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Response of Foxtail Millet (*Setaria italica*) Varieties to Irrigation Schedules

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Abstract

The experiment was conducted with twelve treatment combinations of four irrigation levels and three varieties in a strip plot design and replicated thrice. The results indicated that foxtail millet growth parameters and yield attributes were significantly higher in four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS which is on par with three irrigations at sowing, 15 DAS and 35 DAS. Grain and straw yields were also significantly higher with four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS. Monetary returns like gross and net returns were also recorded higher values with four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS followed by three irrigations at sowing, 15 DAS and 35 DAS. Among varieties, Renadu (SiA 3223) recorded higher grain, straw yield and monetary returns. However, four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS recorded higher values of soil moisture content (%) at 0-30 cm soil depth and higher water use efficiency was recorded at one irrigation at sowing.

Key words: Irrigation levels, Varieties, Foxtail millet yield, Straw yield, Soil moisture, Water use efficiency

Millets, particularly foxtail millet (*Setaria italica*) are gaining renewed attention as climate resilient crops that offer nutritional security, especially in semi-arid and rainfed regions. Millets, often termed "nutri-cereals," are regaining importance in global food systems because of their resilience to climate variability, low input requirements, and high nutritional value. Among them, foxtail millet (*Setaria italica*) stands out as one of the oldest cultivated millets, widely grown in Asia and parts of Africa [1]. It is especially well-suited for semi-arid and rainfed regions where erratic rainfall, prolonged dry spells, and degraded soils limit the productivity of major cereals like rice, wheat, and maize. Its short growing season, efficient C4 photosynthetic pathway, and remarkable capacity to withstand drought and marginal soil fertility make it a climate-resilient crop capable of stabilizing yields under stress conditions [2-3]. From a nutritional standpoint, foxtail millet contributes significantly to food and nutritional security. The grains are rich in dietary fiber, resistant starch, essential amino acids (especially methionine and lysine), vitamins (notably B-complex), and minerals such as iron, calcium, magnesium, and zinc, making them superior to many staple cereals [4]. With a low glycemic index, foxtail millet is particularly recommended for managing diabetes, obesity, and lifestyle-related disorders, addressing both undernutrition and the growing challenge of non-communicable diseases. Additionally, its gluten-free nature makes it a valuable food for individuals with celiac disease or gluten intolerance [5-6].

In the context of climate change, foxtail millet supports agroecological sustainability by thriving with minimal irrigation, tolerating temperature fluctuations, and requiring fewer chemical inputs. Its ability to grow on poor, degraded, or shallow soils without significant yield loss further underscores its role in restoring degraded lands and sustaining smallholder farmers' livelihoods [7]. Moreover, as global food systems shift towards climate-smart agriculture, the revival of millet cultivation including foxtail millet diversifies diets, enhances resilience of cropping systems, and contributes to achieving Sustainable Development Goals (SDGs) such as zero hunger, good health and well-being, and climate action [8].

Foxtail millet is one of the oldest cultivated millets, characterized by its short life cycle, drought tolerance, and adaptability to poor and marginal soils. It is a staple food in several parts of India and Asia and plays an important role in dryland agriculture due to its low water requirement and resilience to environmental stress [9]. The total area under foxtail millet in India wide is 0.87 lakh ha with an annual production of about 0.66 lakh tonnes with an average productivity of 0.76 t ha^{-1}. India ranks second globally in area and production with 70,000 ha and 0.66 lakh t. The average productivity of Andhra Pradesh is 0.8 to 1.0 t ha^{-1} [10]. In recent years, with increasing population pressure and water scarcity, optimizing water use in agriculture has become a critical challenge. Efficient water management through appropriate irrigation scheduling has the potential to enhance crop productivity while conserving precious water resources. Though foxtail millet is typically grown under rainfed conditions, supplemental irrigation can significantly influence its growth, yield components, and overall productivity, especially when grown during the rabi season or under controlled environments [11].

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The response of foxtail millet (*Setaria italica*) varieties to irrigation schedules clearly demonstrates that, although the crop is recognized for its resilience under water-limited conditions, timely and adequate irrigation at critical growth stages substantially enhances its performance. Research indicates that water availability during panicle initiation, flowering, and grain filling stages is vital for promoting tiller survival, efficient pollination, seed set, and proper grain filling, thereby directly improving yield and grain quality. Short-duration varieties often show better adaptability under deficit irrigation as they can escape terminal drought stress, while long-duration and high-yielding varieties exhibit greater responsiveness to multiple irrigations, achieving higher biomass and productivity when assured water supply is available [12]. Moreover, varietal differences in root architecture and water use efficiency (WUE) underline the importance of genotype-specific irrigation strategies, where some cultivars sustain yields under minimal irrigation while others demand frequent watering to realize their full genetic potential. Importantly, efficient irrigation scheduling, such as one or two irrigations at key stages or maintaining soil moisture at 50–60% depletion, strikes a balance between yield maximization and water conservation [13]. Thus, corroborating evidence suggests that integrating varietal characteristics with strategic irrigation schedules not only enhances foxtail millet productivity and nutritional quality but also supports climate-resilient, water-efficient, and sustainable millet-based farming systems. The response of different foxtail millet varieties to irrigation schedules varies depending on their genetic makeup and water use efficiency [14]. Understanding the interaction between irrigation timing and variety performance is crucial for developing sustainable and high yielding millet-based farming systems. However, limited research exists on the combined effect of irrigation regimes and varietal responses under field conditions. Hence, the present study was undertaken to evaluate the performance of foxtail millet varieties under different irrigation schedules, with an objective to identify suitable irrigation strategies and varieties that can maximize water use efficiency, enhance yield and promote sustainable millet cultivation under limited water conditions.

MATERIALS AND METHODS

A field experiment was conducted during rabi, 2024 at College Farm, Agricultural College, Mahanandi on sandy loam soils with pH 7.46, OC 0.43%, EC 0.29 dS m^{-1}, available N (138.7 kg ha^{-1}), available P_2O_5 (36.1 kg ha^{-1}) and available K_20 (562.8 kg ha^{-1}). A total of 31.99 mm rainfall received during crop growth period. The experiment was laid out in strip plot design and the treatments were replicated thrice. The treatments consisted of five irrigation level treatments *viz*., one irrigation at sowing (I_1), two irrigations at sowing and 15 DAS (I_2), three irrigations at sowing, 15 DAS and 35 DAS (I_3) and four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4) and three varieties viz., Suryanandi (SiA 3088) (V_1), Mahanandi (SiA 3159) (V_2), Renadu (SiA 3159) (V_3). Sowing of all varieties were done on 16th November, 2024. Seeds were treated with Thiram 42-S @1g kg^{-1} of seed. Hand dibbled at a depth of 2 cm. Fertilizer doses were calculated as per the treatment schedule and applied in the form of inorganic fertilizers i.e., urea, single super phosphate (SSP) respectively to all the plots. Half dose of nitrogen fertilizer and full dose of phosphorous were applied as basal and remaining half dose of nitrogen fertilizer was applied as top dressing at 30 days after sowing (DAS). Gap filling and thinning was done at 15 days after sowing (DAS) to maintain optimum plant population in all the plots. The crop was maintained by adopting the recommended package of practices. Weeding is done two times at 20 and 40 DAS to keep the plots free from weeds. The data on plant yield attributing characters, yield and water use efficiency were recorded as per standard statistical procedures. Soil moisture percentage was estimated at different crop growth stages by gravimetric method. Water use efficiency (kg ha^{-1} mm^{-1}) was calculated by using formula:

$$\text{Water use efficiency (kg ha}^{-1}) = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Amount of water given (mm)}}$$

RESULTS AND DISCUSSION

Plant growth parameters

Irrigation level treatments and varieties significantly influenced plant height (cm) but was not influenced by their interaction effect (Table 1). Plant height was significantly higher in four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4), followed by three irrigations at sowing, 15 DAS and 35 DAS (I_3) and recorded lower in one irrigation at sowing (I_1). Among the varieties, Renadu (SiA 3159) (V_3) recorded tallest plants and it is comparable with Mahanandi (SiA 3159) (V_2) while, the lowest plant height is observed in Suryanandi (SiA 3088) (V_1). This may be due to plants receiving optimal or higher availability exhibited more vigorous vegetative growth compared to those under limited irrigation conditions [15]. Dry matter accumulation (kg ha^{-1}) was significantly influenced by irrigation level treatments and not influenced varieties by their interaction effect. Dry matter accumulation (kg ha^{-1}) was significantly recorded higher in four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4) and by three irrigations at sowing, 15 DAS and 35 DAS (I_3) and was recorded lower in one irrigation at sowing (I_1). This result might be due to adequate soil moisture availability enhances vegetative growth and biomass production and helps in metabolic processes such as photosynthesis, nutrient uptake and cell expansion all of which directly contribute to dry matter synthesis. Leaf area index was significantly influenced by irrigation level treatments and not influenced varieties by their interaction effect [16]. Leaf area index was significantly recorded higher in four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4) and by three irrigations at sowing, 15 DAS and 35 DAS (I_3) and was recorded lower in one irrigation at sowing (I_1). This indicates that water stress and overwatering both negatively affect canopy development. An optimized LAI enhances light interception and photosynthesis, thereby supporting yield potential [17].

Yield attributing characters and yield

Number of tillers m^{-2}, number of panicles m^{-2}, panicle length (cm), panicle weight (g), weight of the grains $panicle^{-1}$ (g), test weight (g), grain yield and straw yield (kg ha^{-1}) presented in (Table 2) indicated significant differences due to irrigation level treatments, and their varieties and interactions between them were found non-significant. Irrigation level treatments significantly influenced the yield attributing characters viz., Number of tillers m^{-2}, number of panicles m^{-2}, panicle length (cm), panicle weight (g), weight of the grains $panicle^{-1}$ (g), test weight (g) was recorded higher with four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4) which is on par with three irrigations at sowing, 15 DAS and 35 DAS (I_3) and was recorded lower in one irrigation at sowing (I_1). Varieties are not significantly influenced by number of seeds pod^{-1}, number of pods $plant^{-1}$, seed weight $plant^{-1}$ and test weight (g) [18-20].

Table 1 Plant growth parameters of foxtail millet as influenced by irrigation levels and varieties during *rabi*, 2024-2025

Treatments	Plant height (cm)	Dry matter accumulation (kg ha^{-1})	Leaf area index (LAI)
Irrigation levels - 04			
I_1: One irrigation at sowing	114.1	3027.2	1.18
I_2: Two irrigations at sowing and 15 DAS	117.8	4031.5	1.28
I_3: Three irrigations at sowing, 15 DAS and 35 DAS	122.2	5548.2	1.48
I_4: Four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS	128.2	5685.3	1.49
SEm ±	2.06	181.12	0.052
CD (P = 0.05)	7.78	526.03	0.152
CV (%)	9.5	10.0	9.2
Varieties - 03			
V_1: Suryanandi (SiA 3088)	117.5	4185.5	1.26
V_2: Mahanandi (SiA 3159)	118.8	4622.6	1.39
V_3: Renadu (SiA 3159)	125.1	4911.1	1.47
SEm ±	2.53	221.82	0.063
CD (P=0.05)	4.57	NS	NS
CV (%)	3.3	11.3	10.5
Interaction (I × V)			
SEm ±	1.46	128.07	0.032
CD (P=0.05)	NS	NS	NS
CV (%)	9.2	9.7	9.2

Table 2 Yield attributing characters, grain and straw yield of foxtail millet as influenced by irrigation levels and varieties during *rabi*, 2024-2025

Treatments	No. of tillers m^{-2}	No. of panicles m^{-2}	Panicle length (cm)	Panicle weight (g)	Weight of grains panicle^{-1} (g)	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
Irrigation levels – 04								
I_1: One irrigation at sowing	58.2	48.3	14.1	4.9	3.2	2.42	1215	1819
I_2: Two irrigations at sowing and 15 DAS	63.4	52.3	15.9	5.8	3.9	2.63	1620	2415
I_3: Three irrigations at sowing, 15 DAS and 35 DAS	66.8	56.1	17.9	8.2	5.6	2.67	2210	3337
I_4: Four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS	70.1	59.1	20.7	8.6	5.8	2.69	2269	3415
SEm ±	2.43	2.04	0.65	0.27	0.18	0.097	72.3	108.8
CD (P = 0.05)	7.48	6.28	2.00	0.80	0.53	NS	210.1	316.0
CV (%)	10.0	10.1	9.4	7.5	5.5	5.4	10.0	10.2
Varieties – 03								
V_1: Suryanandi (SiA 3088)	59.5	49.9	15.8	6.3	4.2	2.40	1674	2514
V_2: Mahanandi (SiA 3159)	65.2	54.7	17.3	7.0	4.7	2.63	1848	2776
V_3: Renadu (SiA 3159)	69.1	57.9	18.3	7.4	4.9	2.78	1963	2949
SEm ±	2.98	2.50	0.79	0.33	0.22	0.119	88.6	133.2
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	11.4	11.4	9.4	6.8	5.9	5.5	11.3	11.4
Interaction (I × V)								
SEm ±	1.72	1.44	0.46	0.19	0.12	0.069	51.1	76.9
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	9.2	9.4	9.3	7.2	5.8	4.8	9.7	9.8

Economics

The calculated monetary data were presented in (Table 3), which showed that irrigation level treatments are significantly influenced but varieties and their interaction between both were found to be non-significant. Higher amount of gross and net returns was recorded with four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4) which is on par with three irrigations at sowing, 15 DAS and 35 DAS (I_3) with significant difference between them significantly lower returns noticed with one irrigation at sowing (I_1). Benefit cost ratio invested in raising foxtail millet were influenced by irrigation level treatments but not by varieties. The interaction effect between irrigation levels and varieties has been found to be non-significant. Regarding irrigation level treatments, four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4) which was recorded significantly higher B:C ratio followed by three irrigations at sowing, 15 DAS and 35 DAS (I_3) both were significantly superior over one irrigation at sowing (I_1) respectively [21-22].

Soil moisture content (%)

The soil moisture content was estimated at each before and after irrigation and was estimated and presented in Table 4. The results indicated that irrigation levels significantly influenced the soil moisture content at every irrigation. Whereas, varieties and their interaction with irrigation levels and varieties failed to show a significant difference. Among the irrigation level treatments, soil moisture content is non-significant in first irrigation whereas, from second irrigation, the highest soil moisture content was recorded in the treatment with four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4), followed by three irrigations at sowing, 15 DAS, 35 DAS (I_3), two irrigations at sowing and 15 DAS (I_2) and the lowest in one irrigation at sowing (I_1). The increase in soil moisture after irrigation was consistent across all events, indicating the effectiveness of scheduled irrigation in maintaining optimal moisture levels. At the fourth irrigation, soil moisture content after irrigation under I_4 reached 38.5 % at 0-15 cm depth and 39.6 % at 15-30 cm, significantly higher than I_1 which showed only 20.5 % and 21.3 %, respectively. Across all treatments, slightly higher soil moisture was generally observed in the 15-30 cm depth compared to the 0-15 cm depth, both before and after irrigation. This indicates better retention of moisture in deeper layers, potentially beneficial for deeper rooted crops like foxtail millet. These differences were statistically significant at later stages (3rd and 4th irrigations). Similar results are reported by Choudhary *et al*. [23] in quinoa, Pawar and Dahat [24] in pearl millet and Gond *et al*. [25] in wheat.

Table 3 Monetary returns of foxtail millet crop as influenced by irrigation levels and varieties during *rabi*, 2024-2025

Treatments	Gross returns (₹ ha^{-1})	Net returns (₹ ha^{-1})	B:C ratio
Irrigation levels - 04			
I_1: One irrigation at sowing	39971	17005	1.74
I_2: Two irrigations at sowing and 15 DAS	53289	29723	2.26
I_3: Three irrigations at sowing, 15 DAS and 35 DAS	72722	48556	3.01
I_4: Four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS	74657	49891	3.02
SEm ±	2380.6	2380.6	0.098
CD (P = 0.05)	6915.6	6915.6	0.284
CV (%)	10.0	10.0	9.9
Varieties - 03			
V_1: Suryanandi (SiA 3088)	55070	31204	2.29
V_2: Mahanandi (SiA 3159)	60810	36944	2.53
V_3: Renadu (SiA 3159)	64599	40733	2.69
SEm ±	2915.6	2915.6	0.121
CD (P=0.05)	NS	NS	NS
CV (%)	11.3	11.3	9.9
Interaction (I × V)			
SEm ±	1683.3	1683.3	0.121
CD (P=0.05)	NS	NS	NS
CV (%)	9.7	9.7	9.7

Table 4 Soil moisture content (%) before and after irrigation of foxtail millet as influenced by irrigation levels and varieties during *rabi*, 2024-2025

Treatments	1st Irrigation				2nd Irrigation				3rd Irrigation				4th Irrigation			
	Before irrigation		After irrigation		Before irrigation		After irrigation		Before irrigation		After irrigation		Before irrigation		After irrigation	
Soil depth	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Levels – 04																
I_1:	15.3	16.2	30.5	31.3	14.3	15.2	14.3	15.2	12.3	13.1	12.3	13.1	10.4	11.8	10.4	11.8
I_2:	15.7	16.5	30.3	32.8	17.5	18.1	30.5	31.5	15.5	16.5	15.5	16.5	14.6	15.1	14.6	15.1
I_3:	15.8	16.7	30.7	32.2	17.8	18.5	31.6	32.4	16.9	17.6	35.8	36.4	15.6	16.2	15.6	16.2
I_4:	15.9	16.9	30.6	32.6	18.2	18.9	32.9	33.5	17.6	18.3	36.5	37.2	16.1	16.9	38.5	39.6
SEm ±	0.58	0.61	0.95	1.0	0.64	0.67	1.11	1.14	0.59	0.62	1.06	1.08	0.55	0.57	0.81	0.83
CD (P=0.05)	NS	NS	NS	NS	1.91	2.0	2.98	3.04	1.76	1.85	3.08	3.16	1.58	1.69	2.71	2.84
CV (%)	10.1	10.1	10.1	10.1	9.8	9.8	9.4	9.4	9.8	9.8	10.7	10.6	9.7	9.8	11.9	11.9
Varieties – 03																
V_1:	14.5	15.3	30.4	32.9	15.6	16.2	25.0	25.8	14.3	15.0	22.7	23.4	13.0	13.8	18.3	19.2
V_2:	15.9	16.7	30.7	31.2	17.1	17.8	27.6	28.4	15.7	16.5	25.3	26.1	14.3	15.1	20.0	20.1
V_3:	16.7	17.7	30.1	32.8	18.1	18.9	29.3	30.2	16.6	17.5	27.0	27.8	15.1	16.0	21.0	21.2
SEm ±	0.71	0.75	1.16	1.23	0.79	0.82	1.36	1.40	0.73	0.76	1.29	1.32	0.67	0.70	0.99	1.02
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	11.6	11.6	11.6	11.6	11.4	11.4	11.1	11.1	11.3	11.3	11.7	11.7	11.3	11.3	10.6	10.7
Interaction (I × V)																
SEm ±	0.41	0.43	0.67	0.71	0.45	0.47	0.79	0.81	0.42	0.44	0.74	0.76	0.39	0.40	0.57	0.59
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	9.2	9.2	9.2	9.2	9.3	9.3	10.0	10.0	9.4	9.4	10.4	10.3	9.6	9.4	10.0	9.9

Table 5 Water use efficiency (kg ha^{-1} mm^{-1}) of foxtail millet as influenced by irrigation levels and varieties during *rabi*, 2024-2025

Treatments	Water use efficiency (kg ha^{-1} mm^{-1})
Irrigation levels: 4	
I_1: One Irrigation at sowing	15.19
I_2: Two Irrigations at sowing and 15 DAS	12.74
I_3: Three Irrigations at sowing, 15 DAS and 35 DAS	13.99
I_4: Four Irrigations at sowing, 15 DAS, 35 DAS and 55 DAS	8.69
SEm ±	0.465
CD (P=0.05)	1.459
CV (%)	10.0
Varieties: 3	
V_1: Suryanandi (SiA 3088)	12.14
V_2: Mahanandi (SiA 3159)	12.78
V_3: Renadu (SiA 3223)	13.03
SEm ±	0.569
CD (P=0.05)	NS
CV (%)	12.3
Interaction (I × V)	
SEm ±	0.328
CD (P=0.05)	NS
CV (%)	9.0

Water use efficiency

The water use efficiency of foxtail millet was significantly influenced by different irrigation level treatments, while varietal differences were found to be non-significant. The interaction between irrigation levels and varieties was also found to be non-significant. The data is indicated and presented in (Table 5). A clear inverse relationship was observed between the frequency of irrigation and water use efficiency. The highest WUE was recorded under the treatment with one irrigation at sowing (I_1) which is on par with three irrigations at sowing, 15 DAS and 35 DAS. This was significantly higher than the WUE observed in other irrigation treatments. As the number of irrigations increased, the WUE decreased, with the lowest value observed under four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4). These results suggest that excess irrigation reduces water use efficiency, likely due to diminishing returns in yield response per unit of water applied. The statistical analysis confirmed significant differences among irrigation levels indicating that water saving irrigation schedules could enhance water productivity in foxtail millet cultivation [26-28].

CONCLUSION

The renewed attention towards foxtail millet is not only a response to its climate resilience but also to its ability to provide nutritional security in vulnerable ecosystems, making it a strategic crop for the future of food and farming in semi-arid and rainfed regions. Based on the present study, it can be concluded that irrigation scheduling had a significant impact on the growth, yield attributes and yield of foxtail millet, whereas varietal differences were mostly non-significant. Among the treatments, four irrigations at sowing, 15 DAS, 35 DAS and 55 DAS (I_4) recorded the highest plant growth, yield attributes, grain and straw yield and economic returns, although it showed lower water use efficiency. The variety Renadu (SiA 3223) (V_3) exhibited comparatively better growth performance. Overall optimum irrigation scheduling with irrigation at critical stages of crop growth played a crucial role in improving foxtail millet productivity under sandy loam soils at scarce rainfall zone during the rabi season.

LITERATURE CITED

1. Kheya SA, Talukder SK, Datta P, Yeasmin S, Rashid MH, Hasan AK, Anwar MP, Islam AKMA, Islam AKMM. 2023. Millets: The future crops for the tropics - Status, challenges and future prospects. *Heliyon* 9(11): e22123.
2. Mukherjee B, Jha RK, Sattar A, Dutta S, Bhattacharya U, Samanta S, Huirem B, Singh SK, Das S, Bal SK. 2025. Harnessing the potential of millets for climate-resilient and sustainable agriculture. *Front. Plant Science* 16: 1574699.
3. Msweli NS, Agholor IA, Morepje MT, Sithole MZ, Nkambule TB, Thabane VN, Mgwenya LI, Nkosi NP. 2025. Optimizing water conservation in South Africa's arid and semi-arid regions through the cultivation of indigenous climate-resilient food crops. *Sustainability* 17(3): 1149. https://doi.org/10.3390/su17031149
4. Louhar G, Bana RS, Kumar V, Kumar H. 2020. Nutrient management technologies of millets for higher productivity and nutritional security. *Indian Jr. Agric. Science* 90: 2243-2250. doi: 10.56093/ijas.v90i12.110267
5. Agrawal P, Singh BR, Gajbe U, Kalambe MA, Bankar M. 2023. Managing diabetes mellitus with millets: A new solution. *Cureus* 15(9): e44908. doi: 10.7759/cureus.44908.
6. Jacob J, Krishnan V, Antony C, Bhavyasri M, Aruna C, Mishra K, Nepolean T, Satyavathi CT, Visarada KBRS. 2024. The nutrition and therapeutic potential of millets: an updated narrative review. *Frontiers of Nutrition* 11: 1346869. doi: 10.3389/fnut.2024.1346869
7. Uma Gowri M, Prabhu R. 2017. Millet production and its scope for revival in India with special reference to Tamil Nadu. *International Journal of Farm Sciences* 7(2): 88-93.
8. Deshpande SS, Asthana AK. 2024. Millets: A nutrient - Rich path to sustainable development goals, bridging the gap between environment and health. *Jr. Ayurveda Integr. Med. Science* 9(9): 190-196. https://jaims.in/jaims/article/view/3429
9. Singh RK, Prasad M. 2020. Foxtail millet: A climate-resilient crop species with potential to ensure food and agriculture security amidst global climate change. *International Journal of Plant and Environment* 6(3): 165-169
10. Banerjee R, Bharti, Das P, Barman S, Devi S, Ankita. 2024. Comprehensive analysis of millets in India: Area, production, cost of production and export statistics. *Current Agriculture Research Journal* 12(3): 1181-1192.
11. Gao X, Zhao N, Lu Y, Han X, Yang Z. 2022. Effects of supplementary irrigation on soil respiration of millet farmland in a semi-arid region in China. *Atmosphere* 13(10): 1584. https://doi.org/10.3390/atmos13101584
12. Gao S, Wang C, Yang X, Ji T, Shang S, Li S, Wen Y, Ren J, Li X, Zhao J. 2025. Adaptability of foxtail millet varieties based on photosynthetic performance and agronomic traits. *Plants* 14(16): 2502. https://doi.org/10.3390/plants14162502
13. Maurya SK, Kalhapure A, Verma VK, Tiwari A, Chaubey C, Maurya DK, Kumar M. 2024. Irrigation scheduling and cultivar management for increasing water productivity under dryland condition: A review. *International Journal of Environment and Climate Change* 14(1): 461-470.

14. Soumya MB, Reddy MS, Prabhakar K, Sireesha PVG, Reddy ASR. 2025. Response of foxtail millet (*Setaria italica*) varieties to irrigation schedules. *Int. Jr. Res. Agronomy* 8(7): 675-679.
15. Halli HM, Angadi S, Kumar A, Govindasamy P, Madar R, El-Ansary DO, Rashwan MA, Abdelmohsen SAM, Abdelbacki AMM, Mahmoud EA. 2021. Influence of planting and irrigation levels as physical methods on maize root morphological traits, grain yield and water productivity in semi-arid region. *Agronomy* 11(2): 294. https://doi.org/10.3390/agronomy11020294
16. Amanullah, Khalid S, Khalil F, Elshikh MS, Alwahibi MS, Alkahtani J, Imranuddin, Imran. 2021. Growth and dry matter partitioning response in cereal-legume intercropping under full and limited irrigation regimes. Science Reporter 11(1): 12585. doi: 10.1038/s41598-021-92022-4.
17. Saifullah, Jan A, Munsif F, Arif M, Khan H, Ali K, Waqas M, Ali A. 2011. Performance of millet varieties under different irrigation levels. *Sarhad Jr. Agriculture* 27(1): 1-7.
18. Ahmad A, Kumar R. 2015. Effect of irrigation scheduling on the growth and yield of wheat genotypes. *Agricultural Science Digest* 35(3): 199-202.
19. Solanki KA, Malve SH, Solanki DM, Vala YB. 2024. Effect of irrigation and silicon on growth, yield and water use efficiency of summer pearl millet (*Pennisetum glaucum* L.). *International Journal of Research in Agronomy* 7(10): 1030-1034.
20. Shubham, Abraham T, Neha, Choudhary P. 2018. Productivity and water use efficiency of summer pearl millet (*Pennisetum glaucum* L.) hybrids as influenced by irrigation scheduling in Eastern Uttar Pradesh plains. *Chemical Science Review and Letters* 7(27): 801-805.
21. Khafi HR, Mehta AC, Bunsa BD, Dangaria CJ, Davda BK. 2011. Response of summer pearl millet (*Pennisetum glaucum* L.) to irrigation scheduling. *Crop Research* 41(1/3): 28-30.
22. Ray S, Umesha C, Meshram MR, Sanodiya LK. 2021. Influence of irrigation and hydrogel application on yield and economics of pearl millet (*Pennisetum glaucum* L.) under Eastern U.P. conditions *Environment Conservation Journal* 22(3): 31-36.
23. Choudhary M, Tetarwal JP, Ram B, Kumar R, Bijarnia A, Kumawat R. 2022. Effect of land configuration and irrigation scheduling on productivity and water use of quinoa (*Chenopodium quinoa*) under south-eastern ecologies of Rajasthan. *Indian Journal of Agronomy* 67(1): 108-112.
24. Pawar PB, Dahat DV. 2022. Consumptive use, water use efficiency and moisture extraction pattern of summer pearl millet in Western Maharashtra as influenced by sowing times and irrigation regimes. *Journal of Agriculture Research and Technology* 47(3): 247-251.
25. Gond S, Singh MK, Satapathy SM. 2023. Irrigation scheduling and soil moisture use on growth and yield of late sown wheat (*Triticum aestivum* L.) varieties. *Environment Conservation Journal* 24(1): 176-182.
26. Alhassan I, Saddiq AM, Gashuva AG, Kura KKG. 2017. Effects of irrigation scheduling and soil management on maize (*Zea mays* L.) yield in Guinea Savannah Zone of Nigeria. *International Journal of Agricultural and Biosystems Engineering* 11(6): 439-443.
27. Huang Y, Zhang Z, Li Z, Dai D, Li Y. 2022. Evaluation of water use efficiency and optimal irrigation quantity of spring maize in Hetao Irrigation District using the Noah-MP Land Surface Model. *Agricultural Water Management* 264: 107498.
28. Sharma B, Kumari R, Kumari P, Meena SK, Singh RM. 2015. Effect of planting pattern on productivity and water use efficiency of pearl millet in the Indian semi-arid region. *Journal of the Indian Society of Soil Science* 63(3): 259-265.