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Effect of irrigation, mulches and antitranspirant on yield, quality and economics of summer pearlmillet

S.P. KACHHADIYA*, P.K.CHOVATIA, K.V. JADAV AND S.T. SANANDIA
Department of Agronomy, College of Agriculture, Junagadh Agriculture University, JUNAGADH (GUJARAT) INDIA

ABSTRACT

An experiment was conducted during the summer season of the year 2007 and 2008 to study the "effect of irrigation, mulches and antitranspirant on yield, quality and economics of summer pearlmillet (*Pennisetum glaucum* L.) under south saurashtra condition". Treatment I_3 (1.0 IW : CPE ratio) registered significantly highest values of grain and dry fodder yields as well as protein content, but it was remained statistically at par with the treatment l_2 (0.8 IW : CPE ratio) in case of grain and dry fodder yields. With respect to different mulches, treatment M_2 (groundnut shell mulch) resulted significantly higher grain and dry fodder yields as compared to control treatment (M_0). While, treatment M_1 (Wheat cut straw mulch) remained next to treatment M2 by exerting its significant influence on control treatment (M_0). Likewise, treatment AT1 (6 % kaolin spray) also produced significantly higher grain and dry fodder yields over control treatment. Application of different mulches as well as antitranspirants failed to extract its significant effect over control for protein content. The highest net return worth Rs. 33691 ha^{-1} was secured under treatment combination $I_3M_2AT_0$ (1.0 IW : CPE ratio + groundnut shell mulch + water spray) with CBR and net CBR values of 1 : 3.18 and 1 :2.18, respectively. The treatment combination $I_3M_2AT_1$ (1.0 IW : CPE ratio + groundnut shell mulch + 6 % kaolin spray) was found the next best treatment combination with respect to net profit of Rs. 32464 Rs. ha^{-1} and CBR as well as net CBR values of 1 : 2.82 and 1:1.82, respectively.

Key words : Irrigations, Mulches, Antitranspirant, Pearlmillet

INTRODUCTION

Pearlmillet (*Pennisetum glaucum* L.) is one of the major cereal crop grown in the arid and semi arid regions of the world. Among the major food grain crops of India, pearlmillet ranks fourth in the acreages, next to rice, wheat and sorghum. In India, pearlmillet popularly known as 'bajra' or 'bajri', is an important staple food.

Agricultural system being basically a photosynthetic one, availability of water is the major motive factor and hence it must be assessed for its efficiency in terms of both primary productivity and useful end products. Moreover, water plays a vital role in the metabolic processes of the plant and therefore, it has a great impact on growth, development and productivity. Thus, water is considered as an elixir of plant life.

Summer cultivation of pearl millet particularly in the irrigated areas of Gujarat state has got importance because of the assurance of targated crop yield. Irrigation in summer pearl millet is one of the major inputs of crop production. The research work on various agronomic aspects *viz.*, spacing, fertilizers *i.e.* nitrogen and phosphorus and their sources, date of sowing, irrigation etc. have been undertaken for pearl millet crop. But, the information regarding water requirement and irrigation scheduling as well as the use of mulches and antitranspirant for summer pearlmillet crop is lacking for the medium black soils of south Saurashtra agroclimatic zone. Therefore, the present experiment was conducted during the summer seasons of the years 2007 to 2008 to study the "Effect of irrigation, mulches and antitranspirant on yield, quality and economics of summer pearlmillet (*Pennisetum glaucum* L.) under south Saurashtra conditions."

MATERIALS AND METHODS

A field experiment was conducted during summer seasons of 2007 and 2008 at the Instructional Farm, College of Agriculture, Junagadh Agricultural University, Junagadh. The texture of the experimental soil was silty clay with bulk density 1.33 mg/m, field capacity 47 %, wilting point 20 %, pH 7.7, electrical conductivity 0.56 ds m^{-1} and organic carbon content 0.69 %. The experiment was laid out in split-split plot design with four replications. Treatments comprised of 3 irrigation levels [0.6 IW : CPE ratio (l_1), 0.8 IW :CPE ratio (l_2), 1.0 IW :CPE ratio (l_3)] in main plots, 3 mulching levels [control (M1), wheat cut straw @ 5 t ha^{-1} (M_2) and Groundnut shell @ 5 t ha^{-1} (M_3) and 2 antitranspirant levels [control (AT_0) and : 6 % kaolin sparay at 20 and 50 DAS (AT_1)] in sub-sub plots. Pearlmillet variety GHB-558 was sown by drilling on February 9, during both the years 2006 and 2007 at row spacing of 45 cm with seed rate of 3.5 kg ha^{-1} . Crop was fertilized with 60-60-0NPK kg ha^{-1} as basal before sowing and 60 kg N ha^{-1} was applied in two equal splits at an interval of 35-40 days after sowing during both the seasons of experimentation.

*** Author for correspondence.** Present Address : Department of Bio-chemistry, Junagadh Agricultural University, JUNAGADH (M.S.) INDIA

The irrigation treatments were imposed after a common irrigation of 50 mm depth. The mulches were applied at 35 days after sowing of the crop in the respective treatments, leaving the pearlmillet rows open. Water spray as a control treatment (AT_0) and 6 % kaolin (AT_1) were sprayed on the crop plants at 20 and 50 days after sowing of the crop during both the years. The kaolin @ 600 l ha^{-1} solution was applied with a hand operated knapsack sprayer fitted with a fan type nozzle in the morning time under dry and clear sun condition. The data were recorded for grain and fodder yield on net plot basis and then converted on hectare basis.

RESULTS AND DISCUSSION

The finding obtained from the present study as well as relevant discussion have been presented under following heads:

Effect on yield :

It is evident from the data presented in Table 1 that the levels of irrigation reflected significant effect on grain and dry fodder yield. Treatment l_3 (1.0 IW : CPE ratio) and l_2 (0.8 IW:CPE ratio) did not produce any considerably difference in grain and dry fodder yield of summer pearlmillet. Howevr, both these irrigation levels produced appreciably higher grain and dry fodder yield of summer pearlmillet to the extent of 19.27 and 13.73 per cent is grain and 12.05 and 7.22 per cent in dry fodder yield over l_1 (0.6 IW:CPE ratio), respectively in pooled result. Increase in irrigation frequency tended in increase consumptive use of water, which provided congenial condition throughout the growth period of the crop more over less moisture stress experienced by crop during their vegetative and reproductive growth period, that too later stages of crop growth resulting in an improvement of growth and yield attributing characters, thereby produced higher grain and dry folder yield. These results are in line with those reported by Patel *et al.* (1994). Vyas *et al.* (1994) and Malavia *et al.* (1998).

Groundnut shell mulch and wheat cut straw mulch recorded significantly higher grain and dry fodder yield than control (no mulch) treatment. The degree of increased in grain and dry fodder yield under groundnut shell mulch was to the tune of 13.17 and 10.19 per cent over control (no mulch) treatment, respectively. While under wheat cut straw mulch was to the extent of 8.84 and 6.69 per cent higher over control. The highest grain and dry fodder yield recorded under mulch because mulch play an important role in changing hydro-thermal regime of soil and conserving soil moisture. Hence, congenial soil moisture for favourable growth condition available during major life period of pearl millet crop and consequently the higher growth and yield attributing characters reflected higher grain and fodder yield of summer pearl millet. These findings are in conformity with those obtained by Jat and Gautam (2000) and Chaudhary *et al.* (2002).

An application of 6 % Kaolin spray at 20 and 50 DAS recorded significantly higher grain yield (4922 kg ha^{-1} and dry fodder yield (8004 kg ha^{-1}) over control (water spray) in pooled results. The magnitude of increase in grain was 11.38 per cent during the year 2007, 9.03 per cent in the year 2008 and 10.21 per cent in combined analysis. Similarly, application of 6 % Kaolin spray at 20 and 50 DAS recorded higher dry fodder yield during both

Table 1 : Yields and quality of pearlmillet as influenced by levels of irrigation, mulches and antitranspirant

Treatments	Grain yield (kg ha^{-1})			Dry fodder yield (kg ha^{-1})			Protein content (%)		
	2007	2008	Pooled	2007	2008	Pooled	2007	2008	Pooled
Irrigation levels (I)									
0.6 IW : CPE ratio (I_1)	4264	4194	4229	7490	7168	7329	9.94	9.99	9.94
0.8 IW : CPE ratio (I_2)	4929	4691	4810	7977	7740	7858	10.30	10.39	10.30
1.0 IW : CPE ratio (I_3)	5123	4965	5044	8297	8128	8212	10.92	10.83	10.92
C.D. (P=0.05)	539	475	320	561	675	391	0.25	0.34	0.19
Mulches (M)									
Control (M_1)	4363	4349	4356	7446	7296	7371	10.27	10.35	10.31
Wheat cut straw @ 5 t ha^{-1} (M_2)	4837	4689	4763	8099	7662	7881	10.43	10.32	10.38
Groundnut shell @ 5 t ha^{-1} (M_3)	5115	4811	4963	8219	8078	8148	10.58	10.48	10.53
C.D. (P=0.05)	514	264	279	543	308	302	NS	NS	Ns
Antitranspirant (AT)									
Control (Water spray) (AT_0)	4515	4417	4466	7709	7482	7596	10.33	10.32	10.32
6 % Kaolin spray at 20 and 50 DAS (AT_0)	5029	4816	4922	8134	7874	8004	10.53	10.45	10.49
C.D. (P=0.05)	346	261	212	375	359	254	NS	NS	NS

NS = Non significant

the years and in pooled results. The magnitude of increase in fodder yield was 5.51, 5.24 and 5.37 per cent during the year 2007, 2008 and in pooled results, respectively over control. Higher grain yield and fodder yield accured under Kaolin spray treatment would be attributed to favourable effect of higher relative water control in plant because approximately 99 per cent of the water absorbed by plants is lost in transpiration but application of Kaolin might keep transpiration in check to a reasonable extent owing to reflection of incident radiation from the leaf surface or to partial closing of stomata. Thus, better moisture atatus of the plant due to Kaolin spray resulted in less leaf senescence and higher photosynthesis. These favorable effects could resulted in better grain development and ultimately in increased grain yield. This higher yield of grain and fodder might also be due to increase growth and yield attributing characters. It was further noticed that Kaolin spray without any reduction in total water depletion compared to control, resulted in higher fodder and grain yield. Such, appreciable increased in pearl millet grain and fodder yield due to spraying of Kaolin have been also reported by Kaushik and Gautam (1994), Swant and Dayanand (1994) and Jadhav *et al.* (1996).

Among all the possible interactions for irrigations for irrigation, mulches and antitranspirant only I x M (during the years 2007 and 2008) and I x M x AT interactions (during the year 2007 and pooled) were found significant.

Data furnished in Table 2, revealed that the treatment combination I_2M_2 (0.8 IW :CPE ratio + groundnut shell mulch) produced significantly higher grain yield (5962 kg ha^{-1}) than rest of the I x M treatment combinations during 2007, except I_3M_1 (1.0 IW:CPE ratio with wheat cut straw mulch) and I_2M_2 (0.8 IW:CPE ratio + groundnut shell mulch) treatment combinations. While, during 2008 treatment combination I_3M_2 (1.0 IW:CPE ratio + groundnut shell mulch) resulted into significantly the highest grain yield (5522 kg ha^{-1}) as compared to rest of the I x M interaction effects. Further, the data showed that I_1M_0 (0.6 IW:CPE ratio without mulching) treatment combination gave significantly lower grain yield (3992 kg ha^{-1}) as compared to the rest of the treatment combinations, except, I_1M_1 (0.6 IW:CPE ratio + wheat cut straw mulch) and I_1M_2 +(0.6 IW:CPE ratio + groundnut shell mulch) treatment combinations.

The data illustrated in Table 3 revealved that treatment combination $I_2M_2AT_1$ (0.8 IW:CPE ratio + groundnut shell mulch + 6 % kaolin spray) produced significantly higher grain yield (6345 kg ha^{-1}) as compared to rest of all the higher order interaction, except, $I_3M_1AT_1$ (1.0 IW:CPE ratio + wheat cut straw mulch + 6 % kaolin spray), $I_2M_2AT_0$ (0.8 IW:CPE ratio + groundnut shell mulch + water spray), $I_2M_0AT_1$ (0.8 IW:CPE ratio + no mulching + 6 % kaolin spray), $I_3M_1AT_0$ (1.0 IW:CPE ratio + wheat cut straw mulch + water spray) treatment combinations during 2007. Contrarily, the data indicated that the treatment combination $I_1M_0AT_0$ (0.6 IW:CPE ratio + without mulch + water spray) recorded significantly lower grain weight (3565 kg ha^{-1}) as compared to $I_3M_0AT_1$ (1.0 IW:CPE ratio + no mulching + 6 % kaolin spray),

Table 2 : Interaction effect of I x M on grain yield of pearlmillet

Treatments	Grain yield (Kg ha^{-1}) at harvest					
	2007			2008		
	M_0	M_1	M_2	M_0	M_1	M_2
I_1	3935	4710	4146	3992	4222	4367
I_2	4671	4124	5992	4480	5049	4544
I_3	4482	5678	5209	4578	4798	5522
C.D. (P=0.05)		890.30			457.92	

Table 3 : Interaction effect of I x M x AT on grain yield of pearlmillet

Treatment	Grain yield (Kg ha^{-1}) at harvest					
	2007			2008		
	I_1	I_2	I_3	I_1	I_2	I_3
M_0AT_0	3565	3803	4253	3744	4063	4274
M_0AT_1	4306	5539	4711	4183	5089	4783
M_1AT_0	4120	4492	5484	3935	4692	5056
M_1AT_1	5300	3756	5872	4997	4480	5420
M_2AT_0	4139	5639	5142	4089	4953	5388
M_2AT_1	4153	6345	5276	4424	5583	5343
C.D. (P=0.05)		1038.59			636.60	

$I_3M_2AT_0$ (1.0 IW:CPE ratio + groundnut shell mulch + water spray), $I_3M_2AT_1$ (1.0 IW:CPE ratio + groundnut shell mulch + 6 % kaolin spray), $I_1M_1AT_1$ (0.6 IW:CPE ratio + groundnut shell mulch + 6 % kaolin spray), $I_3M_1AT_0$ (1.0 IW:CPE ratio + wheat cut straw mulch + water spray), $I_2M_0AT_1$ (0.8 IW:CPE ratio + no mulching + 6 % kaolin spray), $I_2M_2AT_0$ (0.8 IW:CPE ratio + groundnut shell mulch + water spray), $I_3M_1AT_1$ (1.0 IW:CPE ratio + wheat cut straw mulch + 6 % kaolin spray) and $I_2M_2AT_1$ (0.8 IW:CPE ratio + groundnut shell mulch + 6 % kaolin spray) higher order interactions. Similar trend was observed under treatment combination I x M x AT interactions in pooled base data.

Effect on quality:

Irrigation treatments exhibited their significant influence on protein content in grain of pearl millet. Treatment I_3 (1.0 IW:CPE rato) recorded remarkably higher protein content as compared to its lower levels. The higher protein content obtained under more number of irrigation might be attributed to higher availability of moisture in the root zone, which enhanced absorption of nutrients, especially, nitrogen which is an integral component of many compounds including chlorophyll, enzymes and essential plant growth processes. It is also an essential component of amino acids as well as essential for protein content in the grain. The results are in agreement with Vyas *et al.* (1994) and Rajendran and Sundersingh (1999).

Different mulches as well as application of antitranspirant failed to establish their significant effect on protein content of pearlmillet grain during the years 2007, 2008 and on pooled analysis.

None of the interactions exerted their significant influence during both the years as well as pool based data.

Economics :

The results furnished in Table 4 indicated that net realization was increased with increase in irrigation levels from 0.6 to 1.0 IW:CPE ratio. Thus, the increase in profitability was mainly due to increase in grain yield with increase in irrigation levels. These results are in conformity with the results of Patel *et al.* (1994). Vyas *et al.* (1994) and Malavia *et al.* (1998).

The net realization was increased due to different mulches as compared to control treatment wherein, wheat cut straw @ 5 t ha $^{-1}$ (M_1) recorded higher net realization over an application of Groundnut shell mulch (M_2). An application of groundnut shell mulch recorded higher grain yield though net realization was recorded under treatment M_1 (wheat cut straw @ 5 t ha^{-1}) which was due to higher prices of groundnut shell mulch. Similar results were also reported by Singh *et al.* (1997).

An application of 6 % kaolin spray produced significantly higher grain as well as dry fodder yields over control which ultimately resulted into higher net realization. Results are confirmed with those of Kuganathan and Palaniappan (1980).

An average economics of pearlmillet crop as influenced by different treatment combinations (based on average of two years) presented in Table 5 indicated that the highest net realization of Rs. 33691 ha^{-1} with CBR values of 1:3.18 and 1:2.18, respectively was secured

Table 4 : Economics as influenced by irrigation, mulches and antitranspirant levels (Average of two years)

Treatment	Yield (kg ha^{-1})		Gross realization (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net realization (Rs ha^{-1})	CBR	Net CBR
	Grain	Dry fodder					
Irrigation levels (I)							
I_1	4229	7329	39046	11930	27116	1: 3.27	1 : 2.27
I_2	4810	7858	43933	12490	31443	1: 3.51	1 : 2.51
I_3	5044	8212	46042	13050	32992	1 : 3.52	1:2.52
Mulches (M)							
M_0	4356	7371	40041	9690	30351	1 : 4.13	1: 3.13
M_1	4763	7881	43603	11190	32413	1: 3.89	1: 2.89
M_2	4963	8148	45370	11690	33680	1: 3.88	1 : 2.89
Antitranspirants (M)							
AT_0	4466	7596	41091	9940	31151	1 : 4.13	1 : 3.13
AT_1	4922	8004	44919	12941	31978	1 : 3.47	1 : 2.47

Sale price

Details	Price (Rs kg^{-1})		Average price (Rs kg^{-1})
	2007	2008	
Grain	7.00	8.00	7.50
Dry fodder	1.00	1.00	1.00

Table 5 : Economics as influenced by irrigation, mulches and antitranspirant levels (Average of two years)

Treatment	Yield (kg ha^{-1})		Gross realization (Rs ha^{-1})	Cost of cultivation (Rs ha^{-1})	Net realization (Rs ha^{-1})	CBR	Net CBR
	Grain	Dry fodder					
$I_1M_0AT_0$	3744	7070	35150	12260	22890	1: 2.86	1: 1.86
$I_1M_0AT_1$	4183	7157	38529	15181	23348	1: 2.53	1: 1.53
$I_1M_1AT_0$	3935	6997	36509	13760	22749	1: 2.65	1: 1.65
$I_1M_1AT_1$	4997	7655	45132	16681	28451	1: 2.67	1: 1.67
$I_1M_2AT_0$	4089	7449	38116	14260	23856	1: 2.67	1: 1.10
$I_1M_2AT_1$	4424	7647	40827	17181	23721	1: 1.93	1: 1.67
$I_2M_0AT_0$	4063	6940	37412	12660	24752	1: 2.95	1: 1.95
$I_2M_0AT_1$	5089	8080	46247	15741	30506	1: 2.93	1: 1.93
$I_2M_1AT_0$	4692	7989	43179	14160	29019	1: 3.04	1: 2.04
$I_2M_1AT_1$	4480	8177	41777	17241	24536	1: 2.42	1: 1.42
$I_2M_2AT_0$	4953	7708	44855	14740	30115	1: 3.04	1: 2.04
$I_2M_2AT_1$	5583	8258	50130	17660	32464	1: 2.82	1: 1.82
$I_3M_0AT_0$	4274	7460	39515	13220	26295	1: 2.98	1: 1.98
$I_3M_0AT_1$	4783	7518	43390	16301	27089	1: 2.66	1: 1.66
$I_3M_1AT_0$	5056	8089	46009	14720	31289	1: 3.12	1: 2.12
$I_3M_1AT_1$	5420	8379	49029	17801	31228	1: 2.75	1: 1.75
$I_3M_2AT_0$	5388	8661	49071	15380	33691	1: 3.18	1: 2.18
$I_3M_2AT_1$	5343	9167	49239	18301	30938	1: 2.69	1: 1.69

under treatment combination $I_3M_2AT_0$ (1.0 IW:CPE ratio + groundnut shell mulch + water spray), followed by $I_2M_2AT_1$ (0.8 IW:CPE ratio + groundnut shell mulch + 6 % kaolin spray) treatment combination. The higher net monitory return was on account of more yields of pearlmillet crop and favourable response to irrigation and mulches as well as due to prevailing prices of the mulch and antitranspirant materials used in the respective treatment.

REFERENCES

Chaudhari, A.C., Meena, N.L. and Jat, R.L. (2002). Effect of nitrogen and moisture conservation practices on growth and yield of rainfed pearlmillet [*Pennisetum glaucum* (L) R.Br.]. *Ann. Agric. Res.*, **23**(2) : 223-225.

Jadhav, B.S., Jadhav, A.S. and Jadhav, S.B. (1993). Effects of irrigation scheduling, sowing methods and mulching on *Rabi* maize. *J.Maharashtra Agric. Univ.*, **18** (1) : 56-61.

Jat, M.L. and Gautam, R.C. (2000). Effect of summer ploughing and in-situ moisture conservation practices on growth and yield of rainfed pearlmillet (*Pennisetum glaucum*). *Indian J. Agron.*, **45** (4) :722-727.

Kaushik, S.K. and Gautam, R.C. (1994). Response of rainfed pearlmillet (*Pennsetum glaucum*) to water harvesting, moisture conservation and plant population in light soils. *Indian J. Agric. Sci.*, **64** (12) :858-860.

Kuganathan, A. and Palaniappan, S.P. (1980). Relative efficiency of antitranspirants on grain sorghum. *Indian J. Agric Res.*, **14** (3) : 137-142.

Malavia, D.D., Dudhatra, M.G., Vyas, M.N. and Mathur, R.K. (1998). Direct and indirect effect of FYM, irrigation and fertilizers on rainy season Groundnut-summer pearlmillet cropping sequence. *Indian J.Agric Sci.*, **68** (2) : 117-118.

Patel, P.T., Meisheri, T.G. and Mehta, H.M. (1994). Scheduling irrigations to summer pearlmillet using pan evaporation. *Gujarat Aric. Univ. Res. J.*, 1. **19** (2) : 1-4.

Sawant, A.C. and Dayanand (1994). Effect of moisture conservation methods and antitranspirants on rainfed maize. *J. Maharashtra Agric Univ.*, **19** (1) : 55-57.

Singh, S., Kaushik, S.K. and Gautam, R.C. (1997). Effect of tillage and moisture-conservation practices on productivity, water use and water use efficiency of pearlmillet (*Pennsetum glaucum*) on light soils under dryland condition. *Indian J. Agric. Sci.*, **67** (6) : 232-236.

Vyas, S.H., Patel, J.C., Patel, B.S. and Khanpara, V.D. (1994). Influence of irrigation and N, P fertilization on yield consumptive use of water, water use efficiency and nutrient uptake by summer pearlmillet III Soiuth Saurashtar region. *Gujarat Agric. Univ. J.*, **19** (2) : 113-116.

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