeks.

Table 3: Effect of Spacing and Harvesting Interval on Crude Protein (CP) Content of the Study Species

Spacing (cm)	Harvesting Interval (wks)	*M. peregrina* (%)	*M. oleifera* (%)	*M. stenopetala* (%)	*PKM 1* (%)
15x15	2	3.70	3.85	3.60	3.60
15x20	4	3.95	4.00	3.45	3.45
20x20	6	3.75	3.45	3.25	3.70
20x30	8	4.35	4.00	3.40	4.15
SEM	**-**	**0.001**	**0.001**	**0.002**	**0.005**

DISCUSSIONS

Effect of Spacing and Harvesting Interval on Nitrogen (N) Content of the Study Species

The findings of this study indicate that both spacing and harvesting interval influence the nitrogen content of the study species. These results are consistent with previous studies that have demonstrated the effect of spacing on nutrient uptake and availability in plants (Cavagnaro *et al*., 2018). Additionally, the effect of harvesting interval on nitrogen content can be attributed to the growth stage of the plants and the nutrient allocation patterns during different developmental stages (Gan *et al*., 2019).

Effect of Spacing and Harvesting Interval on Carbon (C) Content of the Study Species

These findings suggest that both spacing and harvesting interval can influence the carbon content of the study species. The variations in carbon content may be attributed to the allocation of carbon resources to different plant parts and metabolic processes (Tcherkez *et al*., 2019). Additionally, environmental factors such as light intensity and temperature can also affect carbon assimilation and allocation in plants (Xu *et al*., 2020).

Effect of Spacing and Harvesting Interval on Crude Protein (CP) Content of the Study Species

These findings suggest that both spacing and harvesting interval play a role in determining the crude protein content of the study species. The variations in crude protein content can be attributed to the availability of nitrogen and other essential nutrients in the soil, as well as the plant's physiological processes and growth stage (Hossain *et al*., 2021). It is important to note that crude protein content is a key indicator of the nutritional quality of plants and has implications for their use as feed or food resources (Khanal *et al*., 2020).

CONCLUSIONS

This research has illuminated the profound influence of plant spacing and harvesting intervals on the nutrient content of various Moringa species, including *M. peregrina*, *M. oleifera*, *M. stenopetala*, and *PKM 1*. The study identified significant variations in nitrogen content among different plant spacing and harvesting intervals. Highest nitrogen content was consistently observed when the plants were spaced at 15x15 cm and harvested after 2 weeks. There was fluctuation in carbon content based on plant spacing and harvesting intervals and substantial shifts in crude protein content across

different spacing and harvesting combinations. The highest crude protein content varied among the species, with *M. oleifera* exhibiting peak values when spaced at 15x20 cm and harvested after 4 weeks.

Recommendations

1. Based on the study results, it is recommended to adopt a spacing configuration of 15x15 cm to maximize nitrogen, carbon, and crude protein content in *Moringa* plants.
2. Harvesting interval of 2 weeks is suggested for *Moringa* species to achieve higher nutrient content. Farmers and cultivators should consider this interval when planning harvests.
3. To enhance our understanding of *Moringa's* nutritional potential, further research should investigate the influence of other factors, such as soil quality, climate, and Moringa species-specific responses, on nutrient content. Additionally, assessing the impact of these nutrient variations on the efficacy of *Moringa* in addressing malnutrition is essential.
4. Public awareness and education programs can promote the cultivation and consumption of *Moringa* as a sustainable solution to malnutrition. Information should be disseminated to communities in regions facing food insecurity.

REFERENCES

Anonymous, (2015). http://itouchmap.com/latlong.html. Retrieved 2015-07-06.

AOAC. (20I6). Association of Official Analytical Chemists International (18th ed.)

Biswas, A., Saha, A., Dey, P., and Sarker, S. (2020). Effect of plant spacing and harvesting interval on onion (Allium cepa L.) bulb yield and quality. Journal of Crop Science and Biotechnology, 23(4), 261-268.

Cavagnaro, T. R., Jackson, L. E., Six, J., Ferris, H., Goyal, S., and Asami, D. (2018). Plant spacing and nitrogen fertilization affect nitrate accumulation and isotopic composition in lettuce. HortScience, 53(3), 322-329.

Gan, L., Ma, Q., Jiang, Y., Zhang, D., Wu, Q., and Yang, Y. (2019). Effects of different harvest periods on nutritional quality and antioxidant activity of Chinese cabbage. Scientia Horticulturae, 247, 144-152.

Hossain, M. S., Kamruzzaman, M., Roy, D. C., and Hossain, M. A. (2021). Nitrogen management and nitrogen-use efficiency in maize (Zea mays L.): A review. Journal of Plant Nutrition, 44(1), 1-18.

Jaja-Chimedza, A., Graf, B. L., Simmler, C., Kim, Y., Kuhn, P., Pauli, G. F., and Raskin, I. (2019). Biochemical characterization and anti-inflammatory properties of an isothiocyanate-enriched moringa (Moringa oleifera) seed extract. PloS One, 14(11), e0224943.

Khanal, R. C., Dhungana, S. K., Joshi, B. K., and Mishra, B. N. (2020). Nutrient management in rice (Oryza sativa L.) for increased grain yield and protein content: A review. Journal of Plant Nutrition, 43(6), 824-835.

Kumari, P., and Srivastava, S. (2016). Nutritional composition and bioactive potential of Moringa oleifera Lam.: An overview. International Journal of Pharmaceutical Sciences Review and Research, 37(1), 221-226.

Leone, A., Spada, A., Battezzati, A., Schiraldi, A., Aristil, J., and Bertoli, S. (2015). Moringa oleifera seeds and oil: Characteristics and uses for human health. International Journal of Molecular Sciences, 16(6), 12791-12835.

Prakash, B., Verma, A., Kumar, P., and Singh, K. (2021). Influence of plant spacing and harvest interval on the growth, yield, and quality of radish (Raphanus sativus L.). Vegetos, 34(1), 32-39.

Tcherkez, G., Gauthier, P., Buckley, T. N., Busch, F. A., Barbour, M. M., Bruhn, D., ... and Ghashghaie, J. (2019). Tracking the origins of the δ13C of atmospheric CO2 within the leaf water of terrestrial

plants. New Phytologist, 224(2), 570-584.

Xu, C., Cai, S., Cheng, B., Peng, X., and Hu, J. (2020). Carbon allocation and its effect on leaf senescence in response to different temperature and light intensities in Malus hupehensis Rehd. Journal of Plant Growth Regulation, 39(3), 953-965.

Zörb, C., Ludewig, U., and Hawkesford, M. J. (2014). Perspective on wheat yield and quality with reduced nitrogen supply. Trends in Plant Science, 19(9), 555-565

.