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NI Patel
All India Coordinated Research Project for Dryland Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India

BR Patel
All India Coordinated Research Project for Dryland Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India

CK Patel
All India Coordinated Research Project for Dryland Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India

Foram B Patel
All India Coordinated Research Project for Dryland Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India

Correspondence
BR Patel
All India Coordinated Research Project for Dryland Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat, India

Effect of foliar spray of nutrients at different growth stages on pearl millet under Dryland condition

NI Patel, BR Patel, CK Patel and Foram B Patel

Abstract
Study to find out the response of pearl millet to foliar spray of nutrients at different growth stages was carried out under dry land condition at All India Coordinated Research Project for Dryland Agriculture centre, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *kharif* 2018-19 on sandy loam soil. The results indicated that application of foliar nutrients at tillering and flowering stages significantly recorded highest plant height (160.3 cm), no. of effective tillers (1.68), length of ear head (25.6 cm), seed yield (1300 kg/ha) and straw yield (2945 kg/ha). Further, foliar spray of water soluble complex fertilizer (19:19:19) and $ZnSO_4$ @ 0.5% produced higher plant height (163.9 cm), no. of effective tillers (1.57), length of ear head (25.7 cm), grain yield (1383 kg/ha) and straw yield (2998 kg/ha). Further, the higher net return (Rs.23762/ha) with highest B:C ratio (1.92) were observed when foliar spray of nutrients were applied at both the tillering and flowering stages of pearl millet. Significantly higher net return (Rs.25411/ha) and B: C ratio (2.03) were recorded under foliar sprays of water soluble complex fertilizer (19:19:19) and $ZnSO_4$ @ 0.5%. Foliar sprays of water soluble complex fertilizer 19:19:19) and $ZnSO_4$ @ 0.5% at both the tillering and flowering stages of pearl millet improved the growth, yield components and yield. The available nutrients status after harvest of crop did not influenced significantly due to stages for foliar sprays and foliar sprays of nutrients.

Keywords: Pearl millet, Dryland, foliar, LER and On-farm trial

Introduction
Pearl millet (*Pennisetum glaucum* (L.) is the staple cereal of arid and semi-arid drier regions of the country. It is the most widely cultivated cereal in India after rice and wheat. India is the largest pearl millet growing country contributing 42 per cent of production in the world. In India, pearl millet is predominantly cultivated as a rainfed crop in diverse soils, climatic condition and indispensable arid zone. In India, pearl millet was cultivated in 7.128 million hectares with 8.06 million tonnes production and productivity of 1132 kg/ha during 2015-16 (DE&S 2015-16). The major pearl millet producing states in India are Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana. Land, which is on mercy of rainfall, is not only thirsty but also hungry. The estimated nutrients removal by all dryland crops is to the tune of 7.4 million tonnes (excluding secondary and micro nutrients). Approximately drylands receive 10 per cent of total nutrients use in the country, which constitutes about 1.4 million tonnes. There remains a net negative balance of about 6.0 million tonnes (Venkata *et al.,* 2001) [11].

The productivity of pearl millet is very low in India mainly due to poor plant stand and less use of fertilizers. Pearl millet removes 72 kg N, P_2O_5 and K_2O/ ha /annum, whereas only 10-20 kg of these nutrient are being supplied through fertilizers (Suresh *et al.,* 2018) [9]. Soil application of nutrients in pearl millet crop is not enough to meet the growing crop demand under deficit soil moisture status through absorption by root system. Foliar application of nutrients may fill this niche in dryland condition where a small tactical top up of nutrients are required to achieve yield potential in seasons with favourable rainfall conditions and higher yield potential. As it is majorly cultivated under rainfed conditions, even application of fertilizer at right time and right quantity may not be efficient due to soil moisture. When availability of moisture becomes scarce, application of fertilizers through foliar spray resulted in efficient absorption, though foliar spray is not a substitute to soil application but it certainly be considered as a supplement to soil application and availability of soluble fertilizers make the task easy (Upadhyay *et al.,* 1994) [10]. Among the methods of fertilizer application, foliar nutrition is recognized as 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) [3]. Generally deficiency of nutrients like N, P, K and Zn are also observed during soil moisture stress. Therefore, the development of foliar fertilization strategies may become a viable on-farm nutrient management technique. Farmers generally take up sowing with basal application of nutrients as recommended and there was no regional recommendation of foliar nutrition during crop growth period. So this experiment is planned to test the influence of these nutrients through foliar application.

Materials and Methods

A field experiment was conducted to find out the response of pearl millet to foliar spray of nutrients at different growth stages was carried out under dry land condition at All India Coordinated Research Project for Dryland Agriculture centre, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar during *kharif* 2018-19. The soil of experimental plot was loamy sand in texture, having low in soil available nitrogen 165.5 kg/ha, medium in available P_2O_5 43.5 kg/ha and K_2O 225.5 kg/ha. The soil was slightly saline in reaction (pH 7.6). The total rainfall received during the period of field experiment was 327.9 mm in 12 rainy days. The relative humidity during morning and evening ranged between 7 and 97 per cent and between 23 and 100 per cent, respectively. The mean maximum temperature ranged between 25^0C and 46^0C, while the mean minimum temperature ranged between 4^0C and 30^0C.

The experiment was laid out in Split Plot Design comprised of three levels of stages for foliar sprays *viz.*, F_1: Tillering stage, F_2: Flowering stage and F_3: Tillering and flowering stages were allotted to main plot and four foliar sprays of nutrients *viz.*, N_1: Urea @ 2.0%, N_2: Water soluble complex fertilizer (19:19:19) @ 0.5%, N_3: Foliar spray of $ZnSO_4$ @ 0.5% and N_4: Water soluble complex fertilizer (19:19:19) @ 0.5% + foliar spray of $ZnSO_4$ @ 0.5% were assigned to sub plot and replicated thrice. Sowing of pearl millet (*var*. GHB 558) was done at a spacing 45 cm × 15 cm. The 75% of RDF (60-30 kg N- P_2O_5/ha) will be applied as common. Other cultural practices and plant protection measures Were followed as per the recommended package of practices. At maturity, 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 straw yields were recorded. The collected data were analyzed by using Fisher's analysis of variance technique and LSD test at 5% probability was used to compare the differences among treatments, means (Steel *et al*., 1997) [8].

Results and Discussion

Growth and yield attributes

Data illustrated in Table 1 revealed that the growth and yield contributing characters *viz*., plant height (cm), number of effective tillers and length of ear head (cm) were significantly influenced by the foliar spray of nutrients at both the tillering and flowering stages of pearl millet.

Table 1: Effect of different treatments on growth and yield attributes, yield and economics of pearl millet

Treatments	Plant height (cm)	No. of effective tillers	Length of ear head (cm)	Yield (kg/ha)		Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	BCR
				Grain	Straw				
[A] Stages for foliar sprays (F)									
F_1: Tillering stage	149.9	1.40	23.8	1107	2462	12153	30604	18451	2.52
F_2: Flowering stage	148.5	1.30	22.8	1019	2309	12153	28342	16189	2.33
F_3: Tillering and flowering stages	160.3	1.68	25.6	1300	2945	12393	36155	23762	2.92
S.Em.±	3.1	0.04	0.4	60.9	117.0				
C.D.(P=0.05)	9.2	0.11	1.2	178.5	343.1				
[B] Foliar sprays of nutrients (N)									
N_1: Urea 2.0%	147.0	1.40	22.5	998	2303	11996	27923	15928	2.33
N_2: Water soluble complex fertilizer (19:19:19) 0.5%	148.6	1.42	23.9	1026	2389	12345	28794	16449	2.33
N_3: Foliar spray of $ZnSO_4$ 0.5%	152.1	1.44	24.2	1161	2597	12079	32157	20078	2.66
N_4: Water soluble complex fertilizer (19:19:19) 0.5% + Foliar spray of $ZnSO_4$	163.9	1.57	25.7	1383	2998	12512	37923	25411	3.03
S.Em.±	3.6	0.04	0.5	70.3	135.1				
C.D.(P=0.05)	10.6	0.12	1.4	206.1	396.2				
Interaction									
F X N	NS	NS	NS	NS	NS				
C.V.%	7.1	8.56	6.1	18.5	15.8				

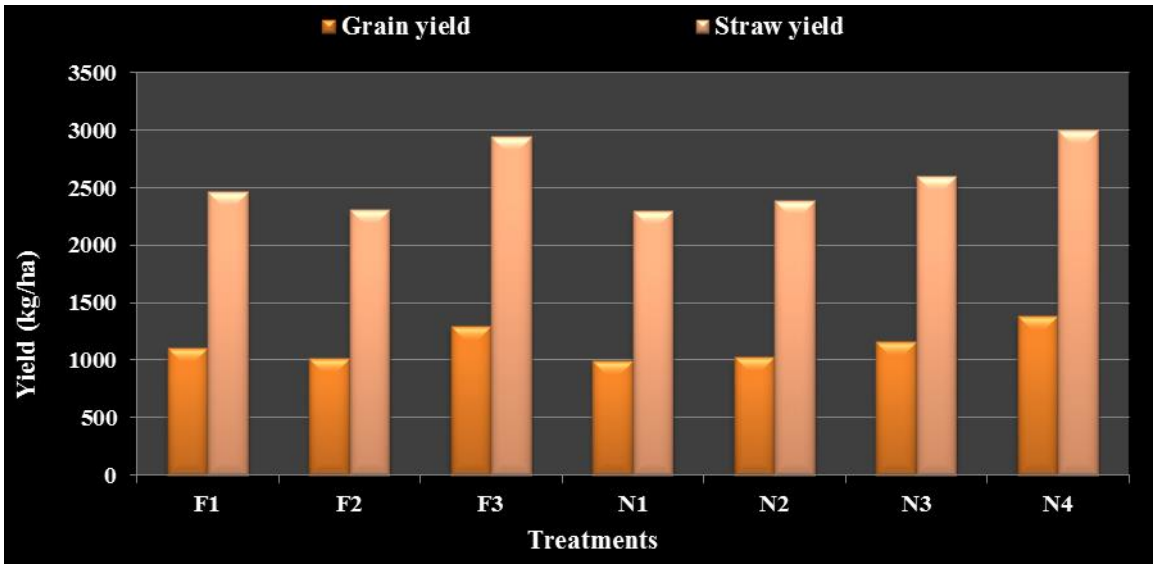

Fig 1: Effect of different treatments on yield of pearl millet

The plant height is indicative of the vigour and growth of plant. The application of foliar spray of nutrients at both tillering and flowering stages significantly recorded highest plant height (160.3 cm) over all other stages. Among the treatments, foliar spray of water soluble complex fertilizer (19:19:19) and ZnSO4 @ 0.5% registered appreciably higher plant height (163.9 cm) compared to other treatments. The highest plant height was might be due to the better nutrition, which plays a vital role in cell division and growth of the plant. The above trend results are in agreement with the findings of Sharnkumar *et al.,* (2012) [7] reported in sorghum where 2% urea spray was superior over other foliar treatments.

The highest number of effective tillers (1.68) were recorded by the foliar spray of nutrients at both the tillering and flowering stages of pearl millet which could be due to better nutrition of crop. The treatment, foliar spray of water soluble complex fertilizer (19:19:19) and ZnSO4 @ 0.5% recorded the highest number of effective tillers (1.57) over all other foliar spray treatments. This finding corroborate with the earlier reports of Rahman *et al.,* (2014) [4] for wheat where maximum number of tillers were recorded with 2% urea spray.

The yield attributes like earhead length was also in similar trends as growth characters. Yield potential of pearlmillet crop is determined by its earhead length. Maximum length of earhead (25.6 cm) which was significantly influenced by both tillering and flowering stages for foliar sprays. Further, foliar application of water soluble complex fertilizer (19:19:19) and ZnSO4 @ 0.5% significantly improved the length of earhead (25.7 cm) when it was sprayed at tillering and at flowering stage. The results are in close conformity with the observations recorded by Reddy *et al.,* (2018) [6] who also reported response of finger millet to different foliar sprays.

Yields of Pearlmillet

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 1 indicated that different stages for foliar sprays and foliar sprays of nutrients had significant influence on grain and stalk yield of pearlmillet.

The significantly highest grain (1300 kg/ha) and straw yield (2945 kg/ha) were recorded by both tillering and flowering stages for foliar sprays compared to rest of stages. Among the different foliar spray treatments, significantly highest grain (1383 kg/ha) and straw yield (2998 kg/ha) were recorded by treatment receiving water soluble complex fertilizer (19:19:19) and ZnSO4 @ 0.5% over all other foliar spray treatments. This might be due to enhancement of growth and yield attributing characters like number of effective tillers, length of earhead and more no. of grain per earhead etc. Similar results were observed by Reddy *et al*., (2014) for fingermillet. The results are confirmed with the findings of Das and Jana (2015) [1] who had reported highest seed yield of chick pea with application of 2% urea spray over different concentrations of 19:19:19 foliar spray. Rahman *et al.,* (2014) [4] has also reported highest seed and straw yield for wheat with 2% urea spray.

Economics

Highest cost of cultivation (Rs.12393/ha), gross (Rs. 36155/ha) and net returns (Rs. 23762/ha) and B:C ratio (2.92) were recorded with foliar spray of nutrients at both the tillering and flowering stages. The treatment, foliar spray of water soluble complex fertilizer (19:19:19) and ZnSO4 @ 0.5% recorded the highest cost of cultivation (Rs. 12521/ha), gross returns (Rs. 37923/ha), net returns (Rs. 25411/ha) and B:C ratio (3.03) compared to other treatments. This was mainly because of higher grain yield of pearlmillet with foliar application of water soluble complex fertilizer (19:19:19) and ZnSO4 @ 0.5% at both tillering and flowering stages.

Effect on post-harvest soil status

The soil properties viz; nitrogen, phosphorus, potash, iron and zinc of soil after harvest of crop did not differ significantly due to different stages for foliar sprays and foliar sprays of nutrients.

The data revealed that the highest residual values of available nitrogen (140.7 kg/ha), phosphorus (41.32 kg/ha), potassium (197.5 kg/ha), and available micronutrients iron (5.19 ppm) and zinc (0.522 ppm) in the soil after the harvest of crop were recorded by the foliar spray of nutrients at both the tillering and flowering stages of pearl millet. (Table 2). Among the different foliar spray treatments, the highest available nitrogen (140.8 kg/ha) was recorded by treatment receiving urea 2%, highest available P_2O_5 (40.83 kg/ha) and K_2O (194.6 kg/ha) were recorded by treatment receiving water soluble complex

fertilizer (19:19:19). The highest micronutrients Fe (5.11 ppm) was recorded by treatment receiving water soluble complex fertilizer (19:19:19) and ZnSO4 @ 0.5% and the highest Zn (0.511 ppm) was recorded by treatment receiving ZnSO4 @ 0.5% over all other foliar spray treatments. The crop growth also had favourable effect on the microbial activity resulting in higher values recorded by this treatment. The soil chemical properties after harvest of pearlmillet were not much more influenced by different foliar treatments. The earlier reports of Radhika *et al.*, (2013) [5] and lend support to the present findings (Table 2).

Table 2: Effect of different treatments on soil fertility after harvest of the crop

Treatment	Av. nutrients (kg/ha)			DTPA extractable micronutrients (ppm)	
	N	P_2O_5	K_2O	Fe	Zn
[A] Stages for foliar sprays (F)					
F_1: Tillering stage	136.1	38.75	186.6	4.93	0.486
F_2: Flowering stage	139.4	40.73	194.8	4.94	0.482
F_3: Tillering and flowering stages	140.7	41.32	197.5	5.19	0.522
C.D.(P=0.05)	NS	NS	NS	NS	NS
[B] Foliar sprays of nutrients (N)					
N_1: Urea @ 2.0%	140.8	39.76	191.8	4.97	0.497
N_2: Water soluble complex fertilizer (19:19:19) @ 0.5%	139.1	40.83	194.6	4.99	0.494
N_3: Foliar spray of $ZnSO_4$ @ 0.5%	135.5	40.32	192.4	5.03	0.511
N_4: Water soluble complex fertilizer (19:19:19) @ 0.5% + foliar spray of $ZnSO_4$ @ 0.5%	139.4	40.16	193.0	5.11	0.480
C.D.(P=0.05)	NS	NS	NS	NS	NS
Interaction	NS	NS	NS	NS	NS
C.V. (%)	7.7	6.52	6.1	7.43	9.22
Initial	165.5	43.5	225.5	5.12	0.56

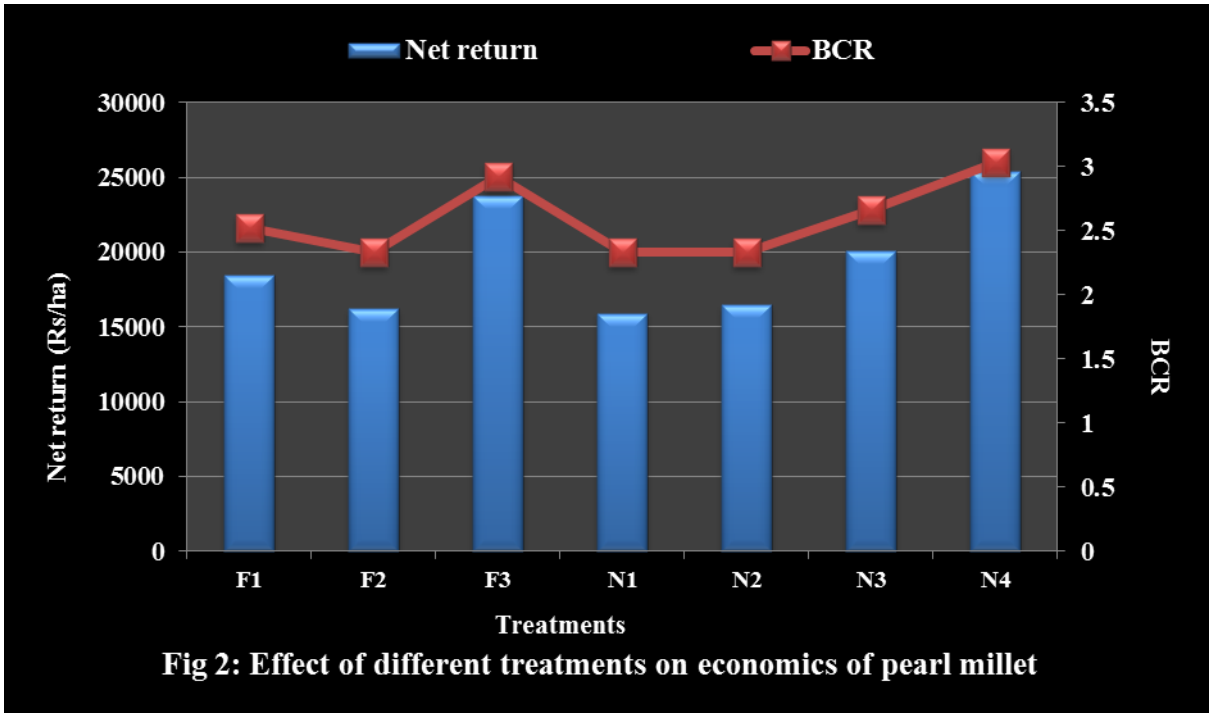

Fig 2: Effect of different treatments on economics of pearl millet

From the above investigation it can be inferred that pearlmillet requires higher amount of nutrients during tillering and flowering stages.

Conclusion

Foliar application of water soluble complex fertilizer (19:19:19) and ZnSO4 @ 0.5% at both tillering and flowering stages of crop growth significantly increased the plant height, no. of effective tillers, length of ear head, grain yield and straw yield. The available nutrient status after harvest of crop did not influenced significantly due to stages for foliar sprays and foliar sprays of nutrients.

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