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Shubham Kumar
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Dr. Joy Dawson
Professor and Head, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Lalit Kumar Sanodiya
Ph.D., Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Rajan Kumar
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Ravi Kumar Dwivedi
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Mayur Meshram
Ph.D., Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Corresponding Author:
Shubham Kumar
M.Sc. Scholar, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India

Effect of nitrogen and potassium with zinc levels on growth and green yield of fodder pearl millet (*Pennisetum glaucum* L.)

Shubham Kumar, Dr. Joy Dawson, Lalit Kumar Sanodiya, Rajan Kumar, Ravi Kumar Dwivedi and Mayur Meshram

Abstract
A field experiment was conducted during Zaid 2021 at Central Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, (U.P.). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 6.7), low in organic carbon (0.35%), available N (230 kg ha^{-1}), available P (20 kg ha^{-1}) and available K (189 kg ha^{-1}). The treatment consisted of sowing on three different levels of N (60 and 80 kg/ha) and K (30 and 40kg/ha) with soil (25kg/ha) and foliar application (0.2%) of $ZnSo_4$. There were 9 treatments each replicated thrice. The experiment was laid out in Randomized Block Design. The result showed that growth parameters *viz.*, plant height (122.6 cm), number of leaves $plant^{-1}$ (17.99), Number of tillers/ plant(5.76) and yield attributes *viz*., Green fodder yield (45.33 t/ha) were recorded maximum in treatment T4 (80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha).Maximum net return of 63915INR/ha and B.C. ratio 2.38 was recorded in treatment T4 (80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha).

Keywords: Green fodder, nitrogen levels, pearl millet, potassium levels, zinc levels

Introduction
Pearl millet {*Pennisetum glancum* (L.) R. Br. emend. Stuntz}, also candle millet, cattail millet, bulrush millet or bajra are all names for it, is an important crop of rainfed areas of Africa and India and serves as staple food for West Africa speople. India is the largest producer of pearlmillet covering about 8.75 million ha of marginal and sub-marginal lands primarily in the states of Rajasthan, Gujarat, Haryana, Uttar Pradesh and Maharashtra and is the fifth important cereal after rice, wheat, maize and sorghum. The crop is not only cultivated for grain, but also for Stover and fodder. In low rainfall regions, pearl millet stover is an important source of fodder. It comprises 40-50% of the dry matter intake and is often the only source of feed during dry months. The dual purpose nature of pearl millet offers both food and fodder security in the arid and semi-arid regions of the country (Ramesh *et al*. 2006).

Forage Pearl millet is an ideal choice for pastures during the warm months. Multicut character of the crop ensured the forage supply over a long time period. Balanced cättle feed and nutritious green fodder are pivotal for enhancing the milk production. To meet the green fodder requirements of milch animals in kharif, Pearl millet is an important green fodder crop in areas of light-textured soils. After 2-3 cuttings, it produces 2-3 cuttings of green fodder. The work on forage yield, quality and anti-quality of pearl millet with respect to nitrogen and phosphorus management, is rather meager. Forage Pearl millet is excellent choice for warm-season pasture because it tolerates acidic soils and drought. Development of intra- specific forage hybrids combining with the ability for repeated harvests (multicuts), earliness to first harvest, short harvesting intervals, quick regeneration, the built-in tillering potential, high green fodder yield, high quality factors and low anti-nutritional factors like oxalic acid and nitrates has tremendous opportunity to improve pearlmillet as a forage crop.

Nitrogen is the main component of protein and chlorophyll. Its in part dark green colour to plant, promote vegetative growth and rapid early growth. By increasing the protein content of fodder crops, it enhances quality and controls the use of potassium, phosphorus, and other nutrients. Potassium also plays a key role in activation of several enzymes involved in growth processes, starch synthesis, nitrogen fixation water relation, energy relation and translocation of assimilation (Mengel and Kirkby, 1996).

In plants, Zn regulates several enzyme systems that are essential for metabolic activity. Plants produce auxin, a growth-regulating substance, through this enzyme. Zinc is also vital for the oxidation processes in plant cells and helps in the transformation of carbohydrates and regulates sugar in plants. (Tandon 1995).

Fodder pearl millet register highest green forage yield potential with improved varieties and optimum nitrogen management. Recent studies have also indicated that recently developed varieties of fodder pearl millet are more responsive to nitrogenous fertilizers (Midha *et al.*, 2015). Thus, Optimizing nitrogen levels in the recently released varieties will have a significant impact on household security and nutrition in the region.

Material and Methods

The experiment took place in the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Science (SHUATS), Prayagraj during the Zaid season of 2021. (UP). The Crop Research Farm is located at 25.57 degrees north latitude, 87.19 degrees east longitude, and 98 metres above mean sea level. This area is on the right bank of the Yamuna River, on the other side of Prayagraj City. All of the necessary equipment for agricultural production was on hand.

The soil chemistry investigation revealed a sandy loam texture, a pH of 7.4, and modest levels of organic carbon [Glass electrode pH metre (Jackson, 1973)] [9]. (0.32 percent) Walkley and Black's rapid titration method (Piper, 1966)], nitrogen [(188.3 kg/ha) Alkaline permanganate method (Subbiah and Asija, 1956)], phosphorus [(35.4 kg/ha) Olsen's colorimetric method (Olsen *et al.*, 1954)] [15] and potassium [(87 kg/ha) Flame Photometer method (Jackson, 1958)] [9]. The soil was electrically conductive and had an electrical conductivity of [(0.270 dS/m) Method No.4 USDA Hand Book No.16 (Richads, 1954)] [19].

The experiment was set up in a randomised block design with nine different treatments, and it was repeated three times. *viz.*, T_1:60 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha, T_2: 60 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha, T_3: 80 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha, T_4: 80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha,T_5: 60 kg N/ha + 30 kg K_2O/ha + 0.2% $ZnSo_4$/ha, T_6: 60 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha, T_7: 80 kg N/ha + 30 kg K_2O/ha + 0.2% $ZnSo_4$/ha, T_8: 80 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha, T_9: 80 kg N/ha + 40 kg K_2O/ha. To address the nitrogen, phosphorus, potassium, and zinc requirements, urea, DAP, MOP, and zinc sulphate were reassessed. Full doses of potassium and phosphorus, as well as half doses of nitrogen, were applied at the base dose, with the remaining nitrogen applied in two splits at top dressing, while zinc was applied in two stages to the soil and at the foliar level. Plant height, number of leaves, number of tillers, and green yield were all recorded. ANOVA was applied to the experimental data by the F test to test for significance of overall differences among treatments and conclusions were generated at a 5% probability level using the data analyzed statistically. Statistical analyses and economic analyses were performed. (Gomez and Gomez, 1984) [7].

Results and Discussion

I. Growth parameters at harvest

a. Plant height (cm): Data related to the plant height is shown in (table 1). It is the most important growth attributing character which increases with the crop age. There was a significant difference among all the treatment combination recorded at harvest. The treatment of 80 kg N/ha + 40 kg K_2O/ha + 25 kg ZnSo4/ha resulted in the highest plant height (122.6 cm) (T4). Which was significantly superior from all the treatment, except treatment with application 80 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha (T_8) was found (116.3 cm) to be statically at par with (T_4). The lowest plant height (95.82 cm) was recorded with 80 kg N/ha + 40 kg K_2O/ha (T_9). The application of nitrogen resulted in a significant rise in plant height. This was evidenced by Chotiya and Singh (2005) [4].

b. Number of leaves: In the present observation number of leaves is shown (table 1). It was recorded at harvest. There was significant difference among all the treatment combination recorded at harvest. The maximum number of leaves (17.99) was recorded in treatment with application of 80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha (T_4).Which was significantly superior from all the treatment, except treatment with application 80 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha (T_8) was found (17.49) to be statically at par with (T_4). The minimum no of leaves (14.19) was recorded with 80 kg N/ha + 40 kg K_2O/ha (T_9). Similar result was reported by Chotiya and Singh (2005) [4].

c. Number of tillers: Total number of tillers/plant is shown in (table 1). It was recorded at harvest. There was a significant difference among all the treatment recorded at harvest. In the treatment with 80 kg N/ha + 40 kg K2O/ha + 25 kg ZnSo4/ha, the largest number of tillers/plant (5.76) was recorded (T4).Which was significantly superior from all the treatment. The minimum no of tillers (3.92) was recorded with 80 kg N/ha + 40 kg K_2O/ha (T_9). Similar result was reported by Chotiya and Singh (2005) [4].

Yield

Green yield (t/ha)

Different fertilizer levels tried showed significant effect on green yield of pearl millet (table 2). The maximum green yield (45.33 t/ha) was obtained with 80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha (T_4). This was statistically significant over the all other treatments. The next best treatment was 80 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha (T_8) was recorded (42.83 t/ha) followed by 80 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha (T_3) was recorded (41.30 t/ha). The lowest green yield (33.53 t/ha) was recorded with 80 kg N/ha + 40 kg K_2O/ha (T_9). Green fodder yields increased significantly when N levels were increased to 60 kg N/ha and then to 80 kg N/ha. Other fertiliser levels, on the other hand, maximised green fodder yields. Similar results were also reported by Singh *et al*., (2016).

Economics: The cost of cultivation varies owing to the different levels of fertiliser used. Highest gross return were

obtained with application of 80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha (T_4) (90666.66 INR/ha), which was superior over all other treatments which was closely followed by (80 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha) (T_8) (85666.66 INR/ha). The maximum cost of cultivation (INR 26751) was recorded under treatment (80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha) (T_4) and treatment (60 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha) (T_2). Treatment T4 (80 kg N/ha + 40 kg K_2O/ha + 25 kg ZnSo4/ha) had the highest net profit (INR63915.66) and benefit cost ratio (2.38), followed by treatment T8 (80 kg N/ha + 40 kg K_2O/ha + 0.2% ZnSo4/ha).Similar results were also reported by Khinchi *et al.*, (2017) [12].

Table 1: Effect of nitrogen and potassium with zinc level on growth of fodder pearl millet

Treatments	Plant height (cm)	No of leaves	No of tiller
T_1:60 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha	98.33	14.70	4.37
T_2: 60 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha	102.49	16.50	4.85
T_3: 80 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha	106.2	17.30	5.31
T_4: 80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha	122.6	17.99	5.76
T_5: 60 kg N/ha + 30 kg K_2O/ha + 0.2% $ZnSo_4$/ha	96.04	14.21	4.22
T_6: 60 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha	100.83	16.40	4.62
T_7: 80 kg N/ha + 30 kg K_2O/ha + 0.2% $ZnSo_4$/ha	104.69	16.81	5.07
T_8: 80 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha	116.3	17.49	5.55
T_9: 80 kg N/ha + 40 kg K_2O/ha – Control	95.82	14.19	3.92
F test	S	S	S
S. EM ±	5.59	0.47	0.16
CD (P = 0.05)	16.79	1.40	0.50

Table 2: Effect of nitrogen and potassium with zinc levels on fodder yield (t ha^{-1}) of fodder pearl millet

Treatments	Green yield(t/ha)
T_1:60 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha	37.53
T_2: 60 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha	38.67
T_3: 80 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha	41.30
T_4: 80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha	45.33
T_5: 60 kg N/ha + 30 kg K_2O/ha + 0.2% $ZnSo_4$/ha	36.07
T_6: 60 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha	37.73
T_7: 80 kg N/ha + 30 kg K_2O/ha + 0.2% $ZnSo_4$/ha	39.43
T_8: 80 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha	42.83
T_9: 80 kg N/ha + 40 kg K_2O/ha – Control	33.53
F test	S
S. EM ±	2.14
CD (P = 0.05)	6.44

Table 3: Economics of Green Fodder Pearl Millet on nitrogen and potassium with zinc levels

Treatments No.	Treatments combinations	Total cost of cultivation	Yield (t ha^{-1})	Selling price (Rs. t^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	B:C
T_1	60 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha	26391	37.53	2000	75066.66	48675.66	1.844
T_2	60 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha	26751	38.67	2000	77333.33	50582.33	1.891
T_3	80 kg N/ha + 30 kg K_2O/ha + 25 kg $ZnSo_4$/ha	26391	41.30	2000	82600	56209	2.130
T_4	80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha	26751	45.33	2000	90666.666	63915.66	2.389
T_5	60 kg N/ha + 30 kg K_2O/ha + 0.2% $ZnSo_4$/ha	25393	36.07	2000	72133.33	46740.33	1.841
T_6	60 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha	25753	37.73	2000	75466.66	49713.66	1.930
T_7	80 kg N/ha + 30 kg K_2O/ha + 0.2% $ZnSo_4$/ha	25393	39.43	2000	78866.66	53473.66	2.106
T_8	80 kg N/ha + 40 kg K_2O/ha + 0.2% $ZnSo_4$/ha	25753	42.83	2000	85666.66	59913.66	2.326
T_9	80 kg N/ha + 40 kg K_2O/ha – Control	25701	33.53	2000	67066.66	41365.66	1.609

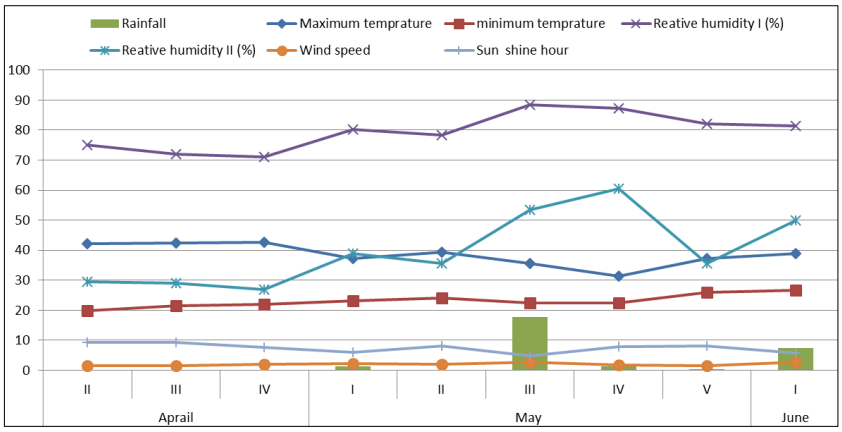

Fig 1: Mean weekly weather parameters and total rainfall during the cropping season *Zaid* 2021

Fig 2: Showing sampling site of crop research farm

Conclusion

It is concluded that for obtaining higher yield in Fodder Pearl Millet (*Pennisetum glaucum* L.), the treatment combination of T_4 (80 kg N/ha + 40 kg K_2O/ha + 25 kg $ZnSo_4$/ha) recorded significantly Higher fodder yield (45.33 t ha^{-1}), Gross Returns (90666 INR/ha), Net Returns (63915 INR/ha) and Benefit Cost Ratio (2.38). Because these findings are based on a single season, more trials may be required before they can be considered a recommendation.

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