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Growth and yield attributes of summer pearlmillet (*Pennisetum glaucum* L.) as influenced by irrigation, mulches and antitranspirant

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SUMMARY

An experiment was conducted during the *summer* season of the year 2007 and 2008 to study the "Effect of irrigation, mulches and antitranspirant on growths and yield of summer pearlmillet (*Pennisetum glaucum* L.) under South Saurastra conditions". Among different irrigation scheduling treatments, treatment I_3 (1.0 IW : CPE ratio), being at par with treatment I_2 (0.8 IW : CPE ratio), recorded significantly higher values for yield attributes *viz.*, plant height, number of effective tillers plant^{-1}, leaf area index, length and girth of earhead, grain weight plant^{-1} , test weight and grain yield. While, significantly the lowest values of these attributes were observed under treatment I_1 (0.6 IW : CPE ratio). Treatment M_2 (groundnut shell mulch) recorded significantly higher values for growth and yield attributes and grain yield over treatment M_0 (control). However, treatment M_2 was remained at par with treatment M_1 (wheat cut straw mulch). Application of 6 % kaolin spray (AT_1) recorded significantly the highest values for growth and yield attributes and grain yield as compared to control treatment (AT_0) except number of effective and non effective tillers plant^{-1} and harvest index.

Key words : Irrigations, Mulches, Anttranspirant, Pearlmillet

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, the total area under pearlmillet cultivation is 6.79 million hectares with total production of 5.56 million tones and productivity of 972 kg ha^{-1}. Among the states, Gujarat ranked third in the area followed by Rajasthan and Maharashtra. Pearlmillet being an important staple food crop grows during both kharif and summer seasons in Gujarat. The total area under pearlmillet cultivation in Gujarat is 9.32 lakh hectares and production 10.97 lakh tones along with productivity of 1177 kg ha^{-1} and area under summer pearlmillet is 1.71 lakh hectares with productivity of 2145 kg ha^{-1}. Therefore, summer bajra cultivation plays an important role in food grain production.

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 pearlmillet particularly in the irrigated areas of Gujarat State has got importance because of the assurance of targeted crop yield. Irrigation in summer pearlmillet is one of the major inputs of crop production. The research work on various agronomic aspects have been undertaken for pearlmillet crop. But, the information regarding water requirement and irrigation scheduling as well as the use of mulches and antitranspirant for summer pearl miilet crop is lacking for the Medium Black soils of South Saurastra 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 growth and yield of summer pearlmillet (*Pennisetum glaucum* L.) under South Saurastra 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 (I_1), 0.8 IW: CPE ratio (I_2), 1.0 IW: CPE ratio (I_3)] in main plots, 3 mulching levels [control (M_1), wheat cut

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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 spray 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- 60-0 NPK 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.

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 seed and straw yield on net plot basis and then converted on hectare basis.

RESULTS AND DISCUSSION

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

Effect on growth:

Growth parameters like periodical plant height and LAI (Table 1) were significantly influenced due to different levels of irrigation, mulches and application of antitranspirant consistently throughout the crop life span. Plant height was increased considerably by irrigating the crop at 1.0 IW: CPE ratio over 0.6 IW:CPE ratio at 30, 45, 60 DAS and at harvest, and the increment was to the tune of 7.4, 11.9, 11.3 and 4.8 per cent, respectively. Leaf area index recorded at 30, 60 DAS at harvest were increased with increase in irrigation levels from 0.6 to 1.0 IW:CPE ratio. Such a positive response might be due to increase in number of irrigations, which raised the moisture status of the soils and availability of soil moisture to the crop plant. Thus plant can absorb more nutrients from the soil which encourage physiological processes such as cell division and expansion. Hence the number of tillers per plant and size of leaves were increased and ultimately it reflected in higher plant height and LAI. These findings are in agreement with Vyas *et al*. (1992).

Significantly maximum plant height noted under M_2 (groundnut mulch) over M_0 (no mulch) but it was at par with M_1 (wheat cut straw mulch) at 30, 45, 60 DAS and at harvest (Table 1). The increase in plant height was attributed to sufficient soil moisture near root zone due to minimized the evaporation loss, resulted in extended period of storage and availability of moisture also leading to higher uptake of nutrient for proper growth and

Table 1 : Effect of irrigation schedule, mulches and anti-transpirant on growth parameters of pearl millet (pooled two years)

Treatments	Plant population at		Plant height (cm) at				Leaf area index at		
	20 DAS	Harvest	30 DAS	45 DAS	60 DAS	Harvest	30 DAS	60 DAS	Harvest
Irrigation levels (I)									
0.6 IW : CPE ratio (I_1)	128.9	124.7	65.35	104.08	119.43	162.05	3.92	4.54	4.85
0.8IW : CPE ratio (I_2)	125.7	121.9	70.20	111.37	131.66	168.77	4.19	4.96	5.32
1.0 IW : CPE ratio (I_3)	125.2	121.0	71.53	113.20	132.98	169.83	4.21	5.08	5.41
C.D. (P=0.05)	NS	NS	2.99	4.50	5.34	4.04	0.15	NS	0.18
Mulches (M)									
Control (M_1)	126.4	123.0	66.47	106.52	124.43	164.39	3.90	4.62	4.96
Wheat cut starw) @ 5 t ha-1(M_2)	126.3	122.4	69.26	110.56	128.14	166.47	4.20	4.95	5.28
Groundnut shell @ 5 t ha-1(M_3)	126.1	122.1	71.35	111.56	131.50	169.79	4.23	5.01	5.33
C.D. (P=0.05)	NS	NS	2.52	2.84	3.48	2.84	0.16	0.16	0.16
Antitranspirant (AT)									
Control (Water spray) (AT_0)	126.0	122.1	67.83	107.94	126.49	164.71	4.03	4.79	5.09
6 % Kaolin spray at 20 and 50 DAS (AT_0)	126.5	122.4	70.23	111.16	129.56	169.06	4.19	4.93	5.29
C.D. (P=0.05)	NS	NS	1.92	2.82	2.00	2.63	0.09	0.10	0.11

NS-Non significant

development of plants, resulted higher plant height as compared to control treatment. Similar findings were also reported by Kaushik and Lal (1996) and Chaudhry *et al*. (2002). The leaf area index (LAI) recorded at 30 and 60 DAS and at harvest were increased with the application of groundnut shall mulch (M_2) or wheat cut straw mulch (M_1) as compared to control (M_0). The highest LAI under groundnut shall mulch and wheat cut straw mulch due to congenial soil moisture for better growth of leaves during entire life span, the reduction in evaporation losses of soil moisture caused by mulches covered the soil surface in between two rows of pearl millet. This result is in agreement with that of Jat and Gautam (2000).

The maximum values of plant height at 30, 45 and 60 DAS and at harvest and leaf area index (LAI) at 30 and 60 DAS and at harvest were recorded under 6 % Kaolin spray at 20 and 50 DAS (AT_1). Improvement in these growth parameters with Kaolin spray might be due to application of Kaolin keep transpiration check to reasonable extent owing to reflection of incident radiation from the leaf surface or to partial closing of stomata. Thus, the better strata of the plants due to this treatment might be resulted in less leaf senescence and higher photosynthates ultimately resulting in to higher plant height and leaf area index due to Kaolin spray. Kaolin acted as transpiration suppressants, reducing heat load on the leaf and also reduced stomatal conductance. The results are in accordance with De *et al.* (1983b).

Effect on yield attributes:

Various yield attributes *viz*., number of effective and non effective tillers plant^{-1}, length and girth of earhead, grain weight plant^{-1} and test weight (Table 2) recorded under irrigation levels 1.0 and 0.8 IW:CPE ratio did not differ significantly but remarkably higher over 0.6 IW:CPE ration treatment. This might be attributed to the increase in levels of irrigation promotes the vegetative growth, accelerates flowering and thus increase number of effective tillers plant^{-1}. The moisture stress in soil might be less as compared to lower IW:CPE ratio, ultimately resulting in to less number of non effective tillers plant^{1}. Due to sufficient moisture surrounding root zone promotes vegetative growth and hence length and girth of earhead increased under higher number of irrigation. The test weight was increased with increase in irrigation levels. Water is also essential component and acts as a career of food for the crop plants. Thus, water accelerates the process of photosynthesis, ultimately resulting into accumulation of more photosynthates which might help in increasing the size and weight of the grains resulting higher test weight of grains. These results collaborate the findings of Vyas *et al*. (1992).

Among the yield attributes studied, number of effective tillers plant^{-1}, length and girth of earhead, grain weight plant^{-1} and test weight increased significantly under groundnut shell mulch (M_2) and wheat cut straw mulch (M_1) over no mulch (control). Such a positive response

Table 2 : Effect of irrigation schedule, mulches and anti-transpirant on yield and yield attributes of pearlmillet (pooled two years)

Treatments	Number of tillers plant^{-1}		Length of earhead (cm)	Girth of earhead (cm)	Grain weight plant^{-1} (g)	1000 grains weight (g)	Yield(kg ha^{-1})		Harvest index (%)
	Effective	Non effective					Fodder	Grain	
Irrigation levels (I)									
0.6 IW : CPE ratio (I_1)	3.89	2.29	18.36	9.17	43.41	9.88	7329	4229	36.58
0.8IW : CPE ratio (I_2)	4.20	1.96	20.76	9.60	50.01	10.77	7858	4810	37.96
1.0 IW : CPE ratio (I_3)	4.32	1.81	21.44	10.02	53.40	10.87	8212	5044	38.05
C.D. (P=0.05)	0.14	0.19	2.25	0.28	2.99	0.38	391	320	NS
Mulches (M)									
Control (M_1)	3.98	2.04	19.22	9.28	43.28	10.30	7371	4356	37.14
Wheat cut starw) @ 5 t ha^{-1}(M_2)	4.19	2.08	20.29	9.69	51.08	10.53	7881	4763	37.67
Groundnut shell @ 5 t ha^{-1}(M_3)	4.24	1.94	21.05	9.83	52.47	10.69	8148	4963	37.85
C.D. (P=0.05)	0.14	NS	0.66	0.26	3.21	0.19	302	279	NS
Antitranspirant (AT)									
Control (Water spray) (AT_0)	4.03	2.06	19.78	9.36	47.06	10.40	7596	4466	37.02
6 % Kaolin spray at 20 and 50 DAS(AT_0)	4.25	1.98	20.59	9.83	50.82	10.61	8004	4922	38.07
C.D. (P=0.05)	NS	NS	0.41	0.18	2.33	0.20	254	212	NS

NS-Non significant

might be due to water losses caused by evaporation reduced by using both mulches resulting more availability of soil moisture resulted in cell turgidity and eventually higher meristematic activity leading to more foliage development, greater photosynthetic rate and consequently better plant growth, manifested in terms of effective tiller plant^{-1}, increased length and girth of earhead and reflected in higher grain weight plant^{-1} and test weight. This is in confirmative with the findings of Kaushik and Lal (1996) and Chaudhry *et al*. (2002).

Significantly higher number of effective tillers plant^{-1}, earhead length and girth of earhead , grain weight plant^{-1} and test weight recorded under 6% Kaolin spray at 20 and 50 DAS over control (water spray) in pooled results. The increase in yield attributes would be attributed to maintenance of favourable soil moisture status in the root zone because application of Kaolin keep transpiration in check to a reasonable extent owing to reflection of incident radiation from the leaf surface or to partial closing of stomata, which in turn helped plants to maintain better turgor, thus, utilized moisture as well as nutrients more efficiently from the moist soil and enhanced vegetative growth. Optimum leaf area made possible for the high rate of photosynthetic activity during the reproductive phase and the channelisation of the photosynthates accumulated during the vegetative phase to the sink. The acclerated rates helped eventual increase in number of effective tillers plant^{-1}, length of earhead, girth of earhead, grain weight plant^{-1} and test weight. These finding are in accordance with Kaushik and Lal (1996).

Effect on yield:

It is evident from the data presented in Table 2 that the levels of irrigation reflected significant effect on grain and dry fodder yield. Treatment I_3 (1.0 IW:CPE ratio) and I_2 (0.8 IW:CPE ratio) did not produce any considerably difference in grain and dry fodder yield of summer pearl millet. However both these irrigation levels produced appreciably higher grain and dry fodder yield of summer pearl millet to the extent of 19.27 and 13.73 per cent in grain and 12.05 and 7.22 per cent in dry fodder yield over I_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 Vyas *et al*. (1994).

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 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 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 accrued 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 status of the plant due to Kaolin spray resulted in less leaf senescence and higher photosynthesis. These favourable 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).

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