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DIFFERENT NITROGEN AND PHOSPHORUS FERTILIZERS EFFECTS ON CROP PERFORMANCE AND NUTRITION MANAGEMENT IN MILLET

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Abstract

The study aimed to determine the impact of varying nitrogen and phosphorus levels on the components and production of millet. The effect of different nitrogen and phosphorus concentrations on the growth and yield of millet was assessed. The variety YBS-98 was treated with five different concentrations of nitrogen and potassium during the trial. T1=No fertilizers, T2=N 40+ P 20 %, T3=N 40+ P 25 %, T4=N 40+ P 30 %, T5=N 60+ P 20 %, T6=N 60+ P 25 %, and T7=N 60+ P 30 %, applied varying amounts of nitrogen and phosphorus. The study achieved the best results with a maximum plant height of 222.1 cm, a stem diameter of 0.90 cm, a leaf area per tiller (cm^{-2}) of 1785.11, green fodder yields (t ha^{-1}) of 77.11 cm, a plant density (m^{-2}) of 155.11 cm, a number of leaves per tiller of 12.50 cm, a dry matter percentage of 14.71 cm, a crude fiber percentage of 10.40 cm, a crude protein percentage of 46.20%, and an ash percentage of 7.30 percent. Giving millet nitrogen 60 and phosphorus 30% positively impacted its growth and yield. On the other hand, the control (T1 = no fertilizer) had the lowest results. The minimum plant height was 155.0 cm, the stem diameter was 0.60 cm, the leaf area per tiller (cm^{-2}) was 802.91, the green fodder yields (t ha^{-1}) were 50.70 cm, the plant density (m^{-2}) was 149.11 cm, the number of leaves per tiller was 10.11, the dry matter percentage was 8.01%, the crude fiber percentage was 7.00, the crude protein percentage was 44.11, and the ash percentage was 5.2.

Keywords: *Integrated, Applied, Nitrogen, Phosphorus, Growth, Millet.*

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INTRODUCTION

One of the hardest cereal crops for the warm season around the globe is pearl millet (*Pennisetum glaucum* L.)[1]. When we talk about "millets," we usually mean a diverse range of highly variable small-seeded grasses (like *Paspalum scrobiculatum*, *Setaria italica, Pennisetum glaucum*, and *Cenchrus americanus*) with varying origins, taxonomies, and cultivation distributions. Proso millet, which dates back more than 10,000 years, is one of the world's oldest cultivated cereal crops and is crucial for smallholder farmers' survival in the semiarid regions of numerous tropical countries[2]. Livestock and poultry farms use pearl millet grain as feed because of its high nutritional content. It also contains high levels of vitamins, riboflavin, and thiamine, and it gives the body a lot of easily digested energy[3]. Nitrogen-deficient plants not only yield shrivelled grains and generally stunted growth, but also mature later and produce fewer blooms. Use fertilizer sparingly and appropriately to improve forage quality, particularly protein content, in addition to yield[4]. Proteins, nucleic acids, and chlorophyll are known to contain nitrogen, which is necessary for plant growth. For the plant to reach its maximum photosynthetic potential and for the tillers and leaves to fully develop, there must be an adequate supply of N in the diet. Pearl millet primarily requires N, and its application has varying effects on yield and growth[5]. Generally recognize pearl millet for its ability to grow with minimal N management. However, a number of studies revealed that applying N could boost millet production efficiency[6]. Fertilizers containing nitrogen and phosphorus are indispensable for achieving food security. Nitrogen made from urea-formaldehyde, urea-super granule, or urea-triple superphosphate could be used as a nitrogen source that releases nitrogen over time with DAP, GSSP, or TSP, which is good for plants[6]. Each nitrogen fertilizer influences nitrogen dynamics in soil-plant systems, as well as the performance of crops[7]. Despite being an essential nutrient for crops, phosphorus availability to plants in phosphorus-fixed soil is often very low due to immobilization by various chemicals, particularly iron and aluminium oxides and clay minerals[8]. Phosphorus is also crucial for facilitating carbon, nitrogen, and sulphur cycles, and phosphorus fertilization can affect soil organic carbon and nitrogen mineralization[9]. Little is known about the different impacts of the same or different nitrogen or phosphorus fertilizers on the performance of crops[10]. As both nitrogen and phosphorus fertilizers are essential for crop growth, studies on the individual and the combination of nitrogen and phosphorus fertilizers are important for advancement[11]. Millet is an important forage crop, playing a significant role in purifying environmental pollutants, providing services, energy, and food production[12]. However, the effects of a series of nitrogen and/or phosphorus fertilizers on the millet-millet companion cropping systems are not clear, Unlike single-crop systems, the effect of different fertilizer combinations on inter-plant competition is a necessary factor for the performance of the eco-agro system[13].

MATERIALS AND METHODS

Field experiment

We conducted a field experiment at the Latif Farm, Sindh Agriculture University, Tando Jam, Sindh, Pakistan, in 2024 to investigate the effects of different nitrogen and phosphorus levels on millet production and growth. Using urea, nitrogen and phosphorus were applied at rates T1=No fertilizers, T2=N 40+ P 20 %, T3=N 40+ P 25 %, T4=N 40+ P 30 %, T5=N 60+ P 20 %, T6=N 60+ P 25 %, T7=N 60+ P 30 % during the course of several growth phases. With a net plot size of 5 m x 3 m = 15 m2, each treatment was duplicated three times in a randomized full block design. After two dry plowings to prepare the land, we laser-leveled the field. Water for irrigation was then used to create the right amount of moisture. To generate a fine seedbed, the soil was then leveled with a planker and ploughed twice with a crosswise cultivator.

Growth and yield parameters

Plant height cm, stem diameter cm, leaf area per tiller (cm-2), green fodder yields (tha-1), plant density (m-2), Number of leaves per tiller: Dry matter%, crude fiber%, crude protein%, and ash% were recorded manually**.**

Statistical Analysis

Using Statistix v. 8.1 (Analytical Software, USA), the analysis of variance (ANOVA) approach was used for the statistical analysis of the gathered data. Using the least significant design (LSD) test with α = 0.05, the difference between treatment means was computed (Steel et al., 1997).

RESULTS

Plant height (cm)

Table-1: Nitrogen and phosphorus application to millet significantly and favorably influenced numerous physiological yields and yield constituent parameters (Table 1). Differences in the amounts of nitrogen and phosphorus impact millet plant height (cm). The treatments T7=N 60+ P 30% ha-1 produced a maximum plant height of 222.1 cm. Furthermore, we found that T1 = Control, which received no fertilizer at a rate of 00 kg ha-1, had the lowest mean plant height of 155.0 cm. The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean plant heights of 211.0 cm, 205.98 cm, 201.17 cm, 195.1 cm, and 168.9 cm, respectively.

Stem diameter (cm)

Table-1: Nitrogen and phosphorus application to millet significantly and favorably influenced numerous physiological yields and yield constituent parameters (Table 1). There are differences in the amounts of nitrogen and phosphorus that impact millet stem diameter (cm). The treatments T7=N 60+ P 30% ha-1 produced a maximum stem diameter (cm) of 0.90 cm. Furthermore, T1 = Control no fertilizer, 00 kg ha-1, was shown to have the lowest mean stem diameter (cm) (0.60 cm). The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean stem diameter (cm) of 0.88 cm, 86 cm, 0.82 cm, 0.78 cm, and 0.72 cm, respectively.

Leaf area per tiller (cm-2)

Table-1: Different levels of nitrogen and phosphorus affect the leaf area per tiller (cm-2) of millet. There are differences in the amounts of nitrogen and phosphorus that impact millet leaf area per tiller (cm-2). The treatments T7=N 60+ P 30% ha-1 produced a maximum leaf area per tiller (cm-2) of 1785.11 cm-2. Furthermore, T1 = Control no fertilizer, 00 kg ha-1, was shown to have the lowest mean leaf area per tiller (cm-2) (802.91 cm-2). The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean leaf area per tiller (cm-2) of 1715.01 cm2, 1611.00 cm2, 1601.56 cm2, 1585.00 cm2, and 13.90.12 cm-2, respectively.

Green Fodder Yields (t ha-1)

Table-1: Different levels of nitrogen and phosphorus affect the Green Fodder yields (tha-1) of millet. Different amounts of nitrogen and phosphorus impact the Green Fodder yields (tha-1) of millet. The treatments T7=N 60+ P 30% ha-1 produced a maximum green fodder yield (tha-1) of 77.11 tha-1. Furthermore, T1 = Control no fertilizer, 00 kg ha-1, was shown to have the lowest mean Green Fodder yields (tha-1) (50.70 tha-1). The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean green fodder yields (tha-1) 75.09 tha-1, 72.91 tha-1, 71.17 tha-1, 63.00,63.00 and 60.63 tha-1, respectively

Table.1 Integrated Impact of Inorganic Fertilizers Nitrogen and Phosphorus Growth Yield of Millet

Treatments	**Plant Height cm**	**Stem diameter cm**	**Leaf area per tiller (cm-2)**	**Green Fodder yields (tha-1)**
T1=No fertilizers	155.0	0.60	802.91	50.70
T2=N 40+ P 20 %	168.9	0.72	1390.12	60.63
T3=N 40+ P 25 %	195.1	0.78	1585.00	63.00
T4=N 40+ P 30 %	201.17	0.82	1601.56	71.17
T5=N 60+ P 20 %	205.98	0.86	**1611.00**	72.91
T6=N 60+ P 25 %	211.0	0.88	1715.01	75.09
T7=N 60+ P 30 %	222.1	0.90	1785.11	77.11
LSD	0.681	0.010	0.698	0.210

Plant density (m-2)

Table-2: Different levels of nitrogen and phosphorus influence the number of plants. The treatments T7 = N 60 + P 30% ha-1 yielded a maximum plant density (m-2) of 155.11 (m-2). Furthermore, T1 = Control no fertilizer, 00 kg ha-1, was shown to have the lowest mean plant densities (149.11 m-2). The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean plant densities (m-2) of 152.66, 150.99, 150.90, and 151.00 cm-2, respectively.

No. of leaves per tiller

Table-2: Different levels of nitrogen and phosphorus affect the number of leaves per tiller of millet. The crops treated with T7 = N 60 + P 30% ha-1 yielded a maximum of 12.50 leaves per tiller. Furthermore, T1 = Control no fertilizer, 00 kg ha-1, was shown to have the lowest mean number of leaves per tiller (10.11). The crops that received T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean numbers of leaves per tiller of 12.45, 11.00, 10.94, 10.45, and 10.22, respectively.

Dry matter%

Table-2: Millet's dry matter% impacts nitrogen and phosphorus content; different amounts of T7=N 60+ P 30% ha-1 produced a maximum dry matter% of 14.71. The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean dry matter % 14.60, 13.75, 13.16, 12.99, and 11.25, respectively. Moreover, T1 = control, no fertilizer, 00 kg ha-1, had the lowest mean dry matter percentage of 8.01.

Crude fiber%

Table 2: Different nitrogen and phosphorus contents have an impact on millet's crude fiber % content. The crops treated with T7=N 60+ P 30% ha-1 produced a maximum crude fiber% of 10.40. The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean crude fiber % 10.25, 10.01, 9.95, 0.12, and 8.80, respectively. Furthermore, T1 = control, which received no fertilizer at a rate of 00 kg ha-1, had the lowest mean crude fiber% at 7.00.

Table.2 Integrated Impact of Inorganic Fertilizers Nitrogen and Phosphorus Growth Yield of Millet

Treatments	Plant density (m-2)	No of leaves per tillers	Dry matter %	Crude fibre %
T1=No fertilizers	149.11	10.11	8.01	7.00
T2=N 40+ P 20 %	151.00	10.22	11.25	8.80
T3=N 40+ P 25 %	150.90	10.45	12.99	9.12
T4=N 40+ P 30 %	151.17	10.94	13.16	9.95
T5=N 60+ P 20 %	150.99	11.00	13.75	10.01
T6=N 60+ P 25 %	152.66	12.45	14.60	10.25
T7=N 60+ P 30 %	155.11	12.50	14.71	10.40
LSD	0.122	0.270	0.221	0.05

Crude protein%

Table 3: Various physiological yields and yield constituent characteristics were significantly and favorably impacted by the application of nitrogen and phosphorus to millet. Different levels of nitrogen and phosphorus affect the crude protein content of millet. The crops treated with T7=N 60+ P 30% ha-1 produced a maximum crude protein % of 46.20. The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3 = N 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean crude protein % 45.90,

45.50, 45.30, 45.15, and 44.90, respectively. Furthermore, T1 = control, which received no fertilizer at a rate of 00 kg ha-1, had the lowest mean crude protein percentage at 44.11.

Ash %

Table 3: Different levels of nitrogen and phosphorus affect the ash content of millet. The crops treated with T7=N 60+ P 30% ha-1 produced a maximum ash% of 7.30. The crops receiving T6=N 60+ P 25%, T5=N 60+ P 20%, T4=N 40+ P 30%, T3=NN 40+ P 25% ha-1, and T2=N 40+ P 20% ha-1 produced mean ash% 7.25, 7.20, 7.11, 7.01, and 6.40, respectively. Furthermore, T1 = control; no fertilizer, 00 kg ha-1, had the lowest mean ash% (5.2).

Table.3 Integrated Impact of Inorganic Fertilizers Nitrogen and Phosphorus Growth Yield of Millet

Treatments	Crude protein %	Ash %
T1=No fertilizers	44.11	5.2
T2=N 40+ P 20 %	44.90	6.40
T3=N 40+ P 25 %	45.15	7.01
T4=N 40+ P 30 %	45.30	7.11
T5=N 60+ P 20 %	45.50	7.20
T6=N 60+ P 25 %	45.90	7.25
T7=N 60+ P 30 %	46.20	7.30
LSD	1.012	2.341

DISCUSSIONS

(Pennisetum glaucum L.), sometimes also called pearl millet, is the sixth most important grain crop in the world and ranks fourth among key tropical cereals[14]. This crop is considered a beneficial way to protect the meals of the agricultural poor in hot, desert places like Pakistan[15]. Studies have demonstrated a close relationship between plants, soil, and fertilizers[16]. Fertilizer availability can directly affect soil fertility, which in turn may influence plant health and ultimately impact plant yield[17]. Our study results indicate that control T1 does not apply any fertilizers. T1=No fertilizers, T2=N 40+ P 20 %, T3=N 40+ P 25 %, T4=N 40+ P 30 %, T5=N 60+ P 20 %, T6=N 60+ P 25 %, T7=N 60+ P 30 %. The current study yielded the best results, with a maximum plant height of 222.98 cm, a stem diameter of 0.91 cm, a leaf area per tiller (cm^{-2}) of 1780.81, green fodder yields (t ha^{-1}) of 77.91 cm, a plant density (m-2) of 154.19 cm, a number of leaves per tiller of 12.60 cm, a dry matter percentage of 14.75 cm, a crude fiber percentage of 10.37 cm, a crude protein percentage of 46.15%, and an ash percentage of 7.29 percent. Giving millet nitrogen 180 and phosphorus 25% positively impacted its growth and yield[18]. Research on the impact of varying nitrogen fertilizer levels on forage corn grain output also found that nitrogen had a significant (p 0.05) effect on forage grain yield[19]. In a related study[20] and also found that adding nitrogen had a favorable impact on finger millet development and yield components, which translates into longer, wider, and larger leaves. These may have enhanced the use of solar energy for more efficient photosynthetic processes[21]. Furthermore, the production of wider and longer leaves may be the cause of the plants' increased height. Optimal photosynthetic activity, in addition to the availability of nitrogen in soil with sufficient water, could also account for the intriguing correlation between increasing nitrogen levels and growth components. This confirmed the assertion by[22] that finger millet responds positively to nitrogen treatment. Sufficient energy provision, early nutrient release, and optimal P availability led to an increase in nutrient usage efficiency. Development of characteristics of growth that increased the potential grain yield. Confirmed these results

by demonstrating the efficient use of phosphate-solubilising and nitrogen-fixing microorganisms in the seed to enhance the growth and yield of finger millet crops[23]. These microorganisms may also be able to reduce the crop's need for chemical fertilizers [24]. Consequently, we examined in this study how fertilizers affected agronomic characteristics, production, component parts of yield, and quality indicators. Various N and P combinations significantly impact the growth and health benefits of millet, according to research. The findings of [25, 26] support this claim. The soluble sugar content of the leaves significantly increased at high levels of phosphorus and nitrogen, whereas the starch content significantly decreased. It's also likely that the soluble sugar of the leaves was more susceptible to treatments with high nitrogen and phosphorus levels, which reduced the starch content [27,28]. In the present study, we found that there were significant differences in the effects of N and P fertilizers and their interactions on the yield and quality in foxtail millet. Previous research has shown that nitrogen fertilization has a big effect on foxtail millet grain yield and aboveground growth[25]. A lack of nitrogen makes folate levels lower[26]. Overall, we found that N had a significant positive correlation with yield and protein content. Excess N application inhibited P absorption rates at the same P levels

CONCLUSIONS

Therefore, applying varying amounts of nitrogen and phosphorus to millet crops can greatly increase grain output. Therefore, considering the agro-climatic conditions in Tando Jam, Sindh, Pakistan, we recommend using T5=Nitrogen 60+ phosphorus 30% as the most cost-effective approach to achieve the highest quality green and dry matter in millet yield.

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AUTHOR’S CONTRIBUTION

Asif Ali Kaleri conducted all research work, Bina Khanzada, Danish Manzoor, Mahmmoda Buriro regarded the main research idea and management of the article, Afshan Afzal, Muhammad Jibran Khan, collection of data, Kashif Ali Samoon, Amjad Ali Sodhro, helped in the and analysis of data. Faheem Ali Ujjan, Ghulam Sajjad Kaleri helped with experimental layout and design.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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