INTERNATIONAL JOURNAL OF FORESTRY AND CROP IMPROVEMENT (December, 2010); 1 (2) : 60-63

RESEARCH ARTICLE

Received : Aug., 2010; Accepted : Sept., 2010

Influence of irrigation schedules, mulches and antitranspirant on growth and yield of summer transplanted pearlmillet (*Pennisetum glaucum* L.)

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ABSTRACT

The field experiment was conducted on pearlmillet during summer seasons of the year 2006 and 2007 with three levels of irrigation schedules (0.7,0.9 and 1.1 IW : CPE ratio), mulches (Control, Pearlmillet Bhusa @ 5 t ha^{-1} and White plastic sheet, 200 gauge) and two levels of antitranspirant (control and 6% kaolin spray at 20 and 50 DATP). Irrigation scheduled at 1.1 IW : CPE ratio recorded significantly higher values for growth, yield attributes, grain and fodder yield of pearl millet. The increase in grain yield under 1.1 IW : CPE ratio was to the tune of 18.2 % and 4.6 % over 0.7 and 0.9 IW : CPE ratios, respectively. Mulching with white plastic sheet was found best over control followed by pearlmillet Bhusa @ 5 t ha^{-1}. Among the mulches 13.2 % increase was observed under white plastic sheet over control. Also application of 6% kaolin antitranspirant found remunerative and increased the 9.7 % grain yield over control.

KEY WORDS : Pearlmillet, Irrigation, Mulch, Antitranspirant, Yield

Patel, P.M., Patel, J.J. and Patel, G.G. and Gediya, K.M. (2010). Influence of irrigation schedules, mulches and antitranspirant on growth and yield of summer transplanted pearlmillet (*Pennisetum glaucum* L.), *Internat. J. Forestry and Crop Improv.,* **1** (2) : 60-63.

INTRODUCTION

Pearlmillet (*Pennisetum glaucum* L.) is one of the major cereal crop grown in the arid and semi arid regions of the world. In India, the total area under pearlmillet cultivation was 6.79 million hectares with total production of 5.56 million tones and average productivity of 972 kg ha^{-1} during the year 2005 (Anonymous, 2006b). The total area under pearlmillet cultivation in Gujarat was 7.7 lakh hectares with average productivity of 1414 kg ha^{-1} and area under summer pearlmillet was 1.71 lakh hectares with average productivity of 2145 kg ha^{-1} in the Gujarat state during the year 2005 (Anonymous, 2006a). In summer season, water is the limiting factor and costly input for crop production for arid and semi arid tropics. Summer cultivation of pearlmillet particularly in irrigated areas of Gujarat states has got importance because of assured yield. Pearlmillet production in summer season is greately influenced by irrigation. Among different approaches to schedule irrigation, climatological approach based on the ratio between irrigation water (IW) and cumulative pan evaporation (CPE) was found the most appropriate, as it integrates all the weather parameters giving their natural waitage in a given soil-water plant continuum. More practicable approaches based on the ratio of a fixed amount of irrigation water (IW) to cumulative pan evaporation (CPE) have been adopted (Parihar *et al.,* 1974). Mulches maintain soil water status by reducing evaporation, runoff and weeds. The adequate supply of moisture increased growth and dry matter production of crops directly as well as indirectly. Application of mulches on the soil surface obstructs the solar radiation inducing into the soil. It also checks the escape of water vapour by physical obstruction. It exerts a decisive effect on earliness, yield and quality of the crop. Reducing loss of water through transpiration appears to be a promising approach for efficient water utilization in summer season. Transpiration could be effectively reduced without materially affecting the photosynthesis through judicious use of energy reflecting material like antitranspirants. Timely sowing of pearlmillet by drilling method yields maximum and decreases subsequently with delay in sowing. Summer pearlmillet is generally grown after vegetable crops like chilli, brinjal, cauliflower, cabbage, potato as well as tobacco and early sown wheat which many times do not permit timely sowing of pearlmillet crop resulting in poor yield under middle Gujarat conditions. In this situation, raising seedling in the nursery and timely

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transplanting of seedlings increases the yield and also compensates the yield losses due to delay in sowing. The present investigation was, therefore, undertaken to determine an appropriate irrigation schedule, mulch and an antitranspirant on summer transplanted pearlmillet under middle Gujarat conditions.

MATERIALS AND METHODS

The field experiment was conducted at the College Agronomy Farm, Department of Agronomy, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat on loamy sand soil during the summer seasons of the year 2006 and 2007. The soils of the experimental site was free from any kind of salinity or sodicity hazards, low in organic carbon and nitrogen, medium in available phosphorus and high in available potassium. There were 18 treatment combinations comprising of three levels, each of irrigation schedules (0.7, 0.9 and 1.1 IW : CPE ratios) and mulches (Control, Pearlmillet Bhusa @ 5 t ha^{-1} and White plastic sheet, 200 gauge) and two levels of antitranspirant (Control *i.e.* water spray and 6 % Kaolin spray at 20 and 50 DATP) embedded in a split-split plot design with four replications. A recommended fertilizer dose of chemical fertilizer 120-60-0 kg NPK per hectare was applied uniformly. Full dose of phosphorus (60 kg P_2O_5 ha^{-1}) through diammonium phosphate and 50 per cent nitrogen (60 kg N ha^{-1}) from diammonium phosphate as well as ammonium sulphate were applied in opened furrows before transplanting. Remaining 50 per cent nitrogen (60 kg N ha^{-1}) was applied in the form of urea in two equal splits at an interval of 20-25 days after transplanting during both the seasons of field experimentation. After fertilization, pre-transplanting irrigation was given to the experimental plot. The uniform healthy seedlings of pearlmillet cv. GHB–558 having an age of twenty five days were uprooted after applying the irrigation to the nursery and one seedling per hill was transplanted at 45 cm x 15 cm spacing. One common irrigation was given uniformly to all treatments for proper establishment of seedlings. The irrigation soil depth was maintained 50 mm in each irrigation. The total numbers of applied irrigation were 7, 9 and 11 under 0.7, 0.9 and 1.1 IW : CPE ratio, respectively. The mulches were applied in the respective treatments, leaving the pearlmillet rows opened. Thus, mulches were used in such a way that soil surface in between the space (45 cm) of two lines were covered by leaving row of pearlmillet crop. Mulches *i.e.* Pearlmillet Bhusa @ 5 t ha^{-1} (organic mulch) and white plastic sheet (200 gauge) were applied at 20 days after transplanting of the crop for M_1 and M_2 treatments, respectively during both the years. Water spray as a control treatment (AT_0) and 6 % kaolin (AT_1) were sprayed on the plants at 20 and 50 days after transplanting of the crop during both the years.

RESULTS AND DISCUSSION

The results of the present study have been discussed under following sub heads :

Effect of irrigation:

Different irrigation levels did not exert their significant influence on plant population on pooled based analysis. The results indicated that (Table 1) levels of irrigation schedules exerted significant influence on growth, yield attributes and yield. Among different irrigation scheduling treatments, treatment I_3 (1.1 IW : CPE ratio) recorded significantly higher plant height and leaf area index, being at par with treatment I_2 (0.9 IW : CPE ratio). While, significantly the lowest value of plant height and leaf area index were obtained under treatment I_1 (0.7 IW : CPE ratio). The irrigation schedule had significant effect on number of effective tillers $plant^{-1}$ recorded at harvest. Among different irrigation scheduling treatments, treatment I_3 (1.1 IW : CPE ratio) registered significantly higher number of effective tillers $plant^{-1}$ and minimum number of non-effective tillers $plant^{-1}$, being at par with treatment I_2 (0.9 IW : CPE ratio). While, significantly the lowest value of number of effective tillers $plant^{-1}$ and higher number of non effective tillers $plant^{-1}$ were recorded under treatment I_1 (0.7 IW : CPE ratio). Frequency of irrigation with shorter interval improved soil moisture status, which might have helped the plants to absorb more nutrients from the soil thereby increasing number of tillers $plant^{-1}$. Treatment I_3 (1.1 IW : CPE ratio) registered significantly higher test weight (10.87 g), grain yield (5294kg ha^{-1}) and fodder yield (8462 kg ha^{-1}) than treatment I_1 (0.7 IW : CPE ratio) , but it was remained statistically at par with the treatment I_2 (0.9 IW : CPE ratio). This indicated that higher number of irrigations at shorter interval had significant effect to harvest maximum yield of pearlmillet. The other reason might be due to that treatment I_3 (1.1 IW : CPE ratio) had a favourable effect on all the yield attributes which resulted into higher grain production as compared to rest of the irrigation treatments. Increased number of irrigation which raised the moisture status of the soil for a longer period and resulted into maximum depletion of available soil moisture through the process of evapotranspiration. Increased frequency of irrigation increased the total consumptive use. The another reason might be that higher frequency of irrigation coupled with

Table 1 : Effect of different levels of irrigation, mulches and antitranspirant on growth attributes, yield attributes and yield of summer transplanted Pearlmillet (Pooled data of 2 year)

Treatments	Plant population net plot^{-1}	Plant height (cm)	Leaf area index	Effective tillers plant^{-1}	Non effective tillers	Test weight (g/1000 grains)	Grain yield (kgha^{-1})	Dry fodder yield (kgha^{-1})
Main plot (Irrigation) (I)								
I_1 : 0.7 IW:CPE Ratio	129.92	172.05	4.85	3.89	2.29	9.88	4479	7579
I_2 : 0.9 IW:CPE Ratio	127.15	178.77	5.32	4.20	1.96	10.77	5060	8108
I_3 : 1.1 IW:CPE Ratio	126.21	179.83	5.41	4.32	1.81	10.87	5294	8462
S.E. ±	1.59	1.31	0.06	0.05	0.06	0.12	103.91	126.89
C.D. (P=0.05)	NS	4.04	0.18	0.14	0.19	0.38	320.19	391.03
C. V. (%)	8.61	5.14	7.74	7.70	20.93	8.23	14.56	10.92
Sub plot (Mulches) (M)								
M_0 : Control	128.29	174.39	4.96	3.98	2.04	10.30	4606	7621
M_1 : Pearlmillet Bhusa @ 5 t ha^{-1}	127.63	176.47	5.28	4.19	2.08	10.53	5013	8131
M_2 : White plastic sheet (200 gauge)	127.35	179.79	5.33	4.24	1.94	10.69	5213	8398
S.E. ±	0.70	0.99	0.06	0.05	0.05	0.07	97.27	105.14
C.D. (P=0.05)	NS	2.84	0.16	0.14	NS	0.19	279.45	302.07
C. V. (%)	3.80	3.87	7.49	8.26	15.81	4.39	13.63	9.05
Sub sub plot (Antitranspirants) (AT)								
AT_0: Control (Water spray)	127.85	174.71	5.09	4.03	2.06	10.40	4716	7846
AT_1 : 6 % Kaolin spray at 20 and 50 DATP	127.67	179.06	5.29	4.25	1.98	10.61	5172	8254
S.E. ±	1.04	0.93	0.04	0.10	0.04	0.07	74.79	89.56
C.D. (P=0.05)	NS	2.63	0.11	NS	NS	0.20	212.20	254.10
C.V.%	6.90	4.45	6.53	8.41	14.72	5.68	12.84	9.44

NS=Non-significant

higher grain yield under this ratio might be responsible for higher water use efficiency. The second reason might be that the increasing trend with increase in number of irrigation (IW : CPE ratio) might have helped to increase all yield attributing characters and ultimately increased grain yield. These results are in line with those reported by Dhonde *et al.* (1986), Vyas *et al.* (1992) and Patel *et al.* (1994).

Effect of mulches:

Results revealed that neither organic (pearlmillet Bhusa) mulch nor white plastic mulch exerted their significant effect on plant population. Application of white plastic sheet (200 gauge) as a mulch (M_2) to summer pearlmillet crop recorded significantly higher plant height over control (M_0; 77.04 cm). However, treatment M_2 remained at par with treatment M_1 (Pearlmillet Bhusa @ 5 t ha^{-1}). An application of white plastic sheet or pearlmillet Bhusa used as a mulch in summer pearlmillet obtained significantly higher leaf area index (5.28 or 5.33) over control. Application of white plastic sheet (M_2) recorded significantly higher yield attributes and yield. Treatment M_2 (white plastic sheet mulch) resulted significantly higher grain (5213 kg ha^{-1}) and dry fodder yields (8398 kg ha^{-1}) as compared to control treatment (M_0). While, Treatment M_1 (pearlmillet Bhusa @ 5 t ha^{-1}) remained next to treatment M_2 by exerting its significant influenced on control treatment (M_0). Mulches played an important role in changing hydro-thermal regime of soil and conserving soil moisture for the better growth of plants. Polyethylene being completely impervious, the loss of water was mostly due to transpiration by the plants. However, the loss of water under control condition without mulch was maximum because of both evaporation from soil and transpiration by plants. Less loss of moisture from soil under pearlmillet Bhusa was due to cover provided the mulch and existence of low thermal gradients. Thus, evaporation from soil under polyethylene mulch being negligible, there was more of transpiration loss which was responsible for increasing the grain yield. The other reason might be that thermal regime of soil during 31 to 45 days period of crop growth was lower than rest of the periods because of the lower prevailing temperature of the atmosphere. The fourth reason might be that moisture conservation greatly

improved the growth and yield components. Adequate availability of water to plants results in cell turgidity and eventually higher meristematic activity, leading to more foliage development, greater photosynthetic rate and consequently better plant growth and ultimately increase grain yield. The results are in conformity with those obtained by Gupta (1980), Jat and Gautam (2000) and Chaudhary *et al.* (2002).

Effect of antitranspirant:

Application of 6 % kaolin spray (AT_1) recorded significantly the highest values for most of the growth parameters *viz.,* Plant height and leaf area index as well as yields as compared to control treatment (AT_0). Number of effective and non effective tillers plant^{-1} of pearlmillet crop were not affected significantly due to 6 % kaolin spray. Treatment AT_1 (6 % kaolin spray) produced significantly higher test weight (10.61 g), grain (5172 kg ha^{-1}) and dry fodder yields (8254 kg ha^{-1}) over control treatment. Kaolin treated plants might have higher relative water content compared with water spray indicating that this chemical kept transpiration in check to a reasonable extent owing to reflexion 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 result in better grain development and ultimately increased grain yield. Such, appreciable increases in pearlmillet grain yield due to spraying of kaolin have been reported by Lal *et al*. (1992), Kaushik and Gautam (1994) and Kaushik and Lal (1996).

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