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Effect of foliar nutrition on nutrient content and uptake in hybrid pearl millet (*Pennisetum glaucum* (L). R.Br.)

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Abstract
A field experiment was conducted at Agronomy farm, of S.K.N. College of Agriculture, Jobner (Rajasthan) during *kharif* 2020 on loamy sand soil, which consist ten treatments of foliar nutrition and was tested in randomized block design with three replications. Results indicated that application of RDF+ DAP 2% spray at FI, RDF + MOP 2% spray at FI, RDF+ urea 2% spray at FI, RDF + Fe chelate 0.5% spray at FI, RDF + Zn chelate 0.5% spray at FI and RDF + B chelate 0.5% spray at FI remaining at par with each other significantly increased nitrogen, phosphorus and potassium content in grain and stover were significantly increased due to application of RDF+ DAP 2% spray at FI. However, zinc, content in grain and stover was significantly increased due to application of RDF+ Zn chelate 0.5% spray at FI, iron content in grain and stover was maximum in RDF+ Fe chelate 0.5% spray at FI and boron content in grain and stover in RDF+ B chelate 0.5% spray at FI and nitrogen, phosphorus, potassium, zinc, iron and zinc uptake by grain and stover of hybrid pearl millet were significantly increased due to application of RDF+ DAP 2% spray at FI.

Keywords: Pearl millet, nitrogen, phosphorus and micronutrient

Introduction
Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is one of the most important staple food crop of majority of poor and small land holders in Asia and Africa. It is also consumed as feed and fodder for livestock. India accounts for half of global millet production in the country. It is the sixth most important cereal crop in the world next to wheat, rice, maize, barley and sorghum. In India, pearl millet is the fourth most widely cultivated food crop after rice, wheat and maize. Pearl millet has a special health beneficial property for people suffering from life style diseases like diabetes, obesity etc. Nutrition value of pearl millet is better than wheat, rice, maize and sorghum. It is good source of energy, carbohydrate, fat (5-7%), ash, dietary fibre (1.2 g/100 g), protein (9-13%), antioxidant such as coumaric acids with better digestibility. Pearl millet has higher contents of nutrients such as iron, zinc, calcium, magnesium, copper, manganese, phosphorus, folic acid and riboflavin.

Foliar nutrition is a method of feeding plants by applying liquid fertilizers directly to their leaves. Plants are able to absorb essential elements through their bark. Foliar uptake is a means of rapid nutrient supply, especially when soil nutrient availability or root activity is reduced. Quick recovery from N deficiency in dry farming areas where soil nutrient is a constraint. Nitrogen is deficient in most of the Indian soils particularly the light textured ones which is one of the basic plant nutrient. N is involved in the formation of proteins, nucleic acids, growth hormones and vitamins and is an integral part of chlorophyll. An adequate supply of nitrogen is associated with vigorous vegetative growth and dark green colour. Phosphorus is known to stimulate extensive root system, thereby, enabling the plant to extract moisture and mineral nutrients optimally. Phosphorus plays a vital role in increasing crop yield because it improves crop quality. It also plays a key role in formation of energy rich phosphate bonds like adenosine triphosphate (ATP), phospholipids and major part of nucleus of the cells where, it is involved in organization of cell and transfer hereditary characteristics. Iron is an essential micronutrient for all living organisms and it plays critical role in metabolic processes such as DNA synthesis, respiration photosynthesis. In plants, iron is involved in the synthesis of chlorophyll and it is essential for the maintenance of chloroplast structure and function. Zinc is one of the eight essential micronutrients. It is needed by plants in small amounts, but yet crucial to plant development. In plant, Zinc is a key constituent of many enzymes and proteins.

It plays an important role in a wide range of processes, such as growth hormone production and internode elongation. In India, Zn is one of the multi-nutrient deficiencies causing poor crop yields. Zinc deficiency in Indian soils is expected to increase from 42% in 1970 to 63% by 2025 due to continuous depletion of soil fertility (Singh 2011) [16]. It is the most widespread micronutrient deficiency around the world and causes large losses in crop production and crop quality (Shorrocks 1997) [15]. Boron deficiency affects vegetative and reproductive growth of plants, resulting in inhibition of cell expansion, death of the meristem, and reduced fertility (Marschner, 1995) [7]. Plants contain boron both in a water-soluble and insoluble form.

Material and Method

This experiment was conducted at Agronomy Farm, S.K.N. College of Agriculture, Jobner (Rajasthan) during *kharif*, 2020. The Jobner is situated 45 km west of Jaipur at 26°05′ N-latitude and 75°28′ E-longitude and at an altitude of 427 metres above mean sea level. The region falls under Agroclimatic zone IIIa (Semi-Arid Eastern Plains Zone) of Rajasthan. The field experiment comprised of 10 treatments involving control, RDF, RDF+ Water spray, RDF+Urea 2% spray at FI, RDF+ DAP 2% spray at FI, RDF+MOP 2% spray at FI, 19:19:19 (N:P:K) 2% spray at FI, RDF+ Boron chelate 0.5% spray at FI, RDF + zinc chelate 0.5% spray at FI, RDF+ Iron chelate 0.5% spray at FI. The experiment was laid out in Randomized Block Design with four replications. In treatment RDF through fertilizer, half dose of nitrogen and full dose of phosphatic fertilizers was drilled as per plan through urea and DAP at the time of sowing and remaining half dose of urea was applied as top dressing in split. The recommended dose of fertilizer is 65:40:0. The foliar spray was done at flowering initiation as par treatments. Seeds of the hybrid bajra variety, RHB-173 were sown on 11th July, 2020 in rows spaced at 45 cm apart at the depth of 4-5 cm with the help of 'kera' method using a seed rate of 4 kg/ha.

Result and Discussion

Nutrient content

A perusal of data (Table 1) reveals that there was a significant increase in N, P and K content in grain and stover due to application of different foliar nutrition over control. Application of RDF+ DAP 2% spray at FI, RDF + MOP 2% spray at FI, RDF+ urea 2% spray at FI, RDF + Fe chelate 0.5% spray at FI, RDF + Zn chelate 0.5% spray at FI and RDF + B chelate 0.5% spray at FI being at par with each other recorded significantly higher nitrogen concentration (1.82 and 0.582%), phosphorus concentration (0.286 and 0.145%) and potassium concentration (0.579 and 1.95%) in grain and stover of hybrid pearl millet over control.

It is evident from data (Table 2) that application of foliar nutrition significantly increased the zinc, boron and iron content in grain and stover of hybrid pearl millet wherein application of RDF+Zn chelate 0.5% spray recorded the maximum zinc content of 35.85 ppm in grain and 25.64 ppm in stover over control, 19:19:19 (NPK) 2% spray at FI, RDF + water and RDF, respectively. However, it remained at par with MOP2% spray at FI, RDF+ urea 2% spray at FI, RDF + Fe chelate 0.5% spray at FI and RDF + B chelate 0.5% spray at FI with respect to Zn content of hybrid pearl millet. Application of RDF+ boron 0.5% spray, RDF + MOP 2% spray at FI, RDF+ DAP 2% spray, RDF+ urea 2% spray, RDF + Fe chelate 0.5% spray and RDF + Zn chelate 0.5% spray remained at par with each other gave significantly maximum boron content in both character. Application of RDF+ Fe chelate 0.5% spray at FI, RDF + urea 2% spray at FI, RDF+ DAP 2% spray at FI, RDF+ Zn chelate 0.5% spray at FI, RDF+ B chelate 0.5% spray at FI and RDF + MOP 2% spray at FI being at par with each other gave significantly maximum iron content in both (grain and stover).

T1: control, T2: RDF, T3: RDF+ Water spray, T4: RDF+Urea 2% spray at FI, T5: RDF+ DAP 2% spray at FI, T6: RDF+MOP 2% spray at FI, T7: 19:19:19 (N:P:K) 2% spray at FI, T8: RDF+ Boron chelate 0.5% spray at FI, T9: RDF + zinc chelate0.5% spray at FI, T10: RDF+ Iron chelate 0.5% spray at FI.

Uptake

It is evident from data (Table 3) that treatments of foliar nutrition significantly increased N,P and K uptake by grain and stover of hybrid pearl millet over control.

Application of RDF+ DAP 2% spray at FI, RDF + MOP 2% spray at FI, RDF + urea 2% spray at FI, RDF + Fe 2% spray at FI, RDF + Zn 2% spray at FI and RDF + boron 2% spray at FI being at par with each other gave significantly higher N,P and K uptake. Application of RDF+ DAP 2% spray at FI, RDF+MOP 2% spray at FI, RDF+ urea 2% spray at FI, RDF+Fe 0.5% spray at FI, RDF+ Zn 0.5% spray at FI and RDF+B 0.5% spray at FI remained at par with each other and gave significantly higher phosphorus uptake indicating an increase of 79.1, 76.5, 71.3, 56.4, 55.6 and 53.0 per cent by grain and 96.0, 93.7, 87.3, 69.8, 66.9 and 63.3 per cent by stover, respectively, over control. Similar results were also reported by Karelia (1990) [6], Sharma (1992) [14], Narendra *et al.* (1993) [9], Basauaraja *et al*. (1995) [2], Arya and Singh (2000) [1] and Parihar (2002) and Kadivala *et al*. (2019) [5] in pear millet.

Data (Table 4) reveals that foliar application of different nutrition significantly increased the Zn, B and Fe uptake by grain and stover of hybrid pearl millet.

Application of RDF+ MOP 2% spray at FI, RDF+ urea 2% spray at FI, RDF+ DAP 2% spray at FI, RDF+ Zn 0.5% spray at FI, RDF+ Fe 0.5% spray at FI and RDF+ B 0.5% spray at FI being at par with each other gave significantly higher Zn, B and Fe uptake over control. These results confirm the findings of Meena *et al*. (2005) [8] and Gunes and Inal (2008) [4] in pulses and Sumeriya *et al*. (2005) [17] and Sammauria and Yadav (2010) in pearl millet.

Protein content

Protein content of hybrid pearl millet grain was significantly affected due to different foliar nutrition. An application of RDF+ DAP 2% spray increased the protein content in grain by 11.4 per cent over control but remains at par with RDF + MOP 2% spray at FI, RDF + urea 2% spray at FI, RDF + Fe 2% spray at FI, RDF + Zn 2% spray at FI and RDF + boron 2% spray at FI and RDF + water spray. The increase in protein content of pearl millet due to application of zinc has also been reported by Dwivedi *et al.* (2001) and Shanmugasundaram and Savithri (2006) and Puniya *et al.* (2014) in moth bean.

Table 1: Effect of foliar nutrition on N, P and K content in grain and stover and protein content in grain of pearl millet

Treatments	N content (%)		P content (%)		K content (%)		Protein content in grain
	Grain	Stover	Grain	Stover	Grain	Stover	
T1	1.48	0.411	0.249	0.113	0.513	1.73	9.25
T2	1.68	0.515	0.266	0.125	0.55	1.84	10.5
T3	1.74	0.538	0.269	0.128	0.553	1.88	10.88
T4	1.8	0.565	0.28	0.142	0.575	1.91	11.25
T5	1.82	0.581	0.286	0.145	0.58	1.95	11.38
T6	1.81	0.571	0.283	0.144	0.579	1.92	11.31
T7	1.66	0.513	0.266	0.13	0.555	1.82	10.38
T8	1.74	0.54	0.274	0.136	0.569	1.83	10.88
T9	1.75	0.549	0.277	0.138	0.576	1.85	10.94
T10	1.77	0.554	0.278	0.14	0.577	1.87	11.06
S.Em+	0.04	0.015	0.005	0.005	0.008	0.03	0.3
CD (P=0.05)	0.13	0.044	0.016	0.013	0.022	0.083	0.88

T1: control, T2: RDF, T3: RDF+ Water spray, T4: RDF+Urea 2% spray at FI, T5: RDF+ DAP 2% spray at FI, T6: RDF+MOP 2% spray at FI, T7: 19:19:19 (N:P:K) 2% spray at FI, T8: RDF+ Boron chelate 0.5% spray at FI, T9: RDF + zinc chelate0.5% spray at FI, T10: RDF+ Iron chelate 0.5% spray at FI

Table 2: Effect of foliar nutrition on Zn, B and Fe content in grain and stover of pearl millet

Treatments	Zn content (ppm)		B content (ppm)		Fe content (ppm)	
	Grain	Stover	Grain	Stover	Grain	Stover
T1	28.81	20.8	2.22	5.18	40.15	88.92
T2	30.84	22.41	2.48	5.68	42.35	98.52
T3	30.88	22.75	2.5	5.72	43.48	99.34
T4	34.18	24.95	2.65	6.1	47.11	104.32
T5	32.82	24.25	2.72	6.24	47.36	104.84
T6	34.92	25.13	2.73	6.22	46.04	103.68
T7	30.35	22.45	2.52	5.88	43.01	99.95
T8	32.45	23.95	2.74	6.27	46.41	103
T9	35.85	25.64	2.56	5.9	46.9	103.65
T10	33.51	24.95	2.58	5.96	48.65	106.84
S.Em+	0.82	0.48	0.07	0.11	1.02	1.54
CD (P=0.05)	2.52	1.39	0.19	0.32	2.93	4.45

Table 3: Effect of foliar nutrition on N, P and K uptake by grain and stover of pearl millet

Treatments	N uptake (kg/ha)		P uptake (kg/ha)		K uptake (kg/ha)	
	Grain	Stover	Grain	Stover	Grain	Stover
T1	22.79	17.46	3.83	4.80	7.90	73.49
T2	35.18	28.92	5.57	7.02	11.52	103.32
T3	36.73	30.99	5.68	7.37	11.67	108.31
T4	42.16	35.76	6.56	8.99	13.47	120.88
T5	43.64	37.71	6.86	9.41	13.91	126.57
T6	43.20	36.88	6.76	9.30	13.82	124.01
T7	32.17	26.80	5.16	6.79	10.76	95.10
T8	37.19	31.13	5.86	7.84	12.16	105.50
T9	37.63	31.85	5.96	8.01	12.38	107.32
T10	38.16	32.25	5.99	8.15	12.44	108.87
S.Em+	1.95	1.30	0.34	0.56	0.58	5.58
CD (P=0.05)	5.62	3.77	1.05	1.65	1.67	16.11

Table 4: Effect of foliar nutrition on Zn, B and Fe uptake by grain and stover of pearl millet

Treatments	Zn uptake (g/ha)		B uptake (g/ha)		Fe uptake (g/ha)	
	Grain	Stover	Grain	Stover	Grain	Stover
T1	44.37	88.36	3.42	22.00	61.83	377.73
T2	64.58	125.83	5.19	31.89	88.68	553.19
T3	65.19	131.06	5.28	32.95	91.79	572.30
T4	80.05	157.91	6.21	38.61	110.33	660.24
T5	78.70	157.41	6.52	40.50	113.57	680.52
T6	83.35	162.31	6.50	40.17	109.90	669.67
T7	58.82	117.30	4.88	30.72	83.35	522.24
T8	69.35	138.07	5.86	36.15	99.19	593.80
T9	77.08	148.74	5.50	34.23	100.84	601.27
T10	72.25	145.26	5.56	34.70	104.89	622.02
S.Em+	3.81	7.60	0.24	1.54	4.43	25.97
CD (P=0.05)	10.99	21.95	0.69	4.44	12.79	75.00

Conclusion

It is concluded that application RDF+ DAP 2% spray, RDF + MOP 2% spray and RDF + urea 2% spray were equally effective in increasing content and uptake of nutrients in grain and stover of hybrid pearl millet.

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