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SUSTAINING PRODUCTIVITY OF HIGH YIELDING HYBRIDS OF PEARLMILLET THROUGH ZINC

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SUMMARY

A field experiment was conducted with nine treatment combinations [three advance hybrids; HHB 94, HHB 197 and HHB 223 and three levels of $ZnSO_4$ i. e. control (T_1), application of 10 kg $ZnSO_4$ as basal + 0.5 per cent as foliar spray 30 days after sowing of the crop (T_2) and application of 20 kg $ZnSO_4$/ha as basal (T_3)] in factorial randomized block design with three replications during **kharif** seasons of 2010 and 2011 in the Bajra Section, Department of Genetics & Plant Breeding, CCS Haryana Agricultural University, Hisar. The hybrids showed variable response to zinc treatments. The hybrid HHB 94 took 6 to 8 more days for 50 per cent flowering than HHB 223 and HHB 197. The increase in the green fodder yield was to the tune of 11.1 and 18.8 per cent in HHB 94, 9.6 and 17.9 per cent in HHB 197 and 10.2 and 17.6 per cent in HHB 223, respectively, with the T_2 and T_3 treatments, respectively, over the control. On mean basis, HHB 223 showed 23.4, 18.8, 18.1 and 13.2 per cent more earhead, grain, green fodder and dry fodder yields, respectively, than HHB 94 and 5.3, 7.0, 7.1 and 4.5 per cent, respectively, as compared to HHB 197. The grain yield was increased by 10.6 and 9.0 per cent, whereas dry fodder yield to the tune of 15.5 and 10.7 per cent by T_3 and T_2 treatments, respectively, than the control (T_1). The results also indicated that basal application of $ZnSO_4$ was slightly better than combination of basal and foliar application.

Key words : Productivity, high yield, zinc, pearlmillet hybrids

Pearl millet [*Pennisetum glaucum* (L.) R. Br.] is a major warm-season cereal crop of rainfed region. It is not only important as a grain crop, but is an indispensable source of dry fodder/stover in dry tracts of South-West Haryana, Gujarat and Rajasthan. In India, it is grown on about 9.05 m ha area with production of 9.73 m t and a productivity of 1070 kg/ha. In Haryana, it is being grown on 0.57 m ha area with production of 1.18 m t and a productivity of 2040 kg/ha (Anonymous, 2012), which is highest in the country. Imbalanced use of plant nutrients not only limits the productivity of the fodder or grain crop but also of the animals feeding on such fodder. Today, balanced fertilization does not mean application of NPK only but taking care of all nutrient deficiencies which occur or may emerge in an area. Fertilizer management in pearlmillet is mainly confined to application of N fertilizer only and P and K fertilizers are seldom applied. Based on an analysis of 3,00,000 soil samples from different states, it was found that 49 per cent of the samples were deficient in zinc, 33 per cent in boron, 13 per cent in molybdenum, 12 per cent in iron, 4 per cent in manganese and 3 per cent in copper (Shukla and Behera, 2012). Continuous cropping of pearlmillet due to omission of micronutrients like Zn and Fe is resulting in decreasing factor productivity or declining response to major nutrients. However, the massiveness of zinc deficiency in Indian soils is well documented and confirms that half of the Indian agricultural land is suffering from zinc deficiency (Rattan *et al.*, 2009). The zinc deficiency is more common under water deficient soil conditions due to reduced availability and mobility of zinc in soil (Kumar, 2012). Adequate supply of zinc not only enhances the synthesis but quality of protein also (Arya and Singh, 2000). Therefore, the present work was undertaken with the aim to improve the productivity of pearl millet through zinc fertilization.

MATERIALS AND METHODS

A field experiment was conducted in the research farm area of Bajra Section, Department of Genetics & Plant Breeding, Chaudhary Charan Singh

Haryana Agricultural University, Hisar during **kharif** seasons of 2010 and 2011. The experimental site (Hisar) is located at an altitude of 215.2 m with 75.46^0 E longitude and 29.10^0 N latitude. The area is characterized as semi-arid and the soil has been classified as sandy loam in texture. The soil of the experimental field was having pH value of 8.0, poor in organic carbon content (0.29%), EC value of 0.23 dS/m, poor in available nitrogen (133 kg/ha), medium in phosphorus (15.0 kg/ha), rich in potash (282 kg/ha) and poor in zinc (0.90 ppm) at the start of the experiment i. e. before **kharif** 2010. Sowing of the crop was done on July 9, 2010 and July 13, 2011, respectively, at planting distance of 45 x 10-12 cm. The experiment was established in factorial randomized block design with nine treatment combinations [three advance hybrids viz., HHB 94, HHB 197 and HHB 223 and three levels of $ZnSO_4$ i. e. Control (T_1), application of 10 kg $ZnSO_4$ as basal+0.5% foliar spray of $ZnSO_4$ at 30 days after sowing of the crop (T_2) and application of 20 kg $ZnSO_4$/ha as basal (T_3)] in three replications. The recommended dose of 125 kg N and 62.5 kg P_2O_5 per ha under irrigated conditions was applied to the crop. Half dose of the nitrogen and full dose of phosphorus were applied at sowing time. Remaining half dose of N in two equal splits was top dressed at three and five weeks after sowing of the crop. The total rainfall received during July, 2010 - October, 2010 and July, 2011-October, 2011 periods was 387.2 and 247.5 mm, respectively. The mean maximum temperature during crop season of 2010 varied from 36.4^{0}C to 46.5^{0}C and mean minimum temperature ranged from 11.5 to 23.5^{0}C and corresponding values for **kharif** 2011 season were 32.3^{0}C to 36.4^{0}C and 13.9^{0}C to 27.1^{0}C, respectively. One irrigation during the month of August 2010 and August 2011 was also applied in the crop. Green fodder was sun dried to obtain dry fodder yield.

RESULTS AND DISCUSSION

Performance of Hybrids

Perusal of the mean data of two years (2010 and 2011) in Table 1 showed that the hybrids took variable time for 50 per cent flowering, and the hybrid HHB 94 took six to eight more days for 50 per cent flowering compared to HHB 223 and HHB 197. At maturity, HHB 94 and HHB 223 hybrids were taller, 18 and 23 cm, respectively, than HHB 197 and total as well effective tillers (Table 2) were significantly more in HHB 94 than other tested hybrids. A difference in the growth parameters of these hybrids was attributed to their inherent genetic differences as well as other factors (Parihar, 2005). For the grain yield attributes, hybrids HHB 197 and HHB 223 recorded more bolder grains (higher test weight) compared to HHB 94. The earhead length was statistically at par among all the hybrids in the year 2010 but the hybrid HHB 94 showed more earhead length than HHB 223 during 2011.

The earhead and green fodder yields were significantly superior in HHB 223 than both the hybrids but dry fodder yield in HHB 197 and HHB 223 was statistically at par but significantly superior 10 HHB 94 (Table 3). The grain yield was significantly superior in HHB 223 than other two hybrids during 2010 but it was

TABLE 1
Effect of $ZnSO_4$ application on different hybrids of pearlmillet

Treatment	Initial plant population/plot			Final plant population/plot			Days to 50% flowering			Plant height (cm)		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Hybrids												
HHB 94	182	172	177	171	163	167	52	51	52	221	230	225
HHB 197	190	178	184	177	165	171	45	44	44	202	212	207
HHB 223	188	177	183	178	168	173	46	46	46	222	238	230
C. D. (P=0.05)	3.0	3.5	-	3.0	2.2	-	1.2	1.4	-	3.9	3.6	-
Micronutrient levels												
T_1	186	176	181	175	165	170	47	46	47	213	220	217
T_2	187	175	181	175	165	170	48	47	48	215	226	220
T_3	188	176	182	175	166	171	48	48	48	217	229	223
C. D. (P=0.05)	NS	NS	-	NS	NS	-	NS	NS	-	3.9	3.6	-

NS–Non-Significant.

TABLE 2

Effect of $ZnSO_4$ application on different hybrids of pearlmillet

Treatment	Total tillers/plant			Effective tillers/plant			Earhead length (cm)			Test weight (g)		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Hybrids												
HHB 94	4.4	4.4	4.4	2.8	2.0	2.4	24.6	24.9	24.8	8.0	7.8	7.9
HHB 197	3.7	3.9	3.8	2.1	1.8	2.0	22.9	24.0	23.5	9.0	8.7	8.9
HHB 223	3.6	3.8	3.7	2.0	1.7	1.9	24.0	23.3	23.7	9.0	8.6	8.8
C. D. (P=0.05)	0.5	0.3	-	0.3	0.2	-	NS	1.0	-	0.18	0.2	-
Micronutrient levels												
T_1	3.8	3.8	3.8	2.2	1.7	2.0	23.0	23.0	23.0	8.5	8.3	8.4
T_2	4.0	4.1	4.1	2.3	1.8	2.1	23.7	24.1	23.9	8.7	8.4	8.6
T_3	4.0	4.2	4.1	2.4	1.9	2.2	24.8	25.1	25.0	8.8	8.4	8.6
C. D. (P=0.05)	NS	0.3	-	NS	0.2	-	NS	1.0	-	0.18	NS	-

NS–Non-Significant.

statistically at par with HHB 197 in 2011. On mean basis, earhead, grain, green fodder and dry fodder yields were 23.4, 18.8, 18.1 and 13.2 per cent superior in HHB 223 than HHB 94, whereas these values were 5.3, 7.0, 7.1 and 4.5 per cent compared to HHB 197. The tested hybrids showed variable response to Zn treatments. The increase in the green fodder yield in HHB 94 hybrid was to the tune of 11.1 and 18.8 per cent and grain yield to the tune of 9.8 and 22.9 per cent with the application of 10 kg $ZnSO_4$ as basal+0.5 per cent foliar application of $ZnSO_4$ (T_2) and 20 kg $ZnSO_4$/ha as basal (T_3) treatments, respectively, than the control (T_1). Within crop species, individual varieties can often vary considerably in their response to zinc application/deficiency (Hacisalihoglu and Kochran, 2003).

The increase in green forage yield in HHB 197 hybrid with T_2 and T_3 treatments was 9.6 and 17.9 per cent, respectively, and in grain yield it was 11.5 and 17.6 per cent, whereas these values were 10.2 and 17.6 for green fodder, and 11.8 and 16.5 per cent for grain yield in HHB 223 (Table 4). The higher earhead, grain, green fodder and dry fodder yields in HHB 223 than HHB 94 and HHB 197 might be ascribed to its better genetic constitution, growth parameters and yield contributing attributes. These results confirm the findings of Hooda *et al.* (2004) and Sarita (2007).

Effect of $ZnSO_4$

Application of $ZnSO_4$ with different methods and rates had significant effect on the plant height. The height was increased by 3.0 and 6.0 cm with T_2 and T_3

TABLE 3

Effect of $ZnSO_4$ application on different hybrids of pearlmillet

Treatment	Earhead yield (kg/ha)			Grain yield (kg/ha)			Green fodder yield (q/ha)			Dry fodder yield (q/ha)		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Hybrids												
HHB 94	5611	5183	5397	3873	3175	3524	362.96	323.17	343.06	100.93	100.83	100.88
HHB 197	6208	6442	6325	4197	3633	3915	418.52	338.00	378.26	111.11	107.50	109.30
HHB 223	6741	6575	6658	4584	3792	4188	458.33	351.83	405.08	117.59	110.83	114.21
C. D. (P=0.05)	446	200	-	239	192	-	22.97	13.75	-	12.70	5.08	-
Micronutrient levels												
T_1	5699	5642	5670	3886	3317	3601	391.67	323.17	357.42	100.00	99.17	99.58
T_2	6347	6217	6282	4327	3617	3972	418.52	342.58	380.55	112.96	107.50	110.23
T_3	6514	6342	6428	4440	3667	4053	429.63	347.25	388.44	116.67	113.33	115.00
C. D. (P=0.05)	446	200	-	239	192	-	22.97	13.75	-	12.7	5.08	-

TABLE 4
Two way (Hybrid x $ZnSO_4$) mean table for green fodder and grain yield per hectare

Treatment (Hybrids/ $ZnSO_4$)	HHB 94		HHB 197		HHB 223	
	Green fodder yield (q/ha)	Grain yield (kg/ha)	Green fodder yield (q/ha)	Grain yield (kg/ha)	Green fodder yield (q/ha)	Grain yield (kg/ha)
T_1	325.00	3249	348.62	3620	355.56	3704
T_2	361.11	3566	381.95	4038	391.67	4142
T_3	386.11	3990	411.11	4258	418.06	4316

treatments, respectively (Table 1). However, plant population and days taken to 50 per cent flowering were not significantly affected by T_2 and T_3 treatments. The total as well as effective tillers per plant and earhead length (cm) were significantly more in zinc treatments during 2011 (Table 2), whereas these were statistically at par during 2010. The test weight (g) in both T_2 and T_3 was found significantly superior to the control during 2010 but it was statistically at par during 2011 (Table 3). The treatments T_2 and T_3 produced significantly superior earhead, grain and fodder yields (fresh and dry) than without zinc treatment.

The increase in yield attributes and yield with zinc application might be ascribed to zinc deficiency in the experimental plot. The mean results of two years showed that grain yield was increased by 9.0 and 10.6 per cent, whereas fodder yield to the tune of 10.7 and 15.5 per cent in T_2 and T_3 treatments than the control (Table 3). Similarly, the yield loss of 10 per cent due to omission of zinc in the fertilization schedule in India was reported by Shukla *et al.* (2009). The above results also indicated that basal application of $ZnSO_4$ was slightly better than combination of basal and foliar application.

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