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Influence of Nutrient Uptake by Irrigation, Nitrogen and Phosphorus and Their Effect on Quality Parameters of *rabi* Pearl Millet

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Abstract: An experiment was conducted in split plot design keeping four levels of irrigation in main plot and six treatment combinations comprising of three levels of nitrogen and two levels of phosphorus, in sub plot with four replications during *rabi* seasons of 1998 on clayey soil at Gujarat Agricultural University, Junagadh Campus, Junagadh (Gujarat) to study effect of various level of irrigation, nitrogen and phosphorus on nutrients content and uptake of pearl millet. The results revealed that application of IW/CPE of 0.7 recorded significantly higher yields *viz*. grain and stover yield and soil moisture parameters *viz*. consumption use of water, water use efficiency was at par with application of IW/CPE ratios of 0.9.

Key words: Pearl millet · *Pennisetum glaucum* · Irrigation · Yield and Nutrient

INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] is the fourth most important food grain crops after rice, wheat and sorghum in India and commonly known as bajra, is an important drought hardy millet crop basically cultivated in the arid and semi-arid areas on light textured sandy soils. It is a dual purpose crop, grains are used for human consumption and its fodder as cattle feed. Pearl millet grains are eaten cooked like rice or 'chapattis' are prepared out of flour like wheat or maize flour and also used as feed for poultry and green fodder or dry *karbi* for cattle. India is the largest producer of pearl millet with an annual production of 10.05 million tonnes from an area of 8.69 million ha and productivity of 1156 kg ha^{-1}(AICMIP, 2014). Rajasthan, Maharashtra, Gujarat, Uttar Pradesh and Haryana are the major pearl millet growing states. Scientific scheduling of irrigation is a technique for determining the quantity of irrigation water, which also aim at optimizing crop yield with the maximum water use efficiency and ensures minimum deterioration of the soil and crop. Among the various approaches, climatological approach has been found to be ideal as it integrates all weather parameter, giving them their natural weightage in a given climate-water-plant continuum. Scheduling irrigation based on data of pan evaporation is likely to increase agricultural production at least by 15 to 20 per cent (Dastane, 1972). The present investigation was undertaken with the objective of finding suitability of different irrigation, nitrogen and phosphorus levels and their doses for pearl millet so that practically convenient feasible strategy for scheduling irrigation for *rabi* pearl millet can be developed.

MATERIALS AND METHODS

An experimental was conducted at the Instructional Farm, Gujarat Agricultural University, Junagadh campus, Junagadh (Gujarat) for *rabi* season of the years 1998. The experiment site is situated at 21.5°N latitude and 70.5°E longitude with an altitude of 60 m above the mean sea level on the western side at the foothill of famous mount 'Girnar'. The maximum and minimum temperature during the crop growth period ranged between 27.3 °C to 34.6 °C and 7.8 °C to 21.9 °C during 1998. The soil was medium clayey in texture and slightly alkaline in reaction with pH (8.10), OC (0.59%) and EC (0.32 dS m^{-1}), low in available N (261.2 kg ha^{-1}) and medium in available P (32.12 kg ha^{-1}), available K (295.1 kg ha^{-1}) and moisture content at field capacity (28.02%) and moisture content at permanent wilting point (13.81%). Total 24 treatments *viz*. main plot treatments were 0.3 IW/CPE ratio, 0.5 IW/CPE ratio, 0.7 IW/CPE ratio 0.9 IW/CPE ratio and sub plot treatments nitrogen 100 kg ha^{-1}, 120 kg ha^{-1} and 140 kg ha^{-1} and phosphorus 40 kg ha^{-1} and 60 kg ha^{-1} tested in split plot design keeping four levels of irrigation in main

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plot and six treatment combinations comprising of three levels of nitrogen and two levels of phosphorus, in sub plot with four replications. 'Bajra-316' was sown at 45 x 15 cm spacing using seed rate of 3.75 kg ha^{-1}. A basal dose consisting of 50% N in the form of urea and full dose of P in the form of single super phosphate as per treatment were applied uniformly to all plots in furrows at the time of sowing. Following formula were used to calculate consumptive use of water and WUE.

Consumptive Use of water = Profile soil+ moisture use (mm) + Effective + rainfall (mm) + Ground water contribution (mm)

$$\text{WUE}\left(\text{kg/ha mm}\right) = \frac{\text{Grain yield}\left(\text{kg/ha}\right)}{\text{Consumptive use of water}\left(\text{mm}\right)}$$

RESULTS AND DISCUSSION

Effect on Nutrient Content in Grain and Stover: The results revealed that the nutrient content, was significantly influenced due to different irrigation and nitrogen levels (Table 1). Among the different treatment IW/CPE ratio of scheduling irrigation at IW / CPE ratio of 0.9 recorded significantly higher nitrogen content in grain and stover as compared to the lowest IW / CPE ratio of 0.3. Significantly higher phosphorus content in grain and stover were recorded under IW / CPE ratio of 0.9 over the lowest ratio of 0.3.

Application of nitrogen enhanced the nitrogen content in grain and stover of pearl millet. Similarly, nitrogen and phosphorus contents in grain and stover were not markedly influenced by different levels of phosphorus.

Effect on Nutrient Uptake by Grain and Stover: The results revealed that the nutrient uptake, was significantly influenced due to different irrigation, nitrogen and phosphorus levels (Table 2). Among the different treatment significantly higher nitrogen uptake by grain, stover by grain, stover and total nitrogen uptake by crop were recorded under IW / CPE ratio of 0.7 over lower IW / CPE ratios of 0.3 and 0.5; however same was statistically at par with IW / CPE ratio of 0.9 were registered under IW / CPE ratio of 0.7 over lower IW / CPE ratio of 0.3 and 0.5, but it was statistically at par with IW / CPE ratio of 0.9. However, significantly higher phosphorus uptake by grain and stover. The higher nitrogen uptake by pearl millet under higher level of nitrogen due to favorable effects of nitrogen on growth parameters and yield attributes which resulted in higher grain and stover yields

Table 1: Effect of different treatment on nutrient content in grain and stover

	Nitrogen content (%)		Phosphorus content (%)	
Treatment	Grain	Stover	Grain	Stover
Irrigation (IW/CPE ratio)				
I_1 (0.3)	1.73	0.632	0.230	0.0583
I_2 (0.5)	1.80	0.655	0.242	0.0627
I_3 (0.7)	1.84	0.671	0.250	0.0644
I_4 (0.9)	1.86	0.684	0.249	0.0658
SEm±	0.03	0.010	0.003	0.0018
C.D. at 5%	0.08	0.032	0.010	0.0051
C.V.%	7.04	7.45	6.16	14.63
N kg ha^{-1}				
N_1 (100)	1.77	0.639	0.240	0.0618
N_2 (120)	1.82	0.665	0.243	0.0632
N_3 (140)	1.84	0.008	0.245	0.0635
SEm±	0.01	0.022	0.002	0.0007
C.D. at 5%	4.10	0.80	NS	NS
C.V.%	1.77	0.639	3.98	6.06
P kg ha^{-1}				
P_1 (40)	1.81	0.658	0.242	0.0625
P_2 (60)	1.81	0.663	0.243	0.0631
SEm±	0.01	0.006	0.001	0.0006
C.D. at 5%	NS	NS	NS	NS
C.V.%	4.10	6.80	3.98	6.06
Interaction	-	-	-	-

Table 2: Effect of different treatment on nutrient uptake in grain and stover

	Nitrogen uptake (%)		Phosphorus uptake (%)	
Treatment	Grain	Stover	Grain	Stover
Irrigation (IW/CPE ratio)				
I_1 (0.3)	29.18	31.38	0.230	0.0583
I_2 (0.5)	40.48	39.22	0.242	0.0627
I_3 (0.7)	48.12	43.27	0.250	0.0644
I_4 (0.9)	49.10	45.52	0.249	0.0658
SEm±	1.06	1.26	0.003	0.0018
C.D. at 5%	3.39	4.02	0.010	0.0051
C.V.%	12.44	15.46	6.16	14.63
N kg ha^{-1}				
N_1 (100)	35.41	35.29	0.240	0.0618
N_2 (120)	44.20	41.59	0.243	0.0632
N_3 (140)	45.19	42.65	0.245	0.0635
SEm±	0.71	0.91	0.002	0.0007
C.D. at 5%	2.00	2.57	NS	NS
C.V.%	9.59	12.91	3.98	6.06
P kg ha^{-1}				
P_1 (40)	41.65	39.96	0.242	0.0625
P_2 (60)	41.79	39.73	0.243	0.0631
SEm±	0.58	0.74	0.001	0.0006
C.D. at 5%	NS	NS	NS	NS
C.V.%	9.59	12.91	3.98	6.06
Interaction	-	-	-	-

Table 3: Effect of different treatment on quality and soil moisture parameters

Treatment	Grain yield kg ha^{-1}	Stover yield kg ha^{-1}	Consumption use of water	Water use efficiency
Irrigation (IW/CPE ratio)				
I_1 (0.3)	1680	4941	148.50	11.30
I_2 (0.5)	2242	5970	207.04	10.78
I_3 (0.7)	2607	6449	220.17	11.75
I_4 (0.9)	2633	6561	242.08	10.88
SEm±	51.62	148.16	1.29	0.28
C.D. at 5%	165.12	473.94	4.12	0.89
C.V.%	11.04	12.14	3.09	12.13
Nitrogen kg ha^{-1}				
N_1 (100)	1992	5554	200.63	9.91
N_2 (120)	2429	6178	205.81	11.74
N_3 (140)	2450	6208	206.91	11.89
SEm±	32.88	120.74	0.57	0.17
C.D. at 5%	93.01	341.51	1.62	0.49
C.V.%	8.12	11.42	1.59	8.69
Phosphorus kg ha^{-1}				
P_1 (40)	2288	6001	203.96	11.22
P_2 (60)	2293	5959	204.94	11.13
SEm±	26.85	98.59	0.47	0.14
C.D. at 5%	NS	NS	NS	NS
C.V.%	8.12	11.42	1.59	8.69
Interaction	-	-	-	-

Application of 120 and 140 kg N / ha were found equally effective in increasing nitrogen uptake by grain, stover and total nitrogen uptake by crop were significantly higher over lower level of 100 kg N / ha as well as nitrogen and phosphorus uptake by grain, stover by pearl millet were not markedly influenced by different levels of phosphorus.

Effect on Yields: The results revealed that the yield attributes were significantly influenced due to different irrigation, nitrogen and phosphorus levels (Table 3). Among the different treatment IW/CPE ratio of 0.9 and 0.7 over lower IW/CPE ratio of 0.5 and 0.3 were most effective to significantly increase grain and straw yields that might be due adequate supply of water under which plant become physiologically more active and also more nutrient availability might have been increased and ultimately resulted in improved the growth and development of sink. The magnitude of increase in grain yield with 0.9, 0.7, 0.5 over 0.3 IW/CPE was the tune of 56.75, 55.17, 33.44%, respectively. The increase in stover yield with 0.9, 0.7, 0.5 over 0.3 IW/CPE was the tune of 32.79, 30.51 and 20.82%, respectively.

Significantly higher grain and stover yields with increasing phosphorus levels 40 P kg ha^{-1} to 60 P kg ha^{-1} indicated that application of phosphorus more than 40 P kg ha^{-1}is not helpful for further increase in grain and stover yields of pearl millet. The non response to higher phosphorus application to *rabi* pearl millet might be due to high calcareousness and clay content of soil along with medium available phosphorus status of the soil.

Effect on Soil Moisture Parameters: Water used by pearl millet was increased significantly with each increment in irrigation levels (Table 3). Scheduling irrigation at IW/CPE ratio of 0.9 recorded significantly the highest consumptive use of water over rest of lower ratios. The per cent increase in water use due to IW/CPE ratio of 0.9 was 9.95, 16.92 and 63.02 over IW/CPE ratio of 0.7, 0.5 and 0.3, respectively. The reason for higher yield water use under higher IW/CPE ratio of 0.9 is attributed to the fact that this ratio received the maximum irrigations each of 50 mm depth with a total of 300 mm water. However, the per cent increase in consumption use of water due to 140 N kg ha^{-1} and 120 N kg ha^{-1}as compare to 100 N kg ha^{-1}. Application of phosphorus more than 40 P kg ha^{-1}did not improve pearl millet grain protein content as phosphorus fertilization failed due to medium available phosphorus status of the soil.

The result pertaining to water use efficiency showed that different treatment appreciably significantly affected water use efficiency. Significantly higher water use efficiency was obtained under IW/CPE ratio of 0.7 over 0.5, but it was statistically at par with lower ratios of IW/CPE ratio of 0.3. Under the highest levels of irrigation lower water use efficiency was attributed to increase in

consumption use of water. However, the per cent increase in water use efficiency due to 140 N kg $ha^{-1}$and 120 N kg ha^{-1}over 100 N kg ha^{-1}.

CONCLUSION

Based on the results of one year experimentation, it can be concluded that higher productivity, qualitative and maintain soil fertility status through nutrient uptake from *rabi* pearl millet can be secured by scheduling irrigation at IW/CPE of 0.7 with 50 mm depth which required 5 irrigation ad fertilizing the crop with 120 N kg ha^{-1} and 40 P kg ha^{-1} on clayed soil in South Saurashtra region of Gujarat.

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