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Research Article

Dry Matter Production and Nutrient Uptake of Summer Bajra at Different Phenological Stages as Influenced by Irrigation

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Abstract

A field experiment was conducted under sandy loamy soil during the summer season of 2018 at College Farm, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad. The experiment comprised of nine irrigation treatments namely, I_1 {Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F) + Grain filling (GF)}, I_2 {Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F)}, I_3 {Irrigation at Tillering (T) + Panicle initiation (PI) + Grain filling (GF)}, I_4 {Irrigation at Tillering (T) + Flowering (F) + Grain filling (GF)}, I_5 {Irrigation at Panicle initiation (PI) + Flowering (F) + Grain filling (GF)}, I_6 {Irrigation at Tillering (T) + Flowering (F)}, I_7 {Irrigation at Tillering (T) + Grain filling (GF)} I_8 {Irrigation at Panicle initiation (PI) + Grain filling (GF)} and I_9 {Irrigation at Flowering (F) + Grain filling(GF)}, were replicated three times in a randomized block design. Results showed that I_1 recorded significantly higher dry matter production and nutrient uptake in grain and stover.

Keywords: Irrigation, Summer Pearl millet, Phenological stages, Dry matter production, Nutrient uptake

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Introduction

Pearl millet (*Pennisetum glaucum*) is a species of the millet family also known as bulrush, spiked or cat-tail millet, it is the most drought tolerant cereal grown in the arid and semi-arid regions of the world. Globally, pearl millet is consumed in different forms: unleavened bread (roti or chapatti), porridge and gruel and hence it is often referred to as poorman's bread [1]. India is the largest producer of pearl millet in the world occupying 7.46 million hectares with annual production of 9.73 million tonnes and average productivity of 1305 kg ha^{-1} [2]. In Telangana it is grown on 0.05 lakh hectares with 0.04 lakh tonnes of production and productivity of 824 kg ha^{-1} [3]. Pearl millet grain is more nutritious and the grain contains 11-19 % protein, 60-78% carbohydrates and 3.0-4.6% fat and also has good amount of phosphorous and iron [4]. High grain and fodder yield of better quality and greater water-use efficiency combined with tolerance to heat during flowering and grain development (air temperature during flowering can exceed 42°C) are the reasons for cultivating pearl millet in the summer season [5].

The productivity of pearl millet in India is very low as compared to important pearl millet growing countries in the world. It is, therefore, necessary to increase the production and productivity of pearl millet by adopting scientific innovations like proper water management technique for optimum crop production. Under water shortage conditions, water could be reserved for irrigation during the critical growth stages [6]. In *kharif* the pearl millet is cultivated under rainfed conditions with low-input-low-output management, while summer pearl millet is cultivated under high-input-high-output management. Due to climate change, yield of kharif crop is adversely affected that's why area under summer pearl millet is increasing. There is a need to explore opportunities to expand the area under summer pearl millet particularly in areas where irrigation is available and the fields are vacant during the summer season. Even though the adaptation of millet to the driest environments is realized, its vegetative response to water deficits has not been clearly described. Considering these facts in view, an irrigation experiment on summer pearl millet (*Pennisetum glaucum* L.) was planned to evaluate dry matter production and nutrient uptake.

Materials and Methods

Field experiment was carried out in sandy loam soil at College Farm, College of Agriculture, PJTSAU, Rajendranagar, Hyderabad. The pH of the experimental site was 7.8, organic carbon was 0.63%, available nitrogen, phosphorus and potassium were 175 kg ha^{-1}, 64 kg ha^{-1} and 352 kg ha^{-1} respectively. The experiment comprised of nine irrigation treatments namely, I1 {Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F) + Grain filling (GF)}, I2 {Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F)}, I3 {Irrigation at Tillering (T) + Panicle initiation (PI) + Grain filling (GF)}, I4 {Irrigation at Tillering (T) + Flowering (F) + Grain filling (GF)}, I5 {Irrigation at Panicle initiation (PI) + Flowering (F) + Grain filling (GF)}, I6 {Irrigation at Tillering (T) + Flowering (F)}, I7 {Irrigation at Tillering (T) + Grain filling (GF)} I8 {Irrigation at Panicle initiation (PI) + Grain filling (GF)} and I9 {Irrigation at Flowering (F) + Grain filling(GF)}, were replicated three times in a randomized block design. Pearl millet was sown on 19th January, 2018 and harvested on 30th April, 2018 During the growing season, the mean weekly maximum, minimum temperature, relative humidity, sunshine hour day^{-1} and evaporation were 34.2 ºC, 16.2 ºC, 78.4%, 25.5%, 8.36 hrs dy^{-1} and 5.46mm. Pearl millet was sown at a spacing of 45 cm x 15 cm using seed rate of 4 kg ha^{-1}. The field was uniformly irrigated on the day of sowing. Further, one irrigation was given at 10 days after sowing. Further irrigations were given based on the treatments. 50 mm depth of irrigation water was applied at each irrigation. The RDF i.e. Nitrogen (80 kg ha^{-1}) was applied through urea in two equal splits, first as basal and the remaining dose at 30 DAS (days after sowing, whereas full dose of P_2O_5 (40 kg ha^{-1}) and full dose of K_2O (30 kg ha^{-1}) were applied through SSP and muriate of potash respectively, as basal dose to all the experimental plots.

Dry matter production at different phenological stages prior to irrigation and at harvest was recorded from five randomly selected plants in the border area marked for destructive sampling. The plants were shade dried and then oven dried at 60 ^{0}C till constant weight was obtained. At harvest same plant is used for determining nutrient uptake in grain and stover.

The nutrient uptake was determined by the following formula

$$\text{Nutrient uptake by grain (kg ha} - 1) = \frac{\text{Nutrient content (\%)}}{100} \times \text{Grain yield (kg ha} - 1)$$

$$\text{Nutrient uptake by stover (kg ha} - 1) = \frac{\text{Nutrient content (\%)}}{100} \times \text{Stover yield (kg ha} - 1)$$

Results and Discussion

Dry matter production (kg ha^{-1})

From the **Table 1**, dry matter production at tillering stage was non-significant. At flowering stage, I_1 treatment significantly produced higher dry matter (5468 kg ha^{-1}**)** followed by I_2 (5352 kg ha^{-1}**)** and I_3 (5231 kg ha^{-1}**)** which were at par with each other and significantly superior over the rest of the treatments.The lowest dry matter was produced by I_9 treatment (3015 kg ha^{-1}). At grain filling, significantly highest value was obtained with I_1 (6484 kg ha^{-1}**)** and I_2 (6147kg ha^{-1}**)** though at par superior to the rest of the treatments. The lowest value (3878 kg ha^{-1}) was observed with I_9. At harvest stage, dry matter production was significantly higher (8101 kg ha^{-1}) with I_1 followed by I_3 and I_4 (7319 kg ha^{-1}) which were at par with each other and differed significantly with the rest of the treatments. Significantly lowest value (4896 kg ha^{-1}) was observed with I_9 treatment.

Table 1 Dry matter production (kg ha^{-1}) of summer pearl millet as influenced by irrigations at different phenological stages

Treatments	T	F	GF	Harvest
I_1 – Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F) + Grain filling (GF)	820	5468 a	6484 a	8101 a
I_2 – Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F)	750	5352 a	6147 a	6780 c
I_3 - Irrigation at Tillering (T) + Panicle initiation (PI) + Grain filling (GF)	806	5231 a	5721 b	7483 b
I_4 - Irrigation at Tillering (T) + Flowering (F) + Grain filling (GF)	739	4533 b	5638 b	7319 b
I_5 - Irrigation at Panicle initiation (PI) + Flowering (F) + Grain filling (GF)	682	4015 c	5097 c	5615 e
I_6 - Irrigation at Tillering (T) + Flowering (F)	765	4428 b	5572 b	6244 d
I_7 - Irrigation at Tillering (T) + Grain filling (GF)	796	4389 b	5163 c	6188 d
I_8 - Irrigation at Panicle initiation (PI) + Grain filling (GF)	736	3729 c	4032 d	5012 f
I_9 - Irrigation at Flowering (F) + Grainfilling (GF)	660	3015 d	3878 d	4896 f
Mean	750	4462	5303	6404
S. Em. +/-	34.08	98.55	127.05	164.07
CD (5%)	NS	295.43	380.86	491.85

T - Tillering, F - Flowering, GF - Grain filling

The maximum dry matter accumulation might be due to increase in plant height, LAI and uptake of nutrients through adequate moisture supply. Which contributed to photosynthetic activity of crop, resulting in higher dry matter accumulation. The results are in agreement with the findings of Singh *et al*. (2012) [7], Kumar and Pannu (2012) [8] and Vishuddha *et al*. (2014) [9].

Nutrient uptake (kg ha^{-1})

An investigation of data pertaining to nutrient uptake i.e. N, P and K by grain and stover as influenced by irrigations are furnished in table 2 and 3. Among the nine irrigation treatments, the nutrient uptake pattern when observed, significantly higher values of N, P and K uptake in the grain and stover was recorded with I_1 followed by I_3 and I_4 treatments which were being at par with each other and significantly superior over the rest of the treatments. The next set of the treatments that also showed significantly higher grain and stover nutrient uptake was I_2 followed by I_6 and I_7 being at par with each other and significantly superior over other treatments. The significantly lowest nutrient uptake of N, P and K in the grain and stover was recorded under I_9 treatment which was also statistically at par with I_8.

Since, nutrient uptake is a function of yield and its content in grain and stover, therefore, higher grain and stover yield together with the higher values of its nutrient content had resulted in higher nitrogen, phosphorus and potassium uptake in the grain and stover. These results are in agreement with those reported by Kumar *et al*. (2013) [10] and Gonzalez *et al*. (2009) [11].

Table 2 Nutrient uptake (N, P and K) in grain (kg ha^{-1}) of summer pearl millet as influenced by irrigation

Treatments	**Grain (kg ha^{-1})**		
	N	**P**	**K**
I_1 – Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F) + Grain filling (GF)	61.2 a	9.77 a	23.8 a
I_2 – Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F)	52.6 c	8.14 c	19.9 c
I_3 - Irrigation at Tillering (T) + Panicle initiation (PI) + Grain filling (GF)	57.8 b	9.00 b	22.2 b
I_4 - Irrigation at Tillering (T) + Flowering (F) + Grain filling (GF)	55.8 b	8.89 b	21.8 b
I_5 - Irrigation at Panicle initiation (PI) + Flowering (F) + Grain filling (GF)	44.0 e	6.46 e	16.3 e
I_6 - Irrigation at Tillering (T) + Flowering (F)	48.6 d	7.35 d	18.3 d
I_7 - Irrigation at Tillering (T) + Grain filling (GF)	47.4 d	7.20 d	17.9 d
I_8 - Irrigation at Panicle initiation (PI) + Grain filling (GF)	40.4 f	5.70 f	13.9 f
I_9 - Irrigation at Flowering (F) + Grainfilling (GF)	38.9 f	5.51 f	12.6 f
Mean	49.6	7.56	18.55
S. Em. +/-	1.03	0.23	0.48
CD (5%)	3.09	0.70	1.46

Table 3 Nutrient uptake (N, P and K) in stover (kg ha^{-1}) of summer pearl millet as influenced by irrigations

Treatments	**Stover (kg ha^{-1})**		
	N	**P**	**K**
I_1 – Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F) + Grain filling (GF)	90.1 a	15.9 a	164 a
I_2 – Irrigation at Tillering (T) + Panicle initiation (PI) + Flowering (F)	74.6 c	13.4 c	138 c
I_3 - Irrigation at Tillering (T) + Panicle initiation (PI) + Grain filling (GF)	82.7 b	14.7 b	153 b
I_4 - Irrigation at Tillering (T) + Flowering (F) + Grain filling (GF)	81.5 b	14.6 b	149 b
I_5 - Irrigation at Panicle initiation (PI) + Flowering (F) + Grain filling (GF)	58.4 e	10.5 e	115 e
I_6 - Irrigation at Tillering (T) + Flowering (F)	67.1 d	12.2 d	128 d
I_7 - Irrigation at Tillering (T) + Grain filling (GF)	65.5 d	11.7 d	125 d
I_8 - Irrigation at Panicle initiation (PI) + Grain filling (GF)	51.3 f	9.2 f	104 f
I_9 - Irrigation at Flowering (F) + Grainfilling (GF)	49.7 f	8.9 f	102 f
Mean	69	12.34	131
S. Em. +/-	2.04	0.38	3.06
CD (5%)	6.12	1.13	9.20

Conclusion

From this investigation it can be concluded that, out of nine treatments, I_1 followed by I_3 irrigation treatments resulted in significantly higher dry matter production and nutrient uptake in grain and stover and lowest in I_9.

References

[1] G. W. Burton, A. T. Wallace and K. O. Rachie. Chemical composition and nutritive value of pearl millet [Pennisetum typhoides (burm.) stapf and E. C. Hubbard] grain. Crop Science, 1972, 12:187–188.
[2] Directorate of Economics & Statistics, DAC & FW 2018.
[3] Department of Agriculture, Telangana, 2016-17.
[4] S. B. P. Reddy, K. V. Naga madhuri, Keerthi Venkaiah, T. Prathima. Effect of nitrogen and potassium on yield and quality of pearl millet (Pennisetum glaucum L.). International Journal of Agriculture Innovations and Research, 2016, 4(4):678-681.
[5] P. N. Upadhyay, A. G. Dixit, J. R. Patel, J. R. Chavda. Response of summer pearl millet (Pennisetum glaucum) to time and method of planting, age of seedling and phosphorous grown on loamy sand soils of Gujarat. Indian Journal of Agronomy, 2001, 46 (1):126-130.
[6] M. J. Seghatoleslami, M. Kafi, E. Majidi. Effect of deficit irrigation on yield WUE and some morphological and phenological traits of three millet species. Pakistan Journal of Botany, 2008, 40(4): 1555-1560.
[7] L. Singh, C. M. Singh, G. R. Singh. Response of bed planted wheat (Tritcum aestivum L.) under different moisture regimes on water use and its efficiency. Journal of Chemical and Pharmaceutical Research, 2012, 4(11):4941-4945.
[8] P. Kumar, R. K. Pannu. Effect of different sources of nutrition and irrigation levels on yield, nutrient uptake and nutrient use efficiency of wheat. International Journal of Life Science, Botany and Pharma Research, 2012, 1(4):187-192.
[9] N. Vishuddha, G. R. Singh, R. Kumar, S. Raj, B. Yadav. Effect of irrigation levels and nutrient sources on growth and yield of wheat (Triticum aestivum L.). Annals of Agricultural Research, 2014, 35(1):14-20.
[10] S. Kumar, A. S. Dhindwal, R. K. Arya. Dry matter and straw yield in wheat as influenced by preceding crops, planting methods and irrigation levels. Forage Research, 2013, 39(2):88-92.
[11] J. A. Gonzalez, M. Gallardo, M. Hilal, M. Rosa, and F. E. Prado. Physiological responses of quinoa (Chenopodium quinoa Willd.) to drought and waterlogging stresses, dry matter partitioning. Botanical Studies, 2009, 50:35-42.

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