

Effect of Different Irrigation Levels, Stage of Water Availability and Different Types of Mulches on Transpiration Rate of Wheat Crop

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ABSTRACT

Field experiments were conducted consecutively for three year in 2004-05, 2005-06 and 2006-07 to find the effect of different irrigation levels, stage of water availability, and different types of mulches on transpiration rate of wheat crop. The transpiration rate was observed to be higher in the crop receiving more number of irrigations as compared to less irrigated wheat. The water available at early stage was more beneficial in enhancement of transpiration rate as compared to its availability at later stage of crop growth. The application of mulches also exhibited considerable influence on transpiration of wheat. Application of mulches enhanced the transpiration rate of the crop with rice husk exhibited the highest response in this regard followed by transparent polythene.

Introduction

Different indices of plant water status, viz., relative leaf water content (RLWC), leaf water potential (LWP), leaf osmotic potential (LOP), leaf diffusion resistance (LDR) and transpiration rate (TR) control physiological processes which influence the quality and quantity of plant growth (Kramer, 1969). These plant water status parameters are affected by various factors such as water and nutrient availability and soil management practices. However, work on the index transpiration rate in crops grown under semi-arid conditions is meager. The present study was therefore made in this direction on wheat crop.

Materials and Methods

Field experiments were carried out for three consecutive years during *rabi* season of 2004-05, 2005-06 and 2006-07 on sandy loam soil classified as Typic Ustochrept at the Research farm of Indian Agricultural Research Institute, New Delhi under different hydro-thermal regimes, created by using different types of mulches and irrigation levels. In the first year four mulch treatments- black polythene (MB), transparent polythene (MT), rice-husk (MR) and control (MO) i.e. no

mulch) were chosen with two different irrigation levels- low level(LI) & high level(HI), as the main treatments. Thickness of both types of polythene used was 400 gauge i.e 100 μ . All the plots were given similar dose of nitrogen 120 KgN/ha. In the second year i.e. in 2005-06 three mulch treatments- no mulch, rice husk and transparent polythene and three nitrogen levels- 0, 100 & 150kgN/ha under two different irrigation levels (high and low) were taken. In the third year i.e. in 2006-07 mulches were the main treatment. Similar to year 2005-06, three different types of mulches - no mulch, rice husk and transparent polythene were selected and three different nitrogen levels- 0, 100 & 150 kgN/ha were taken as sub treatment. Data on the relevant aspects were collected for all the years and for all treatments at different stages during the crop growth period. All the observation were recorded at around 12.00 noon on the day of observation. A Steady State Porometer (LI- 1600) was used for the purpose.

Results and Discussion

Effect of Irrigation Levels and Stage of Water Availability on Transpiration Rate

Variations in the values of transpiration rate at different dates in the year 2004-05 are depicted

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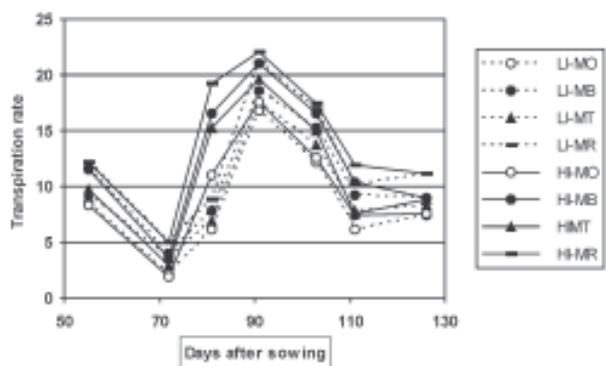


Fig. 1. Impact of irrigation levels, stage of water availability and different types of mulches on transpiration rate ($\mu\text{g cm}^{-2} \text{sec}^{-1}$) of wheat crop (2004-05)

in Fig.1. The effects of different irrigation levels were clearly visible on the transpiration of the crop. The transpiration rate was observed higher in the crop receiving more number of irrigations as compared to less irrigated wheat (Fig 1), irrespective of the type of mulch treatment. The first differentiating irrigation was applied on 72 days after sowing (DAS). In particular, the rate recorded on 81 DAS exhibited considerably higher values, varying from 10.98 to $19.27 \mu\text{g cm}^{-2}\text{s}^{-1}$ in different type of mulches, in higher level of irrigation as compared to the lower values 6.17 to $8.85 \mu\text{g cm}^{-2}\text{s}^{-1}$, observed in case of lower level

of irrigation. These differences disappeared soon due to rains i.e. availability of water. On receiving rains after 81 DAS these values 6.17 to $8.85 \mu\text{g cm}^{-2}\text{s}^{-1}$ jumped to the level 16.8 to $21.15 \mu\text{g cm}^{-2}\text{s}^{-1}$ at 91 DAS. On the other hand, the deficiency of water during the periods (55- 72DAS & 103-110DAS) in which neither rains were there nor the irrigation was applied, reduced the transpiration of the crop considerably. In the year 2005-06 also the effects of irrigation levels on transpiration rate were quite visible. The data for this year is presented in Fig.2. In this figure three sets of diagram are shown belonging to three different nitrogen levels viz. 0,100 & 150KgN/ha. In each set it is observed that irrespective of the mulch used, the curves pertaining to higher irrigation level maintained higher position as compared to corresponding curve for lower irrigation level, which shows the enhancement in transpiration rate under higher level of irrigation. High plant water status under well watered conditions could be attributed to better root growth resulting in higher water and nutrient uptake. Under low plant water status the closure of the stomatal aperture decreases diffusion of water vapour out of the leaf and reduction due to transpiration loss when plant water deficit exceeds a certain threshold value or stress reaches a critical level. Thus, the lower TR was observed

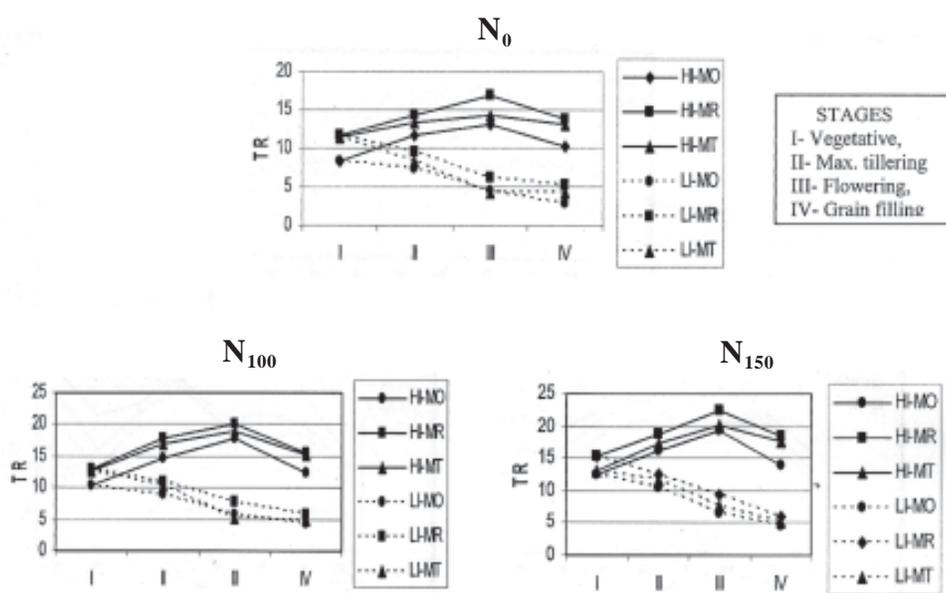


Fig. 2. Effect of different Irrigation levels & Mulches on Transpiration rate ($\mu\text{g cm}^{-2} \text{s}^{-1}$) of wheat (2005-06)

in case of less frequent irrigation. Higher transpiration rate per unit leaf area in wheat under irrigated condition as compared to rain fed crop was also recorded by Zhang *et. al.*, (1998). The stage of water availability also exhibited its impact on transpiration rate. In the year 2004-05 we find that when the irrigation was applied at early date around 70DAS, the TR values were increased considerably whereas when the same was applied at later stage around 110 DAS, TR values were not increased very much (Fig.1). Similar effects were also observed in the subsequent years. In the year 2005-06, when irrigation is applied at early stage (stage-I), transpiration rate is increased and the increase persisted for a longer period up to stage-III. But when it is applied at later stage (stage-III), transpiration rate is no longer increased rather decreased (Fig.2). Similarly, in the year 2006-07 also when water was applied around 68DAS, TR increased considerably whereas at later date around 105 DAS sufficient water was available to the crop, of course in the form of rains, but the transpiration rate was not increased to that extent (Fig.4). Thus the water availability at early stage of crop growth is more beneficial in enhancement of transpiration rate of wheat crop as compared to its availability at later stage.

Effect of Different Mulches on Transpiration Rate

The application of mulches also exhibited their influence on transpiration of wheat in all the years. Variations in TR due to different types of mulches for the year 2006-07 are depicted in fig. 3. Three sets of curves are shown in the figure belongs to different levels of nitrogen viz. 0, 100, 150 kgN/ha. In each set it is observed that both the curves corresponding to mulch (whether it is an application of transparent polythene or rice-husk) remains always at higher position as compared to control i.e. no- mulch application which reflects that the application of mulches indeed enhanced the transpiration rate of the crop. Beneficial effects of mulch on moisture conservation, soil physico-chemical and biological conditions in dry season were reported by Bhatta (2007), Kathmale *et al.* (2000), Mishra (1996) and Rautaray (2005). It is also observed that curve corresponding to application of rice- husk maintained the highest position among the curves in each set. Thus wheat treated with rice husk exhibited the highest response with regard to enhancement in transpiration of wheat crop followed by transparent polythene. A similar response was also observed in the year 2004-05 (Fig 1) and also in 2005-06 (Fig.2). In both the

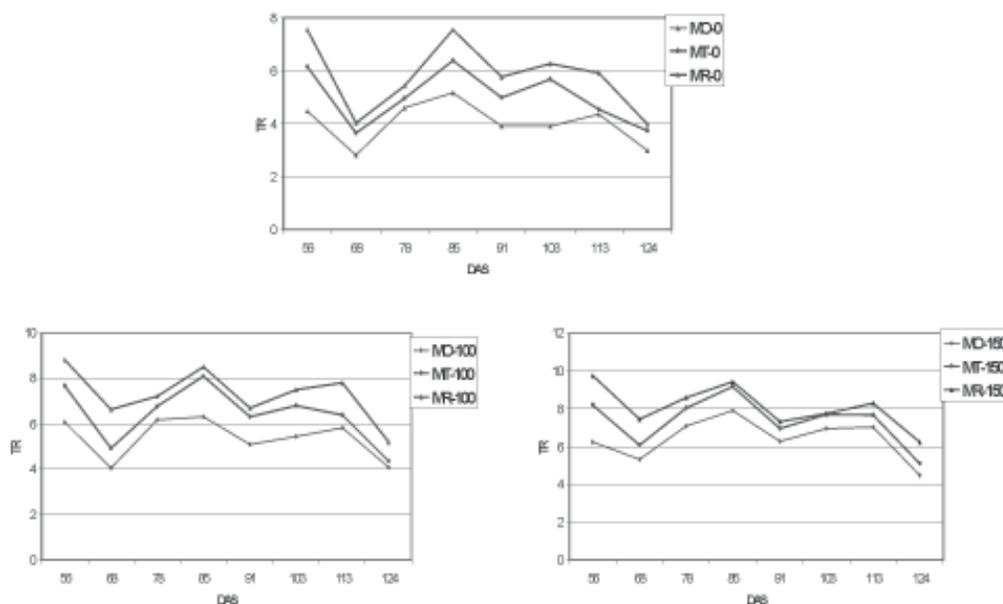


Fig. 3. Effect of different mulches on transpiration rate of wheat crop (2006-07)

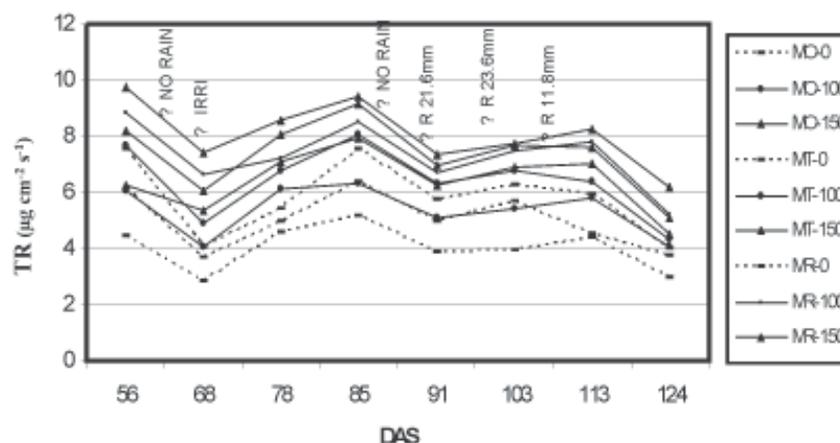


Fig. 4. Impact of water availability on transpiration rate of wheat crop (2006-07)

situations of irrigation levels, whether it is a higher level or a lower level, the curves of the mulches maintained higher position as compared to corresponding curves for no-mulch treatment, showing the enhancement in transpiration rate due to application on mulches. Also, the rice-husk exhibited its highest efficiency in enhancing the transpiration rate of wheat crop.

From the results of the present study it could be concluded that as the plant water status index transpiration rate is quite sensitive and exhibited its true reflection in discriminating the various factors such as water levels, stage of the water availability and mulches in soil management practices, which play a big role in enhancing the growth and productivity of a crop, hence its potential can be exploited in these areas.

References

- Bhahma, R., Janawade, A.D. and Palled, Y.B. 2007. Water Use Studies in Durum Wheat as Influenced by Irrigation Schedules, Mulch and Antitranspirant Application in Black Soils of Northern Transitional Zone of Karnataka. *Karnataka. J. Agric. Sci.*, **20**(1): 120-122.
- Kathmale, D.K., Kamble, M.S., Khadtare, S.V. and Path, R.L. 2000. Polythene film mulch technology for yield maximization in summer groundnut (*Arachis hypogaea*). *Indian Journal of Agronomy*, **45**: 210-213.
- Kramer, P.J. 1969. Plant and water relationship. A modern synthesis, Mc Graw Hill, New York.
- Mishra, O.R. 1996. Influence of mulching and antitranspirants on water consumption, yield and yield contributing characters of different rainfed wheat varieties. *Crop Research*, **11**: 1-8.
- Rautaray, S.K. 2005. Effect of mulching on yield and economics of rainfed rice (*Oryza sativa*) based cropping sequences in lower Assam. *Indian Journal of Agronomy*, **50**: 13-15.
- Zhang, H., Oweis, T., Garabet, S. and Pala, M. 1998. Water use efficiency and transpiration efficiency of wheat under rain fed conditions and supplemental irrigation in a Mediterranean-type environment. *Plant and Soil* **201**: 295-305.