International Journal of Environment and Climate Change

Volume 14, Issue 2, Page 423-430, 2024; Article no.IJECC.112077
ISSN: 2581-8627
(Past name: British Journal of Environment & Climate Change, Past ISSN: 2231–4784)

Effect of Drip Fertigation on Growth and Quality Parameters of Summer Pearlmillet under North Gujarat Agro-climatic Condition

M. A. Chaudhary [a*], D. M. Patel [a], H. N. Chaudhary [a], V. B. Gohil [a] and K. V. Chaudhary [a]

[a] Department of Agronomy, C.P. College of Agriculture, S.D. Agricultural University, Sardarkrushinagar, Gujarat, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2024/v14i23957

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/112077

Short Research Article

Received: 01/12/2023
Accepted: 06/02/2024
Published: 10/02/2024

ABSTRACT

A field experiment was conducted during the two consecutive summer seasons of 2021 and 2022 at Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar to asses the effect of drip fertigation on growth and quality parameters of summer pearlmillet under North Gujarat condition. There were 18 treatment combinations comprising two irrigation intervals *viz*., One and Two days interval; three moisture regimes *viz*., 100, 80 and 60% ETc in the main plot and three levels of N fertigation *viz*., 100, 80 and 60% RDN in sub-plot were tested in split plot design with three replications. The pooled results of irrigation interval, moisture regime and fertigation practice show that application of irrigation at alternate day under 100% ETc along with 100% RDN through drip fertigation had a significant effect on crop growth, yield and yield contributing characters and quality parameters and

**Corresponding author: E-mail: machaudhari111@gmail.com;*

their values were significantly higher than other irrigation interval, drip irrigation regimes and fertigation levels. It also uptake significantly higher nitrogen and phosphorus in grain and straw of pearlmillet raised during summer season.

Keywords: Summer pearlmillet; drip irrigation; drip fertigation; N uptake; P uptake; growth parameters; yield.

1. INTRODUCTION

Pearlmillet is an important staple food and also occupies an important place in the daily diet of the majority classes of people in India. The nutritive value of the pearlmillet crop is fairly high. It contains 12.4% moisture, 11.6% protein 5.0% fat, 67.0% carbohydrates and 2.75 minerals. It is also rich in vitamin 'A,' and vitamin 'B' and imparts substantial energy of 360 kilo calories/100 g [1]. Because of its high nutritive value and capacity to grow in harsh weather conditions, the government of India recognized it as a nutritive millet and considering the high nutritive value of millets, FAO has declared 2023 as the international year of millet.

Irrigation interval plays a vital role in terms of growth, development and yield of pearlmillet during the summer season by maintaining moisture condition around field capacity in the rhizosphere which improves optimum aeration and create favourable condition in the root zone area, as well as enhances the availability of all major and micronutrients. The fluctuations in moisture content have adverse effects on plant growth and crop yield. Drip irrigation is a state-of-the-art technology and one of the advanced methods of irrigation. If the drip system is properly designed and managed, it can provide high uniformity of water distribution. Drip irrigation is the most practical solution for water scarcity as well as for increasing the production per drop of water. Application of water to crops through drip irrigation can save water up to 20 to 48% besides improving crop yield to the extent of 20 to 38% per cent (https://pmksy.gov.in). Application of optimum amount of water to the crops helps to avoid adverse effects such as over-irrigation or under-irrigation. In this condition regular supply of sufficient quantity of water was necessary and it could be achieved through optimum scheduling of irrigation based on sound scientific principles. Among the different approaches to irrigation scheduling, the crop evapotranspiration (ETc) approach is found to be the most appropriate as it include both, evaporation from soil and transpiration from plants. It is estimated that 99% of crop water requirement is used to meet evapotranspiration demand. Fertigation is an efficient and agronomically sound method of providing soluble plant nutrients directly to the active plant root zone. Fertigation is the precise application of irrigation water and plant nutrients through the drip irrigation system to match the real time demand of the crop for nutrients and water need. Addressing these issue requires an introduction of proper interval of irrigation, scheduling of irrigation considering crop evapotranspiration (ETc) and fertigation through drip irrigation in pearlmillet during hot weather season.

2. MATERIALS AND METHODS

The field experiment was carried out during the summer of 2021 and 2022 at the Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, District Banaskantha in North Gujarat. The soil of the experimental field was loamy sand with low organic carbon (0.24%) and available nitrogen (159 kg/ha), medium in phosphorus (33 kg/ha) and high in potassium (289 kg/ha) status. The present investigation was laid out in a split plot design with three replications. The allotment of treatments to various plots in each replication was done by referring to the random number. The treatments comprise irrigation interval (D_1: One-day interval, D_2: Two days interval) and moisture regime (M_1: 100% ETc, M_2: 80% ETc and M_3: 60% ETc) are in the main plot while in a subplot comprising nitrogen fertigation (N_1: 100% RDN, N_2: 80% RDN and N_3: 60% RDN) treatments.

The pearlmillet seeds (variety, GHB 1129) were drilled manually by maintaining 30 cm inter row spacing. The lateral was laid out at 90 cm distance i.e. one lateral between two rows having dripper distance of 30 cm and discharge rate of 4 lph. Drip irrigation was scheduled as per treatment and recommended dose of nitrogen (120 kg/ha) of which 30% RDN are applied as basal at the time of sowing and remaining 70% RDN was applied through drip irrigation using venturies in 6 splits at 6 days interval (starting

from days after sowing) as per treatments. The entire P (60 kg/ha) was applied in furrows as basal dose through SSP. Application of irrigation through drip irrigation system was started 7 DAS and terminated 10 days before the physiological maturity of the crop. First irrigation was applied by surface irrigation to a depth of 5 cm immediately after sowing of pearlmillet during both the years. The statistical analysis of the data generated for various parameters during the investigation was carried out following the procedure of split-plot design described by Panse and Sukhatme [2]. The variances of different sources of variation in ANOVA were tested by the 'F' test and compared with the value of table 'F' at a 5 per cent level of significance.

3. RESULTS AND DISCUSSION

3.1 Effect of Irrigation Interval

All growth attributes *viz*. plant height (cm), dry matter accumulation per plant (g), crop growth rate (g/m2/day) and relative growth rate (mg/g/day) were significantly influenced by different irrigation intervals in pooled results of two years.

Significantly higher plant height (48.0, 125.8, and 179.3 cm at 30, 60 DAS and at harvest respectively), dry matter accumulation per plant (4.16, 40.94 and 78.77 g at 30, 60 DAS and at harvest respectively), crop growth rate (3.08, 27.25 29.01 g/m^2/day between 0-30 DAS, 30- 60 DAS and 60 DAS- at harvest respectively) and relative growth rate (46.69, 119.97 and 124.99 mg/g/day between 0-30 DAS, 30- 60 DAS and 60 DAS- at harvest respectively). Similarly drip system operated at alternate day (D_1) recorded significantly higher uptake of nitrogen and phosphorus uptake by grain (101.30 and 17.24 kg/ha, respectively) and straw (79.48 and 14.21 kg/ha, respectively) as compared to two days interval (D_2) in pooled results. The frequent irrigations (alternate day) enhanced the plant growth in terms of plant height, dry matter production, CGR and RGR mainly due to continued availability of adequate water as per required quantity at all growth stages. Continued availability of soil moisture and nutrients availability to pearlmillet increases the plant growth. A favourable influence on plant height lead to increase in dry matter production per plant, crop growth rate as well as relative growth rate of pearlmillet. These findings confirm the results of Alipatra *et. al.* [3] and Ray *et. al*. [4]. The lowest plant height, dry matter accumulation per plant, CGR and RGR observed in less frequent irrigation treatment (two days interval) leading to moisture stress particularly in hot weather conditions during the crop growth period [5].

3.2 Effect of Moisture Regime

An appraisal of data exhibited in Table 1 indicated that the effect of moisture regime treatments was found significant on periodical plant height (cm), dry matter accumulation per plant (g), crop growth rate (g/m2/day) and relative growth rate (mg/g/day). Data about plant height (cm), dry matter accumulation per plant (g), crop growth rate (g/m2/day) and relative growth rate (mg/g/day) indicated that 100% ETc (M_1) recorded significantly the higher plant height (cm), dry matter accumulation per plant (g), crop growth rate (g/m2/day), relative growth rate (mg/g/day), protein yield (kg/ha) and nitrogen and phosphorus uptake by grain as well as straw as compared to moisture regime of 80% ETc (M_2) and 60% ETc (M_3) during both the years and in the pooled analysis, respectively. Application of irrigation water in M_1 (100% ETc) maintained soil moisture in the available range and might have provided congenial conditions for providing uninterrupted nutritional supply resulting in a favourable growth in terms of cell division and increase in cell size resulting in expansion of the plant. These results are similar to the findings reported by Kachhadia *et al*. [6].

An appraisal of data exhibited in Table indicated that the effect of different levels of crop evapotranspiration was found non-significant on number of internodes per plant, leaf area per plant at 60 DAS, leaf area index at 60 DAS, chlorophyll content at 60 DAS, protein content (%) nitrogen and phosphorus content in grain as well as in straw during both the years of investigation and in pooled mean, respectively [7-9].

3.3 Effect of N Fertigation

Plant height, dry matter accumulation per plant, crop growth rate, relative growth rate, leaf area per plant, chlorophyll index, protein content and protein yield varied significantly in response to different nitrogen fertigation levels (Table 2.). Drip fertigation of 100% RDN (N_1) suppressed the other fertigation levels, i.e. 80% and 60% of RDN by registering the significantly highest plant height (49.8, 123.3 and 179.6 cm at 30, 60 DAS

Table 1. Effect of irrigation interval, moisture regime and N fertigation on plant height, CGR and RGR of summer pearlmillet (Pooled data of two years)

Treatments	Plant height (cm)			dry matter accumulation per plant (g)			Crop growth rate ($g/m^2/day$)			Relative growth rate (mg/g/day)		
Main plot	**30 DAS**	**60 DAS**	**At harvest**	**30 DAS**	**60 DAS**	**At harvest**	**0-30 DAS**	**30-60 DAS**	**60 DAS-harvest**	**0-30 DAS**	**30-60 DAS**	**60 DAS-harvest**
Irrigation interval (D)												
D_1: One day interval	48.0	125.8	179.3	4.16	40.94	78.77	3.08	27.25	29.01	46.69	119.97	124.99
D_2: Two day interval	41.2	110.7	166.9	3.62	38.07	70.75	2.68	25.52	25.06	42.09	117.83	120.00
S.Em.±	0.7	1.81	2.66	0.06	0.49	0.79	0.05	0.36	0.50	0.56	0.44	0.60
C.D. (P = 0.05)	2.1	5.34	7.86	0.19	1.44	2.34	0.14	1.05	1.47	1.67	1.30	1.77
Levels of moisture regime (M)												
M_1: 100% ETc	51.0	128.0	188.6	4.43	42.41	79.85	3.28	28.13	28.72	49.16	121.06	124.59
M_2: 80% ETc	44.8	116.5	174.4	4.17	39.64	76.52	3.09	26.28	28.28	47.10	118.84	124.21
M_3: 60% ETc	38.1	110.3	156.4	3.06	36.46	67.92	2.27	24.74	24.10	36.90	116.82	118.68
S.Em.±	0.9	2.22	3.26	0.08	0.60	0.97	0.06	0.44	0.61	0.69	0.54	0.74
C.D. (P = 0.05)	2.6	6.54	9.62	0.23	1.77	2.86	0.17	1.29	1.80	2.05	1.59	2.17
C.V. %	11.72	11.25	11.31	12.05	9.09	7.78	12.05	9.96	13.56	9.39	2.73	3.60
Sub plot												
Levels of nitrogen fertigation (N)												
N_1: 100% RDN	49.8	123.3	179.6	4.29	41.28	78.56	3.17	27.40	28.58	47.86	120.13	124.34
N_2: 80% RDN	43.7	116.5	172.0	4.01	39.51	74.77	2.97	26.30	27.05	45.46	118.92	122.47
N_3: 60% RDN	40.3	115.0	167.8	3.37	37.72	70.95	2.50	25.45	25.47	39.85	117.66	120.67
S.Em.±	0.68	1.46	2.09	0.06	0.48	0.77	0.05	0.36	0.54	0.53	0.44	0.66
C.D. (P = 0.05)	1.93	4.14	5.95	0.18	1.36	2.20	0.13	1.03	1.52	1.51	1.26	1.87
Sig. interactions	-	-	-	-	-	-	-	-	-	-	-	-
C.V.%	9.13	7.38	7.25	9.89	7.25	6.21	9.89	8.26	11.90	7.21	2.24	3.22

Table 2. Effect of irrigation interval, moisture regime and N fertigation on number of internodes per plant, leaf area per plant at 60 DAS, leaf area index and chlorophyll content at 60 DAS of summer pearlmillet (Pooled data of two years)

Treatments	Number of internodes per plant	Leaf area per plant at 60 DAS (cm^2)	Leaf area index	Chlorophyll content (SPAD value)
Main plot				
Irrigation interval (D)				
D_1: One day interval	6.9	1726.46	3.84	41.68
D_2: Two day interval	6.7	1642.32	3.65	40.53
S.Em.±	0.09	31.56	0.07	0.42
C.D. (P = 0.05)	NS	NS	NS	NS
Levels of moisture regime (M)				
M_1: 100% ETc	7.0	1759.85	3.91	41.60
M_2: 80% ETc	6.8	1666.33	3.70	41.16
M_3: 60% ETc	6.6	1627.00	3.62	40.57
S.Em.±	0.11	38.66	0.09	0.51
C.D. (P = 0.05)	NS	NS	NS	NS
C.V. %	9.95	13.77	13.80	7.48
Sub-plot				
Levels of nitrogen fertigation (N)				
N_1: 100% RDN	6.9	1738.02	3.84	41.88
N_2: 80% RDN	6.8	1677.49	3.73	41.11
N_3: 60% RDN	6.7	1637.66	3.66	40.33
S.Em.±	0.07	22.42	0.05	0.31
C.D. (P = 0.05)	NS	63.76	NS	0.88
Sig. interactions	-	-	-	-
C.V. %	6.62	7.99	8.29	4.49

Table 3. Effect of irrigation interval, moisture regime and N fertigation on protein content, protein yield, N and P content and uptake by grain and straw of summer pearlmillet (Pooled data of two years)

Treatments	Protein content	Protein yield	N content in grain (%)		N uptake by (kg/ha)		P content in grain (%)		P uptake by (kg/ha)	
			Grain	straw	Grain	Straw	Grain	straw	Grain	Straw
Main plot										
Irrigation interval (D)										
D_1: One day interval	11.23	577.4	1.97	0.843	101.30	79.48	0.334	0.151	17.24	14.21
D_2: Two day interval	10.89	499.7	1.91	0.822	87.67	69.59	0.323	0.145	14.85	12.35
S.Em.±	0.14	7.9	0.024	0.007	1.39	0.79	0.005	0.002	0.26	0.22
C.D. (P = 0.05)	NS	23.4	NS	NS	4.10	2.33	NS	NS	0.77	0.66
Levels of moisture regime (M)										
M_1: 100% ETc	11.25	584.4	1.97	0.842	102.52	80.40	0.335	0.153	17.43	14.52
M_2: 80% ETc	11.16	536.7	1.96	0.830	94.16	73.90	0.328	0.149	15.86	13.27
M_3: 60% ETc	10.76	494.6	1.89	0.825	86.77	69.31	0.324	0.143	14.84	12.05
S.Em.±	0.17	9.71	0.030	0.009	1.70	0.97	0.006	0.003	0.32	0.28
C.D. (P = 0.05)	NS	28.6	NS	NS	5.02	2.86	NS	NS	0.94	0.81
C.V. %	9.18	10.82	9.18	6.22	10.82	7.79	10.88	10.60	11.91	12.43
Sub-plot										
Levels of nitrogen fertigation (N)										
N_1: 100% RDN	11.37	576.0	1.99	0.847	101.05	78.76	0.334	0.152	17.01	14.13
N_2: 80% RDN	11.04	536.2	1.94	0.829	94.07	73.84	0.329	0.147	16.01	13.13
N_3: 60% RDN	10.77	503.5	1.89	0.821	88.33	71.01	0.324	0.145	15.11	12.58
S.Em.±	0.12	7.8	0.021	0.005	1.37	0.88	0.005	0.002	0.27	0.25
C.D. (P = 0.05)	0.34	22.3	0.060	0.014	3.90	2.49	NS	NS	0.76	0.71
Sig. interaction	-	-	-	-	-	-	-	-	-	-
C.V. %	6.51	8.72	6.51	3.67	8.72	7.06	8.33	9.72	9.96	11.23

and at harvest respectively), dry matter production per plant (4.29, 41.28 and 78.56 g at 30, 60 DAS and at harvest respectively), crop growth rate (3.17, 27.40 and 28.58 g/m^2/day between 0-30 DAS, 30- 60 DAS and 60 DAS- at harvest respectively), relative growth rate (47.86, 120.13 and 124.34 mg/g/day between 0-30 DAS, 30- 60 DAS and 60 DAS- at harvest respectively), leaf area per plant at 60 DAS (1739.02 cm^2), chlorophyll content (SPAD value of 41.88), protein content (11.37%) and protein yield (576.0 kg/ha) over lower level of N fertigation, 80% and 60% RDN in pooled results. This might be due to application of 100% RDN through fertigation increased the availability of nitrogen in rhizosphere lead to luxurious growth of the plant as nitrogen is directly involved in vegetative growth of the plants that improved the height of plant as well as dry matter production by plant as nitrogen is directly involved in vegetative growth of plants these results are in agreement with those reported by Gomathy *et al*. [10] and Patil *et al*. [11].

The lower level of nitrogen (60% RDN) to pearlmillet resulted in minimum values of growth attributes due to low availability of nitrogen in soils which did not match with the nutrients demand of the crop at different growth stages lead to poor growth of the crop plants [12,13].

Nitrogen content (1.99 and 0.847%) and uptake (101.05 and 78.76 kg/ha) by grain and straw as well as p uptake (17.01 and 14.13 kg/ha by grain and straw, respectively) were found significantly higher under 100% RDN applied through fertigation as compared to fertigation of 60% and 80% RDN in pooled data. Patil *et al*. 2012 noted higher uptake of N and P under higher level of nitrogen applied through drip system in sweet corn crop [14,15].

3.4 Interaction Effect

The interaction effect of irrigation interval, moisture regime and N fertigation level was found non-significant with respect to plant height (cm), dry matter accumulation per plant (g), crop growth rate (g/m2/day), relative growth rate (mg/g/day), chlorophyll content, protein content (%), protein yield (kg/ha), number of internodes per plant, leaf area per plant at 60 DAS and leaf area index at 60 DAS during 2021, 2022 and in pooled mean [16].

4. CONCLUSION

Based on the results of two years of field experimentation, it is concluded that summer pearlmillet crop should be irrigated by drip system at one-day intervals i.e. alternate days with moisture regime of 100% ETc along with the application of 100% RDN through fertigation to obtain better growth and quality under loamy sand soil.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Malik S. Pearlmillet nutritional value and medicinal uses. International Journal for Research Trends and Innovation. 2015; 1(3):414-418.
2. Panse VG, Sukhatne PV. Statistical Methods for Agricultural Workers (Second edition). Indian Council of Agricultural Research, New Delhi; 1967.
3. Alipatra A, Banerjee H, Bhattacharya K, Bandopadhyay P, Mazumdar D, Sarkar S. Productivity, nutrient uptake and profitability of hybrid sunflower (Helianthus annuus) as influenced by irrigation and fertilizer management practices under sub-tropical climate of West Bengal. Indian Journal of Agronomy. 2019;64(1):107-114.
4. Ray S, Umesha C, Meshram MR. Sanodiya LK. Influence of irrigation and hydrogel application on yield and economics of pearlmillet (*Pennisetum glaucum* L.) under Eastern U. P. condition. Environment Conservation Journal. 2021; 22(3):31-36.
5. Rahman AEM, Saifel DM. Effect of irrigation intervals on growth and yield of sesame (*Sesamum indicum* L.) in northern Sudan. Assuit Journal of Agriculture and Science. 2008;30(1):1-9.
6. Kachhadia SP, Chovatiya PK, Jadav KV. Tarapara VD. Effect of irrigation, mulches and anti-transpirant on growth and yield of summer pearlmillet (*Pennisetum glaucum* L.) under South Saurashtra conditions. International Journal of Plant Science. 2012;5(2):463-467.
7. Available:https://agricoop.nic.in/sites/default/files/Crops.pdf
8. Available:https://pmksy.gov.in/microirrigation/Archive/August2015.pdf
9. Patel NH, Patel BM, Patel HB, Patel PM. Effect of irrigation and mulches on summer pearlmillet (*Pennisetum glaucum* L.) under North Gujarat agro-climatic conditions. An

International e-Journal. 2013a;2(2):246-249.

10. Gomathy M, Prakash SD, Thangaraju M, Sundaram SP, Sundaram PM. Impact of bio-fertigation of azophosmet on cotton yield under drip irrigation. Research Journal of Agriculture and Biological Sciences. 2008;4(6):695-699.
11. Patil SA, Mahadkar UV, Mohit NC, Karpe, AH. Effect of irrigation and fertigation on yield, quality and nutrient uptake of sweet corn (Zea mays sacchrata). Journal of Soil and Crops. 2012;22(1):100-104.
12. Parikh P, Patel MR, Patel HK, Patel PM. Effect of irrigation and nitrogen levels on forage yield and quality of pearlmillet [*Pennisetum glaucum* (L.) R. Br.]. International Journal of Agricultural Sciences. 2015;11(2):664-667.
13. Patel PM, Patel GG, Patel JJ, Gediya KM. Influence of irrigation schedules, mulches and anti-transpirant on growth and yield of summer transplanted pearlmillet (*Pennisetum glaucum* L.). International Journal of Forestry and Crop Improvement. 2010a;1(2):60-63.
14. Patel PM, Patel JJ, Patel MR. Yield and water use of summer transplanted pearlmillet (*Pennisetum glaucum* L.) as influenced by IW: CPE ratios, mulches and anti-transpirant. International Journal of Agricultural Sciences. 2010$_b$;7(1):119-122.
15. Patel SJ, Patel BM, Raval CH, Patel KI, Patel PB, Patel PM, Vekaria LC. Response of vegetable clusterbean *[Cyamopsis tetragonaloba* (L.) taub] to fertigation of P and K. Journal of Legume Research. 2013b;37(4):420-423.
16. Saini AK, Patel AM, Chaudhary PP, Saini, LH. Impact assessment osf irrigation, fertility and hydrogel levels on growth attributes, yield and economics of summer pearlmillet (*Pennisetum glaucum* L.) under North Gujarat conditions. Journal of Pharmacognosy and Phytochemistry. 2018;7(2):2914-2918.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/112077