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# Effect of organic manures and planting geometry on growth and yield of little millet (*Panicum sumatrense* L.)

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**Abstract**
A field experiment was conducted during *Kharif* season 2023 at Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.) to study the "Effect of organic manures and planting geometry on growth and yield of little millet". The treatments consisted of organic manures (FYM, Neem Cake, Poultry Manure) and three levels of planting geometry (20 cm x 10 cm, 20 cm x 15 cm, 25cm x 25 cm). The experiment was laid out in a Randomized Block Design with 9 treatments and replicated thrice. The result revealed that application of neem cake in a spacing of 25 cm x 25 cm (Treatment 6) recorded significant and higher plant height (82.57 cm), maximum number of tillers/hill (8.67), higher plant dry weight (15.16 g), maximum number of effective tillers/hill (8.60) higher spike length (28.87 cm), maximum number of grains/spike (432). The data also recorded the highest cost of cultivation (49750 INR/ha) gross return (89,052.77 INR/ha), net return (56,022.77 INR/ha), and B: C ratio (1.70).

**Keywords:** Organic manures, planting geometry, growth, yield, and economics

## 1. Introduction

Little millet, an ancient grain, has been integral to traditional farming and diets, especially in India. Known for its resilience in adverse climatic conditions, little millet is gaining renewed attention due to its impressive nutrient profile, health benefits, and suitability for sustainable agriculture. Little millet is a powerhouse of nutrients, providing a rich source of carbohydrates, proteins, fats, fiber, and essential minerals. Per 100 grams, little millet offers approximately carbohydrates (67 g), protein (7.7 g), fat (4.7 g), and crude fiber (7.6 g). The mineral content includes calcium (17 mg), phosphorus (220 mg), and iron (9.3 mg), making it superior in certain nutritional aspects compared to more commonly consumed grains like rice and wheat (Indirani *et al.*, 2021) [9]. This nutritional composition supports a balanced diet, particularly beneficial in regions where malnutrition is prevalent. The production of little millet is predominantly concentrated in the dryland areas of India, where it thrives with minimal inputs. Its cultivation is relatively straightforward, requiring less water and fewer fertilizers compared to other cereal crops. This makes it an ideal crop for sustainable farming practices, particularly in arid and semi-arid regions. Farmers appreciate its short growth cycle, which allows for multiple harvests in a year, thereby enhancing food security and providing a steady income source.

The global production of millets reached 30.90 million tonnes (FAO, 2022) [6], with India being the top producer. India produced an estimated 11.84 million tonnes of millets over an area of 15.48 million hectares, achieving a productivity rate of 1.23 tonnes/hectare. In Uttar Pradesh, the area under millet cultivation was 2.89 lakh hectares, with a production of 4.62 million tonnes and a productivity rate of 1.6 tonnes/hectare (GOI, 2022) [7].

In the contemporary agricultural landscape, there is a pressing need to develop sustainable and eco-friendly farming practices that ensure high productivity and maintain soil health and environmental balance. Little millet, a minor cereal crop, may be attributed to inadequate rainfall distribution, poor crop management high prices of farm inputs such as fertilizer and pesticides, and low adoption of improved varieties by farmers. In rainfed conditions, millet production, runoff patterns, soil erosion, and soil physical conditions undergo significant changes. The availability and cost of organic manures compared to synthetic fertilizers can impact practicality for farmers. Weed contamination in organic manures can hinder millet growth. Furthermore, the slow release of nutrients from organic manures can be problematic for millet during crucial growth stages. Organic manures are vital for providing essential nutrients such as nitrogen, phosphorus, and potassium. Insufficient application can lead to nutrient deficiencies, which affect plant growth, development, and yield. Using organic manures such as neem cake, farm yard manure, and poultry manure is a promising solution to enhance soil fertility and crop productivity. However, maintenance of optimum planting density is always a big problem for farmers and they maintain sub-optimum plant density leading to severe weed infestation, poor radiation use efficiency, and lower yield, while dense plant population on the other hand may cause lodging, poor light penetration in the canopy and reduced photosynthesis due to shading of lower leaves and drastically reduce the yield. The optimum plant population of little millet needs to be adjusted according to the growth habit of variety and prevailing agro-climatic conditions, apart from identifying the optimum dose of fertilizers. Therefore, this research holds ubstantial importance in promoting the cultivation of little millet, ensuring food security, and advancing sustainable agricultural practices.

Farmyard manure (FYM) is a valuable organic fertilizer that supplies essential nutrients like nitrogen, phosphorus, and potassium (NPK). FYM enhances soil structure, increases nutrient holding capacity, and supports the growth of beneficial soil microorganisms. Its ability to improve soil biodiversity, microbial activity, and organic matter quality makes it a crucial component of sustainable agricultural practices, contributing to both soil health and crop productivity.

Poultry manure is a great organic fertilizer that includes a high concentration of nitrogen, phosphorus, potassium, and other essential nutrients. It increases organic matter in the soil, which enhances soil structures, nutrient retention, aeration, soil moisture holding capacity, and water infiltration. Poultry manure is a good fertilizer that may be used in place of chemical fertilizer**.** Poultry manure has been regarded as one of the most attractive manures because of its high nitrogen concentration.

Neem seed cake, a byproduct of neem oil extraction, is rich in organic carbon, nitrogen, phosphorus, potassium, calcium, magnesium, and various micronutrients. Its unique chemical composition makes it an excellent source of nutrients that support crop growth. Neem seed cake improves the physical, chemical, and biological properties of the soil, enhancing soil structure, nutrient-holding capacity, and microbial activity**.** This makes it a valuable amendment for overall soil health and fertility.

Proper plant spacing is crucial for the growth, development, and yield of millet crops. Optimal plant density ensures efficient use of sunlight and soil nutrients, reducing competition among plants for resources such as nutrients, air, and light. When plants are spaced too closely, they compete intensely, leading to shading, increased lodging, and lower yields (Bhowmik *et al*., 2012) [2]. Maintaining optimal planting density is a challenge for farmers, as sub-optimal densities can lead to weed infestation, poor radiation use efficiency, and reduced yields, while dense populations may cause lodging and reduced photosynthesis. Adjusting the plant population of little millet according to its growth habit and prevailing agro-climatic conditions, along with identifying the optimal nutrient dose, is essential for maximizing yield (Pradhan *et al*., 2011) [16].

Keeping in view the above facts, the present experiment was undertaken to find out the **'**Effect of organic manures and planting geometry on growth and yield of little millet'.

## 2. Materials and Methods

The experiment was conducted during *Kharif* season 2023 at Crop Research Farm, Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of the experimental field was sandy loam in texture, with soil pH 7.5, low level of organic carbon (0.372%), available N (167.4 Kg/ha), P (19.4 kg/ha), K (223.8 kg/ha). The treatments consisted of organic manures (FYM, Neem Cake, Poultry Manure) and three levels of planting geometry (20 cm x 10 cm, 20 cm x 15 cm, 25cm x 25 cm) respectively. The experiment was laid out in a Randomized Block Design with 9 treatments and replicated thrice. The treatment combinations are $T_1$- FYM (10 t/ha) + 20 cm x 10 cm, $T_2$- FYM (10 t/ha) + 20 cm x 15 cm, $T_3$- FYM (10 t/ha) + 25 cm x 25 cm, $T_4$ – Neem cake (1.66 t/ha) + 20 cm x 10 cm, $T_5$ - Neem cake (1.66 t/ha) + 20 cm x 15 cm, $T_6$ - Neem cake (1.66 t/ha) + 25 cm x 25 cm, $T_7$- Poultry manure (1.6 t/ha) + 20 cm x 10 cm, $T_8$ - Poultry manure (1.6 t/ha) + 20 cm x 15 cm, $T_9$- Poultry manure (1.6 t/ha) + 25 cm x 15 cm. Data recorded on different aspects of crop, *viz*., growth, yield attributes and yield were subjected to statistical analysis by analysis of variance method as described by Gomez and Gomez (1976) [8].

## 3. Results and Discussion

### 3.1 Growth Attributes

#### 3.1.1 Plant height (cm)

Significantly higher plant height was recorded with Neem cake (1.66 t/ha) may be due to sufficient amount of nitrogen throughout its life cycle that helps in plant growth and availability of nutrients along with good moisture holding capacity of the soil, resulted increased in plant height. Similar results were found by Suresh *et al.* (2002) in wheat**.** Further, significant and higher plant height was recorded with spacing (25 cm x 25 cm) may be due to wider spacing with single seedlings resulted in less competition between plants for solar radiation, space,water and increased effective utilization of available resources for better growth. Similar result was reported by Debbarma *et.* al (2024) [3] in finger millet

#### 3.1.2 Number of Tillers / hill

Significant and maximum number of tillers/hill was with Neem cake (1.66 t/ha) might be due to the availability of desired and required quantity of nutrients for longer period in root zone of growing plants which helped plant cells to divide. Similar results were found by Swaroop and Debbarma (2023) [18] in foxtail millet. Further, significant and maximum number of tillers/hill with spacing (25 cm x 25 cm) may be due to wider spacing facilitate more absorption of light energy, water and nutrients to produce massive root system resulting higher number of tillers/hill. Similar results were observed by Debbarma *et al* (2024) [3] in finger millet**.**

#### 3.1.3 Plant Dry weight (g)

Significant and higher plant dry weight was with the application of neem cake (1.66 t/ha) may be due to the availability and adequate supply of organic matter by the neem cake, contributing to the increase in dry weight, where, increased dry matter production could be due to enhanced plant growth, leading to greater dry matter accumulation in leaves and stems during the early growth stages and more efficient translocation to gearheads in the later stages. Similar results were found by Nissi and Debbarma (2022) [5] in foxtail millet. Further, significant and higher plant dry weight was with spacing (25 cm x 25 cm) may be due to the effect of spacing, higher plant density was involved in the production of higher reproductive dry matter, where, higher plant density can increase the total dry matter production per unit land area, resulted increased in plant dry weight. Similar results were reported by Kom and Debbarma (2023) [13] in wheat.

### 3.1.4 Crop Growth Rate (g/m$^2$/day)
Significant and higher crop growth rate was with Neem cake (1.66 t/ha) may be due to organic nutrients, present in neem cake are beneficial for the primary growth of plants, resulted increased in crop growth rate. Similar results were observed by Khan *et al.* (2014) [12] in wheat. Further, significant and higher crop growth rate was with spacing (20 cm x 10 cm) may be due to the plant's inherent ability to effectively compete for resources within this spacing and availability of light, water, and nutrients under this arrangement, resulted increased in crop growth rate. Similar results have been reported Kom and Debbarma (2023) [13] in wheat.

### 3.1.5 Relative Growth Rate (g/g/day)
Significant and higher relative growth rate was with Neem cake (1.66 t/ha) may be due to organic nutrients present in the poultry manure, enhance the overall vitality and growth efficiency of the crops, resulted increased in relative growth rate. Similar results were observed by Khan *et al.* (2014) [12] in wheat. Further, the significant and maximum relative growth rate was with spacing (20 cm × 10 cm) may be due to plant's ability to compete for essential resources effectively, optimal spacing ensures that plants have adequate access to light, water, and nutrients, which are critical for their growth, where, reduced competition among plants in an arrangement which allows each plant to maximize its resource intake, further boosting the relative growth growth rate. Similar results were reported by Liu *et al.* (2023) [15] in wheat.

### 3.1.6 Number of effective tillers/hill
The significant and maximum number of effective tillers/hill was with Neem cake (1.66 t/ha) may be due to the effects of neem cake on pest control and the nutrient-rich organic matter it supplies, neem cake's natural pest-repelling properties protected the plants, and allowing them to allocate more resources to tiller development, at the same time, the neem cake provided essential nutrients and organic matter, promoting robust tiller growth. Similar findings were recorded by Kumar *et al.* (2024) [14] in pearl millet. Further, a significant and maximum number of effective tillers/hill was with spacing (25 cm x 25 cm) may be due to better concurrent utilization of moisture, nutrients, and solar radiation as well as the orientation of the leaves, thereby, leading to a greater amount of photosynthesis, which increases the expression of effective tillers. Similar results were reported by Debbarma *et al.* (2024) [3] in finger millet.

## 3.2 Yield and Yield Parameters
### 3.2.1 Spike length (cm)
The significant and higher spike length was with Neem cake (1.66 t/ha), may be due to nutrient availability for the plants, where, increased availability leads to greater nutrient uptake and subsequent translocation to the developing spike, resulting in improved growth and yield. Debbarma and Nissi (2022) [5] in foxtail millet. Further, the significant and maximum spike length was with spacing (25 cm x 25 cm) may be due to the lower rate of leaf senescence in plants that have larger amounts of cytokinins transported into their canopies from the roots. Similar findings were observed by Debbarma *et.* al (2024) [3] in finger millet.

### 3.2.2 Number of grains/spike
The significant and maximum number of grains/spike was with Neem cake (1.66 t/ha) may be due to the positive balance of macro and micronutrients in the soil, where, this improvement has resulted in higher production of assimilates, resulted in an increased in a number of grains/ spike. These observations are consistent with the findings reported by Debbarma and Nissi (2022) [5] in foxtail millet. Further, a significant and maximum number of grains/spike was with spacing (25 cm x 25 cm) may be due to the positive changes in plant structure, where, the changes enhance the photosynthetic efficiency of the leaves and improve both grain size and overall yield, resulted an increased in a number of grains/spike. Similar results have been documented by Hakoomat Ali *et al*. (2009) [1] in cotton

### 3.2.4 Grain yield (t/ha)
The significant and higher grain yield was with Neem cake (1.66 t/ha) may be due to an increase in yield which has been attributed to the release of macro and micronutrients during microbial decomposition of neem cake, which provides an energy source for soil microflora, facilitating the transformation of other soil nutrients or those applied through other means into forms that are easily absorbed by growing plants, thereby enhancing seed yield. These findings align with the results reported by Jagadeesha *et al.* (2010) [10] in finger millet. The higher grain yield due to spacing (20 cm x 10 cm) may be attributed to the development of a denser plant population, larger root volume, the presence of numerous and robust tillers with large panicles, and more well-filled spikelets with higher grain weight. Similar results were reported by Jyothi *et al.* (2021) [11] in rice.

### 3.2.5 Straw yield (t/ha)
The significant and higher straw yield was with Neem cake (1.66 t/ha) may be due to the combination of pest resistance and nutrient enrichment of neem cake, resulted an increased in straw yield, integration of pest control, and nutrient supply maximized productivity in agricultural systems. Similar findings were observed by Kumar *et al.* (2024) [14] in pearl millet. Further, significant and higher straw yield was with spacing (25 cm x 25 cm) may be due to the development of a denser plant population, larger root volume, the presence of numerous and robust tillers, and more substantial plant biomass. Similar results were also reported by Debbarma and Abraham (2016) [4] in rice.

### 3.2.6 Harvest Index (%)
Harvest index of cereal crops is controlled by the partition of photosynthates between harvesting and non-harvesting organs during the crop growth period, where, variation in harvest index might have variation in the partitioning of photosynthates in grain and vegetative organs of the different treatments Debbarma *et al.* (2024) [3] in finger millet. The application of farm yard manure (10 t/ha) may lead to higher availability of nitrogen and phosphorus that promotes growth and development and ultimately results in higher yields, where, spacing (20 cm x 10 cm) may have optimized plant density, allowing for efficient use of light, water, and nutrients, where, spacing likely minimized competition among plants, promoting better resource use efficiency and enhancing grain production relative to total biomass and closer spacing of (20 cm x 10 cm) supported a higher number of plants per unit area, contributing to the overall grain yield without excessively increasing biomass production, thus improving the harvest index. Similar results were reported by Theeshnavi and Dawson (2022) [19] in green gram.

### 3.3 Economics

The data revealed that maximum gross return (89052.77 INR/ha), net returns (5602277 INR/ha), benefit cost ratio (1.70) were recorded in treatment 4 (Neem cake (1.66 t/ha + 20 cm x 10 cm) as compared to other treatments. Maximum Benefit Cost Ratio (B: C) was recorded in Treatment 4 [Neem cake (1.66 t/ha) + 20 cm x 10 cm] due to the lower quantity and cost of neem cake compared to the larger quantity and higher cost of FYM, resulted in greater gross and net returns. Thus, Treatment 4 achieved a higher benefit-cost (B: C) ratio.

**Table 1:** Effect of organic manures and planting geometry on growth attributes of little millet

| S. No. | Treatment Combinations | Plant Height (cm) | Number of Tillers/hill (cm) | Plant dry weight (g) | Crop Growth Rate ($g/m^2/day$) | Relative Growth Rate (g/g/day) | Number of effective tillers/hill |
|---|---|---|---|---|---|---|---|
| 1. | FYM (10 t/ha) + 20 cm x 10 cm | 77.17 | 6.67 | 12.67 | 25.16 | 0.0791 | 5.43 |
| 2. | FYM (10 t/ha) + 20 cm x 15 cm | 77.33 | 7.00 | 13.37 | 16.61 | 0.0699 | 6.07 |
| 3. | FYM (10 t/ha) + 25 cm x 25 cm | 77.53 | 7.67 | 14.46 | 8.05 | 0.0595 | 8.07 |
| 4. | Neem cake (1.66 t/ha) + 20 cm x 10 cm | 79.57 | 8.33 | 13.03 | 25.48 | 0.0820 | 5.67 |
| 5. | Neem cake (1.66 t/ha) + 20 cm x 15 cm | 81.57 | 6.67 | 13.41 | 16.91 | 0.0694 | 6.43 |
| 6. | Neem cake (1.66 t/ha) + 25 cm x 25 cm | 82.57 | 8.67 | 15.16 | 8.66 | 0.0615 | 8.60 |
| 7. | Poultry manure (1.6 t/ha) + 20 cm x10 cm | 75.87 | 8.33 | 12.49 | 24.39 | 0.0740 | 5.33 |
| 8. | Poultry manure (1.6 t/ha) + 20 cm x15 cm | 75.83 | 6.67 | 13.23 | 15.65 | 0.0715 | 5.97 |
| 9. | Poultry manure (1.6 t/ha) + 25 cm x25 cm | 75.70 | 7.33 | 14.30 | 7.92 | 0.0607 | 7.73 |
| | F-test | S | S | S | S | S | S |
| | SEm(±) | 1.57 | 0.49 | 0.38 | 0.74 | 0.0008 | 0.27 |
| | CD (p=0.05) | 4.71 | 1.48 | 1.13 | 2.21 | 0.0024 | 0.81 |

**Table 2:** Effect of organic manures and planting geometry on yield and yield attributes of little millet

| S. No. | Treatment Combinations | Spike Length | Number of grains/spike (cm) | Grain Yield (t/ha) | Stover Yield (t/ha | Harvest Index (%) |
|---|---|---|---|---|---|---|
| 1. | FYM (10 t/ha) + 20 cm x 10 cm | 22.40 | 238.33 | 1.56 | 5.83 | 21.10 |
| 2. | FYM (10 t/ha) + 20 cm x 15 cm | 25.50 | 279.33 | 1.34 | 5.68 | 19.09 |
| 3. | FYM (10 t/ha) + 25 cm x 25 cm | 26.60 | 427.67 | 1.33 | 5.89 | 18.72 |
| 4. | Neem cake (1.66 t/ha) + 20 cm x 10 cm | 24.33 | 242.33 | 1.66 | 6.80 | 19.62 |
| 5. | Neem cake (1.66 t/ha) + 20 cm x 15 cm | 26.67 | 282.00 | 1.44 | 6.81 | 17.44 |
| 6. | Neem cake (1.66 t/ha) + 25 cm x 25 cm | 28.87 | 432.00 | 1.43 | 6.87 | 17.25 |
| 7. | Poultry manure (1.6 t/ha) + 20 cm x 10 cm | 21.93 | 235.33 | 1.51 | 5.75 | 20.79 |
| 8. | Poultry manure (1.6 t/ha) + 20 cm x 15 cm | 24.80 | 290.00 | 1.36 | 5.91 | 18.89 |
| 9. | Poultry manure (1.6 t/ha) + 25 cm x 25 cm | 26.87 | 423.67 | 1.26 | 5.68 | 18.29 |
| | F-test | S | S | S | S | S |
| | SEm(±) | 0.81 | 14.03 | 0.08 | 0.30 | 1.09 |
| | CD (p=0.05) | 2.41 | 42.06 | 0.23 | 0.90 | 3.26 |

**Table 3:** Effect of organic manures and planting geometry on economics of little millet

| S. No. | Treatment Combinations | Cost of Cultivation | Gross Returns (INR/ha) | Net Returns (INR/ha) | Benefit Cost Ratio (B: C) |
|---|---|---|---|---|---|
| 1. | FYM (10 t/ha) + 20 cm x 10 cm | 49750 | 79912.49 | 30162.49 | 0.61 |
| 2. | FYM (10 t/ha) + 20 cm x 15 cm | 49750 | 73297.14 | 23547.14 | 0.47 |
| 3. | FYM (10 t/ha) + 25 cm x 25 cm | 49750 | 74458.24 | 24708.24 | 0.50 |
| 4. | Neem cake (1.66 t/ha) + 20 cm x 10 cm | 33030 | 89052.77 | 56022.77 | 1.70 |
| 5. | Neem cake (1.66 t/ha) + 20 cm x 15 cm | 33030 | 83559.76 | 50529.76 | 1.53 |
| 6. | Neem cake (1.66 t/ha) + 25 cm x 25 cm | 33030 | 83888.46 | 50858.46 | 1.54 |
| 7. | Poultry manure (1.6 t/ha) + 20 cm x 10 cm | 35750 | 78073.18 | 42323.18 | 1.18 |
| 8. | Poultry manure (1.6 t/ha) + 20 cm x 15 cm | 35750 | 75427.53 | 39677.53 | 1.11 |
| 9. | Poultry manure (1.6 t/ha) + 25 cm x 25 cm | 35750 | 71350.73 | 35600.73 | 1.00 |
| | F-test | | S | S | S |
| | SEm(±) | | 2859.51 | 2859.51 | 0.07 |
| | CD (p=0.05) | | 8572.79 | 8572.79 | 0.21 |

## 4. Conclusion

It is concluded that using Neem cake at a rate of (1.66 t/ha), combined with specific planting geometry (Treatment 6), resulted in higher yield attributes in little millet, while (Treatment 4) achieved a higher benefit cost ratio.

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## 6. References

1. Ali H, Afzal MN, Muhammad D. Effect of sowing dates and plant spacing on growth and dry matter partitioning in cotton (*Gossypium hirsutum* L.). Pakistan Journal of Botany. 2009; 41(5):2145-2155.
2. Bhowmik SK, Sarkar MAR, Zaman F. Effect of spacing and number of seedlings per hill on the performance of aus rice cv. NERICA 1 under dry direct seeded rice (DDSR) system of cultivation. Journal of the Bangladesh Agricultural University. 2012;10(2):191-195.
3. Debbarma V, Abraham T, Singh V, Lal RB. Agronomic response of System of Finger Millet Intensification

technique on growth and yield of organic finger millet (*Eleusine coracana* L.). International Journal of Environment and Climate Change. 2024;14(2):106-120.
4. Debbarma V, Abraham T. Agronomic response on growth and yield of organic rice [*Oryza sativa* (L.) sub sp. japonica]. The Allahabad Farmer, 2016, 71(2).
5. Debbarma V, Nissi WI. Effect of organic manures and fish amino acid on growth and yield of foxtail millet (*Setaria italica* L.). International Journal of Plant & Soil Science. 2022; 34(23):601-607.
6. Food and Agriculture Organization of the United Nations. World Food and Agriculture - Statistical Yearbook 2022. FAO; c2022.
7. Government of India. Ministry of Agriculture and Farmers Welfare, Government of India; c2022.
8. Gomez KA, Gomez AA. Statistical Procedures for Agricultural Research.
9. Indirani K, Devasena M. Review on nutritional profiles and health benefits of little millets – India. International Journal of Research in Engineering and Science. 2021;9(11):7-11.
10. Jagadeesha N, Reddy VC, Krishnamurthy N, Sheshadri T. Effect of organic manures on productivity of finger millet and redgram intercropping system under protective irrigation. International Journal of Agricultural Sciences. 2010;6(2):453-455.
11. Jyothi KN, Sumathi V, Subramanyam D, Sudhakar P, Giridhar Krishna T, Sagar KG, *et al*. Productivity and profitability of foxtail millet (*Setaria italica* L.) as influenced by varied agro techniques under Southern agro-climatic Zone of Andhra Pradesh. The Pharma Innovation Journal. 2021;10(7):907-911.
12. Khan P, Imtiaz M, Memon MY, Aslam M, Depar N, Shah JA, *et al*. Response of wheat genotype NIA-Sundar to varying levels of nitrogen and phosphorus. Sarhad Journal of Agriculture. 2014;30(3):325-331.
13. Kom MK, Debbarma V. Influence of Organic Manure and Spacing on Growth and Yield of Wheat. International Journal of Environment and Climate Change. 2023;13(10):4349-4355.
14. Kumar T, Pandey S, Kumar D, Yadav B, Pathak S, Sharma VK, *et al*. Effect of different organic sources and their combination on growth, yield and economics of millet crop-pearl millet. Journal of Agriculture and Ecology. 2024;18:39-43.
15. Liu P, Yin B, Liu X, Gu L, Guo J, Yang M, *et al*. Optimizing plant spatial competition can change phytohormone content and promote tillering, thereby improving wheat yield. Frontiers in Plant Science. 2023;14:1147711.
16. Pradhan A, Thakur A, Patel S, Mishra N. Effect of different nitrogen levels on kodo and finger millet under rainfed conditions. Research Journal of Agricultural Sciences. 2011;2:136-138.
17. Suresh Kumar R, Ganesh P, Tharmaraj K, Saranraj P. Growth and development of black gram (*Vigna mungo*) under foliar application of panchagavya as organic source of nutrient. Current Botany. 2011;2(3):09-11.
18. Swaroop BT, Debbarma V. Effect of organic manures and zinc on growth, yield and economics of foxtail millet (*Setaria italica* L.). International Journal of Environment and Climate Change. 2023;13(8):344-351.
19. Theeshnavi V, Dawson J. Effect of spacing, farm yard manure and neemcake on growth and yield of Greengram (*Vigna radiata* L.). The Pharma Innovation Journal. 2022;11(4):1685-1687.