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FOLIAR SPRAY EFFECTS THE PRODUCTION AND PROFITABILITY OF PEARL MILLET (*PENNISETUM GLAUCUM* L.) UNDER DRYLAND CONDITIONS

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SUMMARY

Field experiments were conducted at Dryland Agriculture Research Farm of CCS Haryana Agricultural University, Hisar during *Kharif* season of 2020 and 2021 to study the effect of various foliar sprays on the production and profitability of pearl millet under dryland conditions. On the basis of pooled data, results revealed that foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl recorded significantly higher plant height (186.8 cm), number of effective tillers (3.1), length of earhead (25.0) and earhead girth (31.4) over control. However, foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ and urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl remained at par with regard to plant height. Foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl also remained statistically at par with urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$, urea @ 2% + 0.5% $ZnSO_4$, water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ and water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ with respect to yield attributing parameters. Further, the data showed that foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ increased grain and stover yield of pearl millet by 26.6 and 34.1 % compared to control (no spray of any material/water) with higher net returns (Rs. 21788 ha^{-1}) and BC ratio (2.13).

Key words: Dryland, economics, foliar spray, pearl millet, yield attributes, yield

Pearl millet [*Pennisetum glaucum* (L) R.Br.] is world's sixth and India's fourth most important food grain crop after rice, wheat and maize. Besides that, India is largest producer in the world occupying an area of 6.93 million ha, with the production of 8.61 million tons and average productivity of 1243 kg/ha (Anonymous 2021 a). In Haryana, pearl millet is grown over an area of 4.2 lakh ha with the production of 6.9 lakh tons and productivity of 1609 kg/ha (Anonymous 2021 b). It 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. Grains of pearl millet are mainly used for human consumption in the form of diverse food and dry stover of pearl millet, 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 largely grown under dryland-rainfed conditions. The yield of pearl millet varies from state to state with varying rainfall and soil type. The productivity imbalance is due to unusual distribution of rainfall, erratic rains and shifting of pearl millet cultivation to marginal soils due to diversification of traditional areas with high value crops across the country.

Application of fertilizer in right amount applied at right time may even not be efficient due to soil moisture. Integrated use of chemical fertilizers (N, P and K) through foliar feeding has been accepted an effective way to compensate soil deficiency and inability of soil to transfer nutrients to the plants to maintain high productivity of undernourished crop (Rundla and Bairwa, 2018). Foliar application of nutrients is an important method of fertilization, since foliar nutrients usually penetrate the leaf cuticle or stomata and enters the cells facilitating easy and rapid utilization of nutrients. Further, it has been well established that the fertilizer elements which are absorbed through roots can also be absorbed with equal efficiency through foliage (Ganapathy *et al.*, 2008). Micronutrients have not only cured nutritional disorder in plants but are also known to improve the yield and quality (Jakhar *et al*., 2006). Zinc is important for plant growth, as plants require a proper

balance of all the essential nutrients for normal growth and optimum yield. It is required as a structural component of a large number of proteins such as transcription factors and enzymes (Singh and Kumar, 2009). Under dryland conditions, dry spell may occur after sowing of pearl millet thereby affect the grain yield of the crop. Foliar spray of fertilizer along with micro nutrients is necessary to cope with the dry spell in the crop. Therefore, the present experiment was undertaken in order to cope with dry spells and higher production and profitability of pearl millet by foliar sprays.

MATERIALS AND METHODS

A field experiment was conducted during two consecutive *Kharif* (rainy) seasons of 2020 and 2021 at Dryland Agriculture Research Farm of the Chaudhary Charan Singh Haryana Agricultural University, Hisar which is located at $29^0$10' N latitude and $75^0$46' E longitude with an altitude of 215.2 m above mean sea level. The average annual precipitation of the experimental site is estimated to 425.5 mm and most of which is received from South-Western monsoon during July to September. The rainfall is highly erratic with coefficient of variation ranging between 30-50 per cent during the crop season. The experiment was laid out in randomized block design having 8 treatments *viz.,* control (no spray of any material/water), water soluble complex fertilizer (19:19:19) @ 0.5% + 0.5% $ZnSO_4$ spray, water soluble complex fertilizer (19:19:19) @ 0.5% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ spray, water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ spray, water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ spray, urea @ 2% + 0.5% $ZnSO_4$ spray, urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ spray and urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl spray with three replications. The sandy loam soil of the experimental field was low in organic carbon (0.35%), low in available nitrogen (136 kg/ha), medium in available phosphorus (14.7 kg/ha) and available potassium (284 kg/ha). The crop was sown on 14 July and 15 July and harvested on 3 October and 6 October during 2020 and 2021, respectively. Pearl millet hybrid HHB 67 Improved was used in a row spacing at 45 cm using 5 kg seed ha^{-1}. Uniform recommended dose of fertilizer (40-20 kg NP/ha) was applied through DAP and urea. Full quantity of phosphorus fertilizer was given at the time of sowing. Half amount of nitrogen was applied as basal dose and rest was given at 30-35 DAS when some amount of rainfall received. Foliar application of Fe, Zn and K was done through iron sulphate, zinc sulphate and potassium chloride, respectively. The spray was done at 37 and 38 DAS during 2020 and 2021, respectively. The other agronomic practices were followed as per package of practices during the crop growth period. At physiological maturity of pearl millet crop, the observations on ancillary characters were recorded on five randomly selected plants in each plot. The crop was harvested separately from the net plots, threshed and winnowed and thereafter grain and stover yields were recorded. The prevailing market price of inputs as per treatments of each crop was considered for working out the cost of cultivation. Net returns (Rs./ha) was calculated by deducting the cost of cultivation (Rs./ha) from gross returns, while BC ratio was worked out as a ratio of gross returns (Rs./ha) to cost of cultivation (Rs./ha). All the results were then analyzed statistically for drawing conclusion using Analysis of Variance (ANOVA) procedure.

TABLE 1
Rainfall recorded at experimental site

Month	Actual rainfall (mm)		Normal Rainfall (mm)
	2020	2021	
June	33.2	49.9	57.6
July	151.9	141.1	119.7
August	94.2	58.7	104.7
September	34.7	300.7	55.8
Kharif (Jun-Sep)	314.0	550.4	337.8

TABLE 2
Dry spell during crop growing season

Year	Duration (days)	Dry spell Dates and months	Stage of the crop
2020	18	24-07-20 to 10-08-20	Tillering
	11	21-08-20 to 03-09-20	Flowering
	12	07-09-20 to 18-09-20	Grain filling
2021	12	04-08-21 to 20-08-21	Tillering

The total rainfall received during the crop growth period was 239.4 and 481.0 mm while during *Kharif* season (Jun-Sep) it was 314.0 and 550.4 mm during 2020 and 2021, respectively compared to mean normal rainfall of 337.8 mm. The total *Kharif* season rainfall was 7.0% less and 62.9% higher compared to normal rainfall during 2020 and 2021, respectively. Month wise it was 26.9 and 17.9% higher in July and 42.3 and 13.4% deficit in June and 10.0 and 43.9%

deficit in August over the mean monthly normal rainfall during 2020 and 2021, respectively (Table 1). The total dry spells occurred during the crop growth period were 3 and 1 coinciding with tillering, flowering and grain filling stages of pearl millet during 2020 and 2021, respectively (Table 2).

RESULTS AND DISCUSSION

Growth and yield attributes

The plant height is indicative of the vigour and growth of plant. All the foliar spray treatments showed significant improvement in plant height over control (Table 3). Foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl produced significantly highest plant height (186.8 cm) compared to other treatments except foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$. The highest plant height might be due to the better nutrition, which plays a vital role in cell division and growth of the plant. The results are in conformity with the findings of Patel *et al*. (2019). The highest number of effective tillers (3.1) were recorded by foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl compared to other treatments and were statistically at par with foliar spray of water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$, water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$, urea @ 2% + 0.5% $ZnSO_4$ spray and urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ spray. This could be due to better nutrition of the crop. The findings corroborate with the findings of Suresh *et al.* (2018).

The yield attributes like earhead length and earhead girth were also significantly influenced by different foliar spray treatments over control. Yield potential of pearl millet crop is determined by its earhead length. Maximum length of earhead (25.0) was achieved by foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl. Application of foliar spray of nutrients might have ensured prolonged availability of nutrients for earhead development than control. The results are in close conformity with the findings of Kalaliya *et al.* (2022). Foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl recorded significantly highest earhead girth (31.4) over other treatments being at par with foliar spray of water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ spray, water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ spray, urea @ 2% + 0.5% $ZnSO_4$ spray and urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ spray. None of the foliar spray treatments significantly affected the test weight of pearl millet. The results are in close conformity with the findings of Kumar *et al.* (2020).

Yield

The final grain yield is the expression of the effects of various yield components developed under the particular set of environmental conditions. The data presented in Table 4 indicated that among the different foliar spray treatments, significantly highest grain (1509 kg/ha) and stover (4024 kg/ha) yields were recorded by treatment receiving urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl over all other foliar spray treatments except foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ and urea @ 2% + 0.5% $ZnSO_4$. Foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ increased grain and stover yield of pearl

TABLE 3
Effect of treatments on growth and yield attributes of pearl millet

Foliar spray	Plant height (cm)	No. of effective tillers/plant	Ear head length (cm)	Ear head girth (mm)	Test weight (g)
Control (no spray of any material/water)	150.5	2.1	21.3	26.1	7.7
Water soluble complex fertilizer (19:19:19) @ 0.5% + 0.5% $ZnSO_4$	152.3	2.3	22.0	27.1	7.9
Water soluble complex fertilizer (19:19:19) @ 0.5% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$	157.3	2.4	22.4	28.1	8.1
Water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$	160.7	2.5	23.0	28.5	8.1
Water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$	168.5	2.7	23.5	28.8	8.3
Urea @ 2% + 0.5% $ZnSO_4$	176.1	2.9	24.2	30.4	8.3
Urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$	180.9	3.1	24.7	31.1	8.5
Urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl	186.8	3.1	25.0	31.4	8.6
CD (P=0.05)	7.4	0.6	2.0	3.1	NS

TABLE 4
Effect of treatments on crop yield and economics of pearl millet

Foliar spray	Grain yield (kg/ha)	Stover yield (kg/ha)	Cost of cultivation (Rs./ha)	Net returns (Rs./ha)	BC ratio	RWUE (kg/ha-mm)
Control (no spray of any material/water)	1171	2929	17600	14038	1.80	4.38
Water soluble complex fertilizer (19:19:19) @ 0.5% + 0.5% $ZnSO_4$	1259	3202	18975	15132	1.80	4.71
Water soluble complex fertilizer (19:19:19) @ 0.5% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$	1272	3238	19160	15316	1.80	4.73
Water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$	1324	3450	19190	16857	1.88	4.95
Water soluble complex fertilizer (19:19:19) @ 1% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$	1352	3541	19375	17457	1.90	5.06
Urea @ 2% + 0.5% ZnSO4	1445	3842	18830	20662	2.10	5.41
Urea @ 2% + 0.5% ZnSO4 + 0.5% $FeSO_4$	1483	3930	19015	21788	2.13	5.58
Urea @ 2% + 0.5% ZnSO4 + 0.5% $FeSO_4$ + 1% KCl	1509	4024	19565	21702	2.11	5.65
CD (P=0.05)	67	186				

millet by 26.6 and 34.1 % compared to control (no spray of any material/water). This might be due to enhancement of growth and yield attributing characters like number of effective tillers, earhead length and earhead girth. Similar results were observed by Ram *et al.* (2021). The increased supply of nutrients and their higher uptake by plants might have stimulated the rate of various physiological processes in plants and led to increased yield. Foliar application of nutrients might compensate for soil deficiencies and soil inability to transfer nutrients to the plants and furthermore higher efficiency of foliar supply of nutrients can further boost photosynthetic efficiency by delaying the onset of leaf senescence which improved the yield of pearl millet. The results are in close agreements with the findings of Shekhawat and Kumawat (2017) and Sharma and Singh (2021).

ECONOMICS

Foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl recorded the highest cost of cultivation among all other treatments. Foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ recorded the highest net returns (Rs. 21788 ha^{-1}) and BC ratio (2.13) among all other treatments. This was mainly because of lower cost of cultivation and similar yields in comparison to foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl. The percent increase in net returns and BC ratio was 55.2 and 18.3% with foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ over control. The lowest net returns and BC ratio were recorded under control. Foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ + 1% KCl recorded highest rain water use efficiency (5.65 kg/ha-mm) compared to other treatments. These findings are in vicinity with those reported by Gurjar *et al.* (2022).

CONCLUSION

The present study exhibited that foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ increased the growth parameters, yield attributes and yield of pearl millet. Similarly, maximum net returns and BC ratio was also observed under foliar spray of urea @ 2% + 0.5% $ZnSO_4$ + 0.5% $FeSO_4$ in pearl millet under dryland conditions.

REFERENCES

Anonymous 2021a. Accessed from *agricoop.nic.in*. Department of Agriculture Cooperation and Farmer Welfare.

Anonymous 2021b. Accessed from *agricoop.nic.in*. Department of Agriculture Cooperation and Farmer Welfare.

Ganapathy, M., G. Baradhan and N. Ramesh, 2008: Effect of foliar nutrition on reproductive efficiency and grain yield of rice fallow pulses. *Legume Res.,* **31**(2): 142-144.

Gurjar, B.S., L.R. Yadav, B.S. Rathore, P. Yadav, K. Singh and R. Kumar, 2022: Effect of foliar nutrition on

growth and yield of hybrid pearl millet (*Pennisetum glaucum*). *Pharma Innov.,* **11**(2): 252-255.

Jakhar, S.R, M. Singh, and C.M. Balai, 2006: Effect of farmyard manure, phosphorus and zinc levels on growth, yield, quality and economics of pearl millet (*Pennisetum glaucum*). *Indian J. Agric. Sci.,* **76**(1): 58-61.

Kalaliya, A., S.K. Sharma, and B.R. Kamboj, 2022: Effect of nutrient management on growth, yield attributing characters, yield and economics of rainfed pearl millet (*Pennisetum glaucum*). *Pharma Innov.,* **11**(7): 290-294.

Kumar, L., V. M. Sankaran, M. Hemlatha, and S. Suresh, 2020: Effect of different levels of fertilizers and foliar nutrition on yield attributes and yield of pearl millet under rainfed condition. *Int. J. Chem. Stud.,* **8**(6): 979-982.

Patel, N.I., B.R. Patel, C.K. Patel and B. Patel, 2019 : Effect of foliar spray of nutrients at different growth stages on pearl millet under dryland condition. *Int. J. Chem. Stud.,* **7**(5): 05-09.

Ram, M., R.C. Meena, H.P. Parewa and D.S. Meena, 2021: Productivity and profitability of pearl millet as affected by zinc and iron application in arid and semi-arid region. *Int. J. Agric. Environ. Biotechnol.,* **14**(03): 375-380.

Rundla, S. and R.C. Bairwa, 2018: Response of foliar supplementation of N, P and K fertilizers on yield and economics of fertilizers. *Int. J. Curr. Microbiol. Appl. Sci.,* **7**(4): 1203-1209**.**

Sharma, S.K. and K. Singh, 2021: Response of foliar spray on production and profitability of pearl millet (*Pennisetum glaucum* L) under rainfed conditions. *Annals Agric. Res.,* **42**(1): 34-39.

Shekhawat, P.S. and N. Kumawat, 2017: Response of zinc fertilization on production and profitability of pearl millet (*Pennisetum glaucum*) under rainfed condition of Rajasthan. *J. AgriSearch.,* **4**(4): 251-254.

Singh, A.K. and P. Kumar, 2009: Nutrient management in rainfed dryland agro ecosystem in the impending climate change scenario. *Agric. Situ. India.,* **65**: 265-270.

Suresh, G., G., Guru, S. Lokanadan, 2018: Effect of nutrient levels and plant growth regulators on growth parameters of pearl millet. *Int. J. Pure App. Bio. Sci.,* **6**(3): 271-277.