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SHORT COMMUNICATION

EFFECT OF DIFFERENT PRODUCTION FACTORS ON PRODUCTIVITY, NPK UPTAKE AND QUALITY OF PEARL MILLET [*PENNISETUM GLAUCUM* (L.) R. BR.]

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SUMMARY

The experiment was conducted at Hisar during **kharif** season of 2011 with an objective to see the effect of different production factors on the NPK content and their uptake as well as quality of pearl millet in terms of protein content. Eight different treatments i. e. T_1–Full package of practices [RDF (125 kg N+62.5 kg P_2O_5/ha)+$ZnSO_4$ @ 25 kg/ha+biofertilizer *biomix* (*Azospirillum*+PSB)+thinning and gap filling+weeding and hoeing (20 and 35 DAS)+irrigation], T_2 : T_1–RDF (N and P), T_3 : T_1–$ZnSO_4$ @ 25 kg/ha, T_4 : T_1–*Biomix*, T_5 : T_1–Thinning and gap filling (19 DAS), T_6 : T_1–Weeding and hoeing (20 and 35 DAS), T_7 : T_1–Irrigation and T_8 : Control were laid out in randomized block design with three replications. Non-adoption of individual factors recommended dose of fertilizer (T_2), $ZnSO_4$ (T_3), biomix (T_4), thinning and gap filling (T_5), weeding and hoeing (T_6) and irrigation (T_7) caused a decrease in grain yield by 32.8, 12.2, 7.7, 16.7, 30.1, 20.2 and 48.0 (control), per cent and stover yield by 22.7, 7.9, 4.0, 10.0, 18.9, 16.0 and 32.2 per cent (control) than T_1 (FPP), respectively. Among all the treatments, T_1 recorded significantly higher N, P, K and protein contents and their uptake in grain as well as in stover. Nitrogen content in grain increased significantly from 1.66 per cent under control (T_8) to 1.84 per cent in T_1 and followed by T_4 (1.82%), T_3 (1.82%) and T_5 (1.79%). The phosphorus content also increased from 0.24 per cent (T_8) to 0.31 per cent (T_1) in grain, whereas potassium content in grain was lowest under T_8 (0.53%) and highest under T_1 (0.60%) treatment. The total N, P and K uptake was found highest in T_1 (129.78, 26.47 and 308.77 kg/ha, respectively). The protein content in grain also significantly increased from 10.4 per cent (T_8) to 11.5 per cent in T_1 and followed by T_4 (11.4%) and T_3 (11.3%) treatments. The present study clearly indicated that non-adoption of individual factors i. e. recommended dose of N & P and weeding and hoeing caused a maximum decrease in grain yield by 32.8 and 30.1 per cent and stover yield by 22.7 and 18.9 per cent than full package of practices, respectively. The adoption of full package of practices resulted in the higher N, P, K and content (%) and their uptake (kg/ha) in grain and stover.

Key words : N, P, K, protein content, yield, pearl millet

In India, area under grain pearl millet is about 7.95 million hectares with production of 8.80 million tonnes and national average productivity of 1106 kg/ha (Anonymous, 2013-14). While in Haryana, the area under this crop is 4.04 lakh hectares with production and productivity of 8.31 lakh tonnes and 2057 kg/ha, respectively (Anonymous, 2013-14). Productivity of any crop depends on so many production factors like application of major and micronutrients through organic, inorganic or biofertilizers, thinning, gap filling, weeding, hoeing, irrigation management and every factor has significant role towards productivity, quality and nutrient aspects of the crop. Non-adoption of improved package of practices recommended for specific zone by the farmers is one of the major causes of low yield of pearl millet crop. Therefore, it is necessary to find out the contribution of individual or combination of production factors on the nutrients and quality aspects of pearl millet. But very less information is available on nutrient content (NPK) and their uptake as well as with respect to protein

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content in the latest high yielding hybrids of pearl millet as affected by individual or combination of production factors. Keeping the above points in view, the present study was carried out.

The experiment was conducted at Research Farm Area of the Department of Agronomy, CCS Haryana Agricultural University, Hisar during **kharif** season of 2011. Eight treatments viz., T_1–Full package of practices [RDF (125 kg N+62.5 kg P_2O_5/ha)+$ZnSO_4$ @ 25 kg/ha+biofertilizer *biomix* (*Azospirillum*+ PSB)+thinning and gap filling+weeding and hoeing (20 and 35 DAS)+one irrigation], T_2 : T_1-RDF (N and P), T_3 : T_1–$ZnSO_4$ @ 25 kg/ha, T_4 : T_1–*Biomix*, T_5 : T_1–Thinning and gap filling (19 DAS), T_6 : T_1–Weeding and hoeing (20 and 35 DAS), T_7 : T_1–Irrigation and T_8 : Control were tested in randomized block design with three replications. The soil was sandy loam in texture with slight alkaline in pH (8.5), medium in organic carbon (0.42%), medium in P (16 kg/ha) and high in potash (320 kg/ha). The crop was planted on 20 July 2011 at 45 cm row spacing and plant to plant spacing was maintained at 10-15 cm. The total rainfall received during the crop growth period was 247.5 mm. One irrigation was applied on 6 August 2011 among all the treatments except in the treatment T_7. 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 was worked out by multiplying per cent nitrogen in grain with a conversion factor of 6.25.

Pearl millet grain yield was maximum under the full package of practice (T_1) with a grain yield of 3444 kg/ha (Table 1) and it was statistically at par with T_4 (3178 kg/ha). T_1 treatment was significantly superior in terms of grain yield/ha compared to rest of the treatments as it had received full package of practices. The grain yield in T_1, T_2, T_3, T_4, T_5, T_6 and T_7 treatments was higher by 92.4, 29.2, 68.9, 77.5, 60.3, 34.4 and 53.3 per cent, respectively, than control (T_8). The grain yield in T_2, T_3, T_4, T_5, T_6, T_7 and T_8 treatments decreased by 32.8, 12.2, 7.7, 16.7, 30.1, 20.2 and 48.0 per cent, respectively, compared to T_1. It means that contribution of recommended dose of N and P in pearl millet productivity was 32.8 per cent, 12.2 per cent by $ZnSO_4$, 7.7 per cent by *biomix*, 16.7 per cent by thinning and gap filling, 30.1 per cent by weed control and 20.2 per cent by one irrigation. This increase in grain yield may be due to the application of balanced fertilizer, adequate water supply, seed treatment with biofertilizer and weed control thereby resulting in better root growth and development, more nutrient uptake and higher dry matter accumulation/plant and its subsequent translocation to the developing panicles/earhead. Similar results were also reported by Singh *et al*. (2006), Rajput (2006), Rani (2007) and Neelam (2009). In terms of stover yield, the T_1 treatment produced significantly more in stover yield /ha compared to rest of the treatments. The stover yield in T_1, T_2, T_3, T_4, T_5, T_6 and T_7 treatments was higher by 47.4, 14.0, 35.7, 41.5, 32.7, 19.5 and 23.8 per cent, respectively, over control. The stover yield of T_2, T_3, T_4, T_5, T_6, T_7 and T_8 treatments was lower by 22.7, 7.9, 4.0, 10.0, 18.9, 16.0 and 32.2 per cent, respectively, over T_1. This increase in the stover yield of pearl millet may be attributed to the increase in plant height, leaf area and dry matter production.

TABLE 1
Effect of different treatments on productivity, nitrogen content and its uptake

Treatment	Grain yield (kg/ha)	Stover yield (kg/ha)	Nitrogen content (%)		Nitrogen uptake (kg/ha)		Total uptake (kg/ha)
			Grain	Stover	Grain	Stover	
T_1 : FPP	3444	10697	1.84	0.62	63.44	66.35	129.78
T_2 : T_1–RDF	2315	8271	1.70	0.50	39.23	41.02	80.26
T_3 : T_1–$ZnSO_4$ @ 25 kg/ha	3025	9846	1.80	0.58	54.62	57.22	111.85
T_4 : T_1–Biomix	3178	10265	1.82	0.61	57.90	62.58	120.49
T_5 : T_1–Thinning and gap filling	2870	9629	1.79	0.56	51.31	54.26	105.57
T_6 : T_1–Weeding and hoeing	2407	8673	1.75	0.53	42.20	45.96	88.16
T_7 : T_1–Irrigation	2747	8981	1.77	0.55	48.68	49.41	98.10
T_8 : Control	1790	7253	1.66	0.48	29.74	34.66	64.41
S. Em±	106	215	0.03	0.02	1.98	2.96	3.63
C. D. (P=0.05)	326	657	0.09	0.07	6.06	9.06	11.11

Among treatments, nitrogen content in grain of pearl millet was variable (Table 1). Nitrogen content in grain varied from 1.66 to 1.84 per cent among different treatments and T_1 treatment had significantly higher values of nitrogen content in grain as compared to T_2, T_6 and T_8 treatments. Nitrogen uptake by grain varied from 29.74 kg/ha (T_8) to 63.44 kg/ha (T_1) and T_1 treatment was significantly superior in nitrogen uptake than other treatments except T_4. Higher nitrogen content in stover was found in T_1 (0.62%) and it was followed by T_4 (0.61%), T_3 (0.58%) and T_5 (0.56%) treatments. Uptake of N was the result of N content in stover and yield of the crop. T_1 treatment had significantly higher uptake of N than rest of the treatments except T_4 treatment where the difference was found non-significant. As total N uptake of pearl millet crop was governed by N content in both grain and stover and their respective yields. The range of uptake was between 64.41 to 129.78 kg N/ha among different treatments. The highest value was recorded in T_1 treatment and it was followed by T_4, T_3 and T_5 treatments.

Data pertaining to P content in grain are presented in Table 2. Treatment T_1 (0.31%) had maximum P content and it was followed by T_4, T_3 and T_5 treatments, respectively. The data related to P uptake in grain revealed that maximum P uptake was in T_1 (10.69 kg/ha) and it was statistically at par with treatment T_4 (9.62 kg/ha) and later was statistically at par with T_3 (8.78 kg/ha) and T_5 (8.06 kg/ha) treatments. P content in stover was significantly inferior in T_8 than rest of the treatments except T_2 where difference was non-significant. Maximum P uptake was in T_1 (15.78 kg/ha)

TABLE 2
Effect of different treatments on phosphorus content and its uptake

Treatment	Phosphorus content (%)		Phosphorus uptake (kg/ha)		Total uptake (kg/ha)
	Grain	Stover	Grain	Stover	
T_1 : FPP	0.31	0.15	10.69	15.78	26.47
T_2 : T_1–RDF	0.25	0.12	5.87	9.77	15.65
T_3 : T_1–$ZnSO_4$ @ 25 kg/ha	0.29	0.14	8.78	13.95	22.73
T_4 : T_1–Biomix	0.30	0.15	9.62	14.95	24.58
T_5 : T_1–Thinning and gap filling	0.28	0.14	8.06	13.30	21.35
T_6 : T_1–Weeding and hoeing	0.26	0.13	6.28	11.27	17.55
T_7 : T_1–Irrigation	0.27	0.13	7.54	11.80	19.36
T_8 : Control	0.24	0.11	4.30	8.14	12.45
S. Em±	0.01	0.01	0.51	0.44	0.71
C. D. (P=0.05)	0.04	0.02	1.57	1.36	2.16

TABLE 3
Effect of different treatments on potassium content and its uptake

Treatment	Potassium content (%)		Potassium uptake (kg/ha)		Total uptake (kg/ha)
	Grain	Stover	Grain	Stover	
T_1 : FPP	0.60	2.74	20.71	288.06	308.77
T_2 : T_1–RDF	0.54	2.63	12.56	228.05	240.61
T_3 : T_1–$ZnSO_4$ @ 25 kg/ha	0.58	2.70	17.64	266.36	284.00
T_4 : T_1–Biomix	0.59	2.72	18.85	272.60	291.45
T_5 : T_1–Thinning and gap filling	0.57	2.69	16.46	263.08	279.53
T_6 : T_1–Weeding and hoeing	0.55	2.67	13.30	244.09	257.39
T_7 : T_1–Irrigation	0.56	2.68	15.42	251.30	266.72
T_8 : Control	0.53	2.54	9.60	207.38	216.98
S. Em±	0.01	0.03	0.63	10.90	11.16
C. D. (P=0.05)	0.03	0.09	1.92	33.95	34.19

and it was statistically at par with T_4 (14.95 kg/ha) but significantly superior to other treatments. Total uptake of P in the whole plant followed the trend of grain and stover uptake where maximum uptake was in T_1 and minimum in T_8 treatment. Phosphorus especially under adequate environment is known to increase the cation exchange capacity of roots and enhance P absorption by crop plants thereby improving the crop yield and also the total P uptake.

Potassium content in grain varied from 0.53 to 0.60 per cent (Table 3). T_1 recorded significantly higher potassium content in grain compared to rest of the treatments except T_4 and T_3 where difference was non significant. Potassium uptake by grain varied from 9.60 kg/ha (T_8) to 20.71 kg/ha (T_1) and later treatment was significantly superior to all other treatments except T_4 (18.85 kg/ha). Maximum potassium content in stover was found in T_1 (2.74%) which was followed by T_4 (2.72%), T_3 (2.69%) and T_5 (2.68%). Maximum total K uptake was in T_1 (288.06 kg/ha) and it was statistically at par with T_4 (272.61 kg/ha), T_3 (265.43 kg/ha) and T_5 (262.60 kg/ha) but significantly superior to remaining treatments. Nitrogen and phosphorus especially under adequate water supply are known to increase the cation exchange capacity of roots and enhance N, P and K absorption (Elgabaly, 1962) by crop plants. Corroborative findings have also been reported by Rajput (2006) and Rani (2007).

Protein Content (%) and its Yield (kg/ha)

The data presented in Table 4 reveal that highest protein content (11.5%) in grain was recorded in treatment T_1 which was significantly superior to T_8 and T_2 treatments. The highest protein yield in grain was recorded in treatment T_1 (396.5 kg/ha) which was significantly superior to rest of treatments. The lowest protein yield in grain was observed in treatment T_8 (185.9 kg/ha). Nitrogen improved the protein content in grain of pearl millet due to utilization of photosynthesis in protein synthesis and its translocation to grain. Similar findings have been reported by Shivaran and Pareek (2001) and Neelam (2009).

The present study clearly indicated that adoption of all the production factors i. e. RDF (125 kg N+62.5 kg P_2O_5/ha)+$ZnSO_4$ @ 25 kg/ha+biofertilizer *biomix* (*Azospirillum*+PSB)+thinning and gap filling+weeding and hoeing (20 and 35 DAS)+irrigation resulted in the higher N, P and K content (%) and their uptake and protein yield (kg/ha) in grain and stover.

TABLE 4
Effect of different treatments on protein content in grain and its yield

Treatment	Protein content (%)	Protein yield (kg/ha)
T_1 : FPP	11.5	396.5
T_2 : T_1–RDF	10.6	245.2
T_3 : T_1–$ZnSO_4$ @ 25 kg/ha	11.3	341.4
T_4 : T_1–Biomix	11.4	361.9
T_5 : T_1–Thinning and gap filling	11.2	320.7
T_6 : T_1–Weeding and hoeing	11.0	263.7
T_7 : T_1–Irrigation	11.1	304.3
T_8 : Control	10.4	185.9
S. Em±	0.19	12.4
C. D. (P=0.05)	0.56	37.9

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