EFFECT OF DRIP FERTIGATION ON GROWTH AND QUALITY PARAMETERS OF SUMMER PEARLMILLET UNDER NORTH GUJARAT AGRO-CLIMATIC CONDITION

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 study the effect of drip fertigation on growth and quality parameters of summer pearlmillet under North Gujarat agro-climatic condition. There were 18 treatment combinations comprising two irrigation intervals *viz*., One-day interval and Two days interval, three moisture regimes *viz*., 100, 80 and 60% ETc in the main plot and three N fertigation levels *viz*., 100, 80 and 60% RDN in sub-plot were tested in split plot design with three replications. The results of pooled data 2 years revealed that application of irrigation to summer pearlmillet at a shorter irrigation interval of one day proved superior with respect to plant height and dry matter accumulation per plant, crop growth rate, relative growth rate, protein yield and N and P uptake by grain and straw as compared to two days irrigation interval. Significantly higher plant height, dry matter accumulation per plant, crop growth rate, relative growth rate, protein yield as well as N and P uptake in grain and straw were registered under moisture regime levels of 100% ETc over 60 and 80% ETc. The majority of the growth and quality parameters *viz*., plant height, dry matter accumulation per plant, crop growth rate, relative growth rate, chlorophyll content, protein content, protein yield, N content in grain and straw and N and P uptake in grain as well as straw were recorded under 100% RDN (N1) applied through fertigation.

INTRODUCTION

India ranks first both in production and area of pearlmillet in the world. In India, it is annually grown on a 13.8 million ha area, production of 17.3 million tonnes with productivity of 1254 kg/ha (https://Agricoop.in). Major pearlmillet growing states in India are Rajasthan (52.34%), Maharashtra (14.6%), Gujarat (9.9%) and Uttar Pradesh (8.6%).

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 moisture (12.4%), protein (11.6%), fat (5.0%), carbohydrates (67.0%) and minerals (2.7%). It is also rich in vitamin 'A,' and vitamin 'B' and imparts substantial energy of 360 kilo calories/100 g (Malik, 2015). 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.

Agriculture is the largest consumer of fresh water and water is becoming a scarce natural resource year after year. Traditional irrigation methods are characterized by high fluctuations in soil moisture content because a higher quantity of water is applied at longer intervals. Irrigation interval plays a vital role in terms of growth, development and yield of pearlmillet during the summer season by maintaining moisture content at field capacity in the rhizosphere which improves optimum aeration 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. It refers to both, evaporation from soil and transpiration from plants. These two processes are going on simultaneously in standing crops under field conditions and it is difficult to separate them. It is estimated that 99% of crop water requirement is used to meet evapotranspiration demand. The practice of supplying water-soluble fertilizers to the crops along with irrigation water is called fertigation. It 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 irrigation system to match the current demand of the crop being nourished and irrigated. It has been recently introduced and would be a promising practice for the most economical crops.

In light of the above facts with respect to the importance of crop evapotranspiration and drip fertigation for improving crop growth and quality, the present investigation on "Effect of drip fertigation on growth and quality parameters of summer pearlmillet under North Gujarat agro-climatic condition" was planned and conducted.

MATERIALS AND METHODS

The experiment was carried out during the summer seasons 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 pH, 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 carried out with cultivar GHB 1129 of pearlmillet. A total of eighteen treatment combinations were tested 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 treatment comprises 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 recommended dose of fertilizer for summer pearlmillet is 120:60:00 kg N:P_2O_5:K_2O/ha. 30% N was applied as basal and the remaining 70% N was applied in six equal splits at an interval of six days. First irrigation was applied by flood irrigation immediately after sowing the crop for uniform seed germination. Irrigation through the drip system was started at 7 DAS of pearlmillet.

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 (1967). 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.

RESULTS AND DISCUSSION

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 improved with different irrigation intervals.

Application of irrigation at an interval of one day (D_1) recorded significantly 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), nitrogen and phosphorus uptake by grain as well as straw than application of irrigation at an interval of two days (D2) through drip system during both years and in pooled analysis, respectively. It was observed that reduction in plant height (cm), dry matter accumulation per plant (g), crop growth rate (g/m2/day), relative growth rate (mg/g/day), protein content (%) under longer irrigation interval (two days interval) was due to lack of regular supply of water to plant by need of crop as against shorter irrigation interval of one day. Similar results were observed by Rahman et al. (2008) and Alipatra et al. (2019).

Table 1: Effect of irrigation interval, moisture regime and N fertigation on plant height, number of internodes per plant, 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	60 DAS-harvest	30 DAS	60 DAS	60 DAS-harvest	30 DAS	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
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												
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

Scrutiny of data highlighted in Table 1 revealed that the interval of irrigation to summer pearlmillet either at alternate day (one-day interval) or two days interval did not show any significant variation in several internodes per plant, leaf area per plant at 60 DAS, leaf area index at 60 DAS, chlorophyll content at 60 DAS, and nitrogen and phosphorus content in grain as well as in straw during 2021, 2022 and in pooled mean.

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*. (2012).

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

Effect of N fertigation

An application of 100% RDN through fertigation proved its superiority over both lower levels of nitrogen fertigation on periodical plant height (cm), dry matter accumulation per plant (g), crop growth rate (g/m2/day), relative growth rate (mg/g/day) (Gomathy *et al*. 2008) and chlorophyll content, protein content (%), protein yield (kg/ha), nitrogen content in grain as well as in straw, nitrogen and phosphorus uptake by grain as well as straw (Patil *et al*. 2012) during both the years and in pooled data. This might be due to nitrogen has a direct effect on the vegetative growth of plants and application of a higher rate of nitrogen leads to luxurious vegetative growth The effect of different nitrogen fertigation levels was found non-significant with respect to a number of internodes per plant, leaf area per plant at 60 DAS leaf area index at 60 DAS and phosphorus content in grain as well as in straw during 2021, 2022 and in pooled mean, respectively.

Table 2: Effect of irrigation interval, moisture regime and N fertigation on number of internodes per plant at harvest, leaf area per plant at 60 DAS, leaf area index, 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
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
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				
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
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										
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

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.

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.

REFERENCES

Alipatra, A.; Banerjee, H.; Bhattacharya, K.; Bandopadhyay, P.; Mazumdar, D. and Sarkar, S. (2019). 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, 64(1): 107-114.

Gomathy, M.; Prakash, S. D.; Thangaraju, M.; Sundaram, S. P. and Sundaram, P. M. (2008). Impact of bio-fertigation of azophosmet on cotton yield under drip irrigation. Research Journal of Agriculture and Biological Sciences, 4(6): 695-699.

https://agricoop.nic.in/sites/default/files/Crops.pdf

https://pmksy.gov.in/microirrigation/Archive/August2015.pdf

Kachhadia, S. P.; Chovatiya, P. K.; Jadav, K. V. and Tarapara, V. D. (2012) 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, 5(2): 463-467.

Malik, S. (2015). Pearlmillet nutritional value and medicinal uses. *International Journal for Research Trends and Innovation*, **1**(3): 414-418.

Panse, V. G. and Sukhatne, P. V. (1967). Statistical Methods for Agricultural Workers (Second edition). Indian Council of Agricultural Research, New Delhi.

Patel, N. H.; Patel, B. M.; Patel, H. B. and Patel, P. M. (2013a). Effect of irrigation and mulches on summer pearlmillet (Pennisetum glaucum L.) under North Gujarat agro-climatic conditions. An International e-Journal, 2(2): 246-249.

Patel, P. M.; Patel, G. G.; Patel, J. J. and Gediya, K. M. (2010a). 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, 1(2): 60-63.

Patel, P. M.; Patel, J. J. and Patel, M. R. (2010b). 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, 7(1): 119-122.

Patel, S. J.; Patel, B. M.; Raval, C. H.; Patel, K. I.; Patel, P. B.; Patel, P. M. and Vekaria, L. C. (2013b). Response of vegetable clusterbean [Cyamopsis tetragonaloba (L.) taub] to fertigation of P and K. Journal of Legume Research, 37(4): 420-423.

Patil, S. A.; Mahadkar, U. V.; Mohit, N. C. and Karpe, A. H. (2012). Effect of irrigation and fertigation on yield, quality and nutrient uptake of sweet corn (Zea mays sacchrata). Journal of Soil and Crops, 22(1): 100-104.

Rahman, A. E. M. and Saifel, D. M. (2008). Effect of irrigation intervals on growth and yield of sesame (Sesamum indicum L.) in northern Sudan. Assuit Journal of Agriculture and Science, 30(1): 1-9.