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NUTRIENT MANAGEMENT IMPACTS ON GRAIN AND STOVER QUALITY AND NUTRIENT UPTAKE OF PEARL MILLET [*PENNISETUM GLAUCUM* (L) R.BR.] UNDER RAINFED CONDITION

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SUMMARY

A field experiment was carried out at Dryland Agriculture Research Farm of the Chaudhary Charan Singh Haryana Agricultural University, Hisar during *Kharif* season of 2019 to study the nutrient management impact on grain and stover quality and nutrient uptake of pearl millet [*Pennisetum glaucum* (L) R.Br.] under rainfed condition. The experiment consisted of thirteen nutrient management practices viz. T_1- control, T_2- 40:20 kg NP/ha, T_3- 50:25 kg NP/ha, T_4- 60:30 kg NP/ha, T_5- 40:20:10 kg NPK/ha, T_6- 50:25:12.5 kg NPK/ha, T_7- 60:30:15 kg NPK/ha, T_8- 40:20:10 kg NPK/ha + $ZnSO_4$@ 0.5% at 30 DAS, T_9- 50:25:12.5 kg NPK/ha + $ZnSO_4$@ 0.5% at 30 DAS, T_{10}- 60:30:15 kg NPK/ha + $ZnSO_4$@ 0.5% at 30 DAS, T_{11}- 40:20:10 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS, T_{12}- 50:25:12.5 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS and T_{13}- 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS was laid out in randomized block design with three replications. Results revealed that application of 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS enhanced grain and stover quality of pearl millet in terms of protein, iron, zinc content and protein yield under rainfed condition. The maximum N, P and K uptake by grain (28.66, 8.60 and 13.00 kg/ha, respectively) and stover (20.52, 3.20 and 62.07 kg/ha, respectively) of pearl millet was recorded by application of 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS among all the treatments. The total uptake of N (49.18 kg/ha), P (11.80 kg/ha) and K (75.07 kg/ha) was found highest with the application of 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS over rest of treatments.

Key words : NPK uptake, nutrient management, pearl millet**,** protein yield, rainfed

The livestock productivity in India is very less, which can be attributed to poor feed and fodder availability. India needs to feed 512 million livestock population, which is the largest in the world, from its 2.4% geographical area creating pressure on land and water resources. However, only 4.4% of the net cultivated area is under fodder cultivation in the country (Kumar and Chaplot, 2020). There lies a net deficit of green fodder (35.6%), dry fodder (10.95%) and concentrated feeds (44%) (IGFRI- Vision 2050). By 2050 this is expected to increase continuously to the tune of 1012 mt green fodder and 631 mt dry fodder (Ghosh *et al*., 2016). Due to unavailability of adequate amount of green fodder the livestock are feed with straws, husk and stover. Furthermore, increased population growth coupled with rapid urbanization necessitates proper residue management to fulfil livestock demands and increasing their production (Katoch *et al.,* 2017).

In India, area under grain pearl millet is about 6.93 million hectares with production of 8.61 million tonnes and national average productivity of 1243 kg/ha (Anonymous 2021a). In Haryana, the area under this crop is 4.2 lakh hectares with production and productivity of 6.9 lakh tonnes and 1609 kg/ha, respectively (Anonymous 2021b). Pearl millet is nutritionally better than many cereals and good source of protein having higher digestibility (12.1%), fat (5%), carbohydrate (69.4%) and minerals (2.3%). It is the most drought tolerant crop among cereals and millets. It is locally known as bajra whose fodder is used for livestock feeding, a basis of ration for a large bovine population that is regarded as the most critical component of providing stability in the risk prone crop-livestock farming system in water limited regions. It is a fast growing short duration crop which has high biomass production potential and mainly grown in arid and semi-arid regions where moisture is a limiting factor for crop growth. It is an ideal crop with high tillering ability, high dry matter production,

high protein content (10-12%) with excellent growth habit, high palatability and better nutritive value (Bind *et al*., 2015). Nitrogen and phosphorus is one of the basic plant nutrients essential for profuse growth. It increases vegetative growth of plant and herbage quality which is highly desirable for the forage yield and dry matter accumulation. Different nutrient management involves efficient use of inorganic fertilizers which can substantially enhance crop production, and also minimize environmental pollution. Balanced fertilization is necessary to increase productivity of pearl millet. Regular and judicious use of primary nutrients not only helps in raising good crop yield but can help farmers to gain higher profit. Keeping the above points in view, the present study was carried out under rainfed environment with better grain and stover quality to be recommended to the farmers.

MATERIALS AND METHODS

A field experiment was carried out at Dryland Agriculture Research Farm of the Chaudhary Charan Singh Haryana Agricultural University, Hisar during 2019 (20°-10' N, 75°46' E and 215.2 m above mean sea level). The experiment was laid out in randomized block design having 13 treatments with three replications. The treatments comprised of T_1- control, T_2- 40:20 kg NP/ha, T_3- 50:25 kg NP/ha, T_4- 60:30 kg NP/ha, T_5- 40:20:10 kg NPK/ha, T_6- 50:25:12.5 kg NPK/ha, T_7- 60:30:15 kg NPK/ha, T_8- 40:20:10 kg NPK/ha + $ZnSO_4$ @ 0.5% at 30 DAS, T_9- 50:25:12.5 kg NPK/ha + $ZnSO_4$ @ 0.5% at 30 DAS, T_{10}- 60:30:15 kg NPK/ha + $ZnSO_4$ @ 0.5% at 30 DAS, T_{11}- 40:20:10 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS, T_{12}- 50:25:12.5 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS and T_{13}- 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS. The sandy loam soil of the experimental field was low in organic carbon (0.33%), low in available nitrogen (135 kg/ha), medium in available phosphorus (14.20 kg/ha) and available potassium (240 kg/ha). Fertilizers were applied in the form of urea, DAP and MOP. Foliar application of Fe and Zn was done through iron sulphate and zinc sulphate. Full quantity of phosphorus and potash fertilizers was given at the time of sowing. Half amount of nitrogen was applied as basal dose and rest was given at 25 DAS when some amount of rainfall received after sowing. Certified seed of pearl millet hybrid (HHB 272) was sown by *kera* method with a row to row spacing of 45 cm using 5 kg seed ha^{-1}. Nitrogen, phosphorus and potassium contents were determined by Nessler's reagent method (Lindner, 1944), Vanadomolybdo phosphoric acid yellow colour method (Koening and Johnson, 1942) and flame photometric method (Jackson, 1973), respectively. Protein content of grain and stover was worked out by multiplying per cent nitrogen in grain and stover with a conversion factor of 6.25. Nutrient uptake by grain and stover were computed using the following formula :

$$\text{Nutrient uptake} = \frac{\text{Nutrient content in grain/stover x grain/stover yield (kg/ha)}}{100}$$

All the results were then analysed statistically for drawing conclusion using Analysis of Variance (ANOVA) procedure.

RESULTS AND DISCUSSION

Weather parameters

The data on rainfall was recorded by the rain guage located at the experimental site and other climatological data was collected at meteorological station of CCS Haryana Agricultural University, Hisar (Table 1). The total rainfall received during the crop growth period was 98.7, 104.2, 68.2, 17.3 mm in June, July, August and September, respectively. The maximum and minimum temperature ranged from 35.5-43.7 and 23.7-26.0ºC, respectively. The relative humidity varied from 55 to 93% in the morning to 17 to 73% in the evening. The average wind speed ranged from 3.8 to 8.8 km/hr. The bright sun shine hours ranged between 4.1 on a cloudy day to 9.9 on a clear day. Evaporation from open pan evaporimeter ranged between 3.7 to 9.6 mm/day.

Quality parameters of grain and stover

All the nutrient management treatments showed their significant superiority in the protein content of grain and stover over control, however, maximum protein content in grain (9.38 %) and stover (1.50 %) was found in T_{13} (60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS) which remained statistically at par with T_{10}, T_{12}, T_9, T_7 and T_4 (Table 2). Nutrient management treatments brought about significant variation in protein yield of grain and stover over control. Significantly higher protein yield from grain (179.25 kg/ha) and stover (75.09 kg/ha)

TABLE 1
Climatic data during crop season (June to Sept.) of the region during the study period

Parameters	Months			
	June	July	August	September
Rainfall (mm)	98.7	104.2	68.2	17.3
Max. Temp (ºC)	35.5-43.7	32.5-38.6	33.3-35.6	33.4-36.2
Min. Temp (ºC)	24.6-26.0	23.7-26.2	25.1-27.0	24.3-27.4
Bright sunshine hours	5.5-7.4	6.2-9.9	4.7-7.2	4.1-6.8
Wind speed (km/hr)	7.6-8.8	3.8-6.5	4.5-8.2	6.2-7.2
Evaporation (mm/day)	5.6-9.6	3.8-6.5	3.7-4.7	4.6-5.1
Relative humidity (%)				
Morning	55-77	74-93	86-89	83-89
Evening	17-44	56-73	56-70	49-59

were recorded with application of 60:30:15 kg NPK/ ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS (T_{13}) over rest of treatments and were at par with T_{12} and $T_{10.}$ These higher values may be attributed to higher nitrogen contents in grain and stover owing to improvement in plant available nitrogen in soil with application of increased level of fertilizers. It is well known fact that nitrogen in seed is directly responsible for higher protein content because it is a primary component of amino acid which constitutes the basis of protein. Similar findings were also reported by Gautam *et al*. (2020), Kumar *et al*. (2015). Application of both iron and zinc brought out significant increase in iron content in grain of pearl millet over control. Maximum iron content (33.81 ppm) was recorded in T_{13} (60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS) in which iron and zinc both were sprayed at 30 DAS of pearl millet over control (31.11 ppm) which was statistically at par with T_{12} and T_{11} treatments. All the nutrient management treatments significantly increased the Zn concentration in the grain of pearl millet as compared to control. Foliar spray of either Zn or combination of both Fe and Zn with different nutrition levels gave significantly higher Zn content in grain of pearl millet over rest of the treatments. T_{13} (60:30:15 kg NPK/ha + 0.5% $ZnSO_4$+0.5% $FeSO_4$ at 30 DAS) had significantly higher Zn content (13.33 ppm) being at par with T_8, T_9, T_{10}, T_{11} and T_{12} over other treatments. The increased concentration of Zn and Fe in grain of pearl millet might be due to the improvement in Zn and Fe uptake by plants as the foliar applied Zn and Fe are phloem mobile and can be easily translocated in to developing grains. The foliar applied $ZnSO_4$ and $FeSO_4$ are highly water soluble which allows for its greater and immediate uptake by plant leaves. The increased micronutrient concentration in grain of pearl millet with foliar application of Zn and Fe have been reported by Jadhav *et al.* (2011) and Reddy *et al.* (2016).

TABLE 2
Effect of nutrient management practices on grain and stover quality of pearl millet

Treatment	Grain			Stover		
	Protein content (%)	Protein yield (kg/ha)	Iron content (ppm)	Zinc content (ppm)	Protein content (%)	Protein yield (kg/ha)
T_1	8.23	85.26	31.11	11.65	1.32	53.23
T_2	8.70	120.58	32.32	12.31	1.39	60.89
T_3	8.89	133.35	32.39	12.39	1.42	64.05
T_4	9.06	146.04	32.46	12.43	1.45	68.38
T_5	8.72	123.03	32.35	12.38	1.39	62.00
T_6	8.93	142.07	32.46	12.42	1.43	65.72
T_7	9.19	157.97	32.76	12.49	1.47	70.57
T_8	8.81	135.67	32.39	13.15	1.41	64.05
T_9	9.11	153.14	32.59	13.21	1.46	68.60
T_{10}	9.36	170.25	32.73	13.29	1.50	73.57
T_{11}	8.98	147.27	33.68	13.17	1.44	66.97
T_{12}	9.19	163.21	33.75	13.26	1.47	70.54
T_{13}	9.38	179.25	33.81	13.33	1.50	75.09
SEm±	0.11	5.62	0.23	0.17	0.02	1.48
C. D. (P=0.05)	0.34	17.10	0.72	0.54	0.06	4.50

T_1- control, T_2- 40:20 kg NP/ha, T_3- 50:25 kg NP/ha, T_4- 60:30 kg NP/ha, T_5- 40:20:10 kg NPK/ha, T_6- 50:25:12.5 kg NPK/ha, T_7- 60:30:15 kg NPK/ha, T_8- 40:20:10 kg NPK/ha + $ZnSO_4$ @ 0.5% at 30 DAS, T_9- 50:25:12.5 kg NPK/ha + $ZnSO_4$ @ 0.5% at 30 DAS, T_{10}- 60:30:15 kg NPK/ha + $ZnSO_4$ @ 0.5% at 30 DAS, T_{11}- 40:20:10 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS, T_{12}- 50:25:12.5 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS and T_{13}- 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS.

Nutrient uptake by grain and stover

Significant improvements in nutrient uptakes by grain and stover and hence total uptake were observed with various nutrient management treatments (Table 3). Uptake of N was the result of N content in both grain and stover and their respective yields.

Application of 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS (T_{13}) had significantly higher uptake of N by grain and stover of pearl millet than rest of the treatments except T_{12} and T_{10} treatment where the difference was found non-significant. Uptake of P was the result of P content in both grain and stover and their respective yields. The uptake of P was significantly influenced by various nutrient management treatments over control. However, T_{13} (60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS) treatment recorded the highest P uptake than rest of the treatments except T_{12} and T_{10} treatment where the difference was found non-significant. Uptake of K was the result of K content in both grain and stover and their respective yields. The range of uptake by seed was between 4.76 to 13.00 kg K/ha among different treatments. The range of uptake by stover was between 36.70 to 62.07 kg K/ha among different treatments. The highest value was recorded in T_{13} (60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS) treatment and it was followed by $T_{10,}$ $T_{12,}$ $T_{9,}$ $T_{7,}$ $T_{11,}$ $T_{4,}$ $T_{6,}$ $T_{3,}$ $T_{8,}$ $T_{5,}$ $T_{2,}$ and T_1 treatments.

Application of 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS (T_{13}) recorded significantly higher total N, P and K uptakes by the pearl millet crop (49.18, 11.80 and 75.07 kg/ha, respectively) over rest of treatments except T_{12} and T_{10} treatments which remained at par with each other. The total N uptake with application of 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS (T_{13}) was to the tune of 12.1, 26.8, 6.4, 20.5, 37.4, 14.7, 31.8, 51.1, 23.3, 37.6, 53.9 and 123.5 per cent over $T_{12,}$ $T_{11,}$ $T_{10,}$ $T_{9,}$ $T_{8,}$ $T_{7,}$ $T_{6,}$ $T_{5,}$ $T_{4,}$ $T_{3,}$ T_2 and $T_{1,}$ respectively. Similarly, total P uptake with this fertility level was higher by 15.6, 49.9, 14.9, 39.5, 66.4, 29.7, 57.8, 83.8, 38.0, 55.5, 83.2 and 151.1 per cent and K uptake was higher by 7.1, 15.4, 5.7, 13.2, 28.8, 13.8, 25.6, 47.0, 19.0, 28.7, 51.0 and 81.1 per cent than $T_{12,}$ $T_{11,}$ $T_{10,}$ $T_{9,}$ $T_{8,}$ $T_{7,}$ $T_{6,}$ $T_{5,}$ $T_{4,\ T3,}$ T_2 and $T_{1,}$ respectively. Increased grain and stover yields and nutrient (N, P and K) contents in plant were the reason for this increased nutrient uptake due to increase in fertility level. Higher concentration of nutrients in plant available form in the plant root zone caused higher N, P and K extraction resulting greater uptake of nutrients. Corroborative findings have also been reported by Meena and Gautam (2005) and Singh *et al*. (2006).

CONCLUSION

The pearl millet stover is a potential alternative to bridge the deficit of dry fodder under rainfed areas of the country. From this study, it can be concluded that application of 60:30:15 kg NPK/ha + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ at 30 DAS in pearl millet crop will provide better grain and stover quality and thus, can be recommended to the farmers in the rainfed condition of sandy loam soils in arid/semi-arid regions.

TABLE 3
Effect of nutrient management practices on nutrient uptake by pearl millet

Treatment	Nutrient uptake (kg/ha)								
	Nitrogen			Phosphorus			Potassium		
	Grain	Stover	Total	Grain	Stover	Total	Grain	Stover	Total
T_1	13.57	8.43	22.00	3.01	1.69	4.70	4.76	36.70	41.46
T_2	19.26	12.70	31.96	4.30	2.14	6.44	6.79	42.93	49.72
T_3	21.30	14.43	35.73	5.25	2.34	7.59	7.80	50.52	58.32
T_4	23.37	16.51	39.88	5.96	2.59	8.55	8.87	54.23	63.10
T_5	19.61	12.94	32.55	4.23	2.19	6.42	6.91	44.16	51.07
T_6	22.59	14.71	37.30	5.09	2.39	7.48	8.27	51.48	59.75
T_7	25.27	17.60	42.87	6.36	2.74	9.10	9.80	56.17	65.97
T_8	21.71	14.08	35.79	4.77	2.32	7.09	7.85	50.43	58.28
T_9	24.37	16.45	40.82	5.88	2.58	8.46	9.92	56.39	66.31
T_{10}	27.10	19.13	46.23	7.30	2.97	10.27	11.65	59.35	71.00
T_{11}	23.45	15.35	38.80	5.41	2.46	7.87	9.68	55.35	65.03
T_{12}	26.11	17.75	43.86	7.28	2.93	10.21	11.54	58.55	70.09
T_{13}	28.66	20.52	49.18	8.60	3.20	11.80	13.00	62.07	75.07
SEm±	0.85	0.92	1.76	0.45	0.10	0.53	0.49	1.18	1.66
C. D. (P=0.05)	2.60	2.82	5.41	1.36	0.30	1.64	1.50	3.60	5.12

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