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# Water Use Studies in Durum Wheat as Influenced by Irrigation Schedules, Mulch and Antitranspirant Application in Black Soils of Northern Transitional Zone of Karnataka

Wheat is one of the most important cereal crops of the world on account of its wide adaptability to different agro-climatic and soil conditions. In Karnataka, wheat is grown in typical semi-arid climate which is characterized by high temperature during crop growth. Average productivity is much lower than the national average because of high temperature and low humidity coupled with rainfall. In cultivation of high yielding wheat varieties, irrigation assumes greater importance because during growing season of crop (October to April) weather remains relatively dry. Various agronomic practices have been developed to conserve rain or irrigation water and proper utilization of conserved moisture goes a long way in increasing crop productivity per unit amount of water used. To increase the duration of moisture availability with the existing available moisture, the losses of it from plants (transpiration) and soil (evaporation) have to be reduced. For this antitranspirants and mulches, respectively are being tried under many occasions. Zhang *et al*. (2002) reported that straw mulching in winter wheat reduced soil evaporation by 40 mm and improved water use efficiency over 10 per cent. Antitranspirants, in general, reduce the transpiration loss of water occurring mainly through closing stomatal pores present on leaf surface. Spraying of antitranspirant results in higher relative water content and water use efficiency in association with lower rate of water use per day and consumptive use which enhance crop yield (Mishra, 1996).

Keeping these points in view, an experiment was conducted to find out the effect of irrigation schedules, mulch and antitranspirant application on consumptive use, water use efficiency and moisture depletion pattern of wheat crop. A field experiment was conducted during rabi season of 2004-05 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. There were 15 treatment combinations consisting of 5 main plots of irrigation schedules ($I_1$ = One irrigation at crown root initiation (CRI), $I_2$ = Two irrigations at CRI + Flowering stage, $I_3$ = Three irrigations at CRI + Late jointing + Milk stage, $I_4$ = Four irrigations at CRI + Tillering + Late jointing + Milk stage, $I_5$ = Five irrigations at CRI + Tillering + Late jointing + Flowering + Milk stage) and 3 sub plots ($M_0$ = Control, $M_1$ = Mulch (finger millet straw @ 6 tonnes ha$^{-1}$), $M_2$ = Antitranspirant (kaolin @ 6% w/v)). The experiment was laid out in split plot design with 3 replications. The gross and net plot sizes were 4.0 x 2.76 m and 3.0 x 1.84 m, respectively. Variety used for the experiment was DWD-1006.

Measured quantity of irrigation water was applied to the plots as per irrigation schedule. For measuring irrigation water, volume method was used. The depth of irrigation was 60 mm. The ground water table remained lower than three metres throughout the crop growth. Mulching was undertaken in respective treatments with finger millet straw at the rate of 6 tonnes per ha at 30 DAS. Respective treatments were sprayed twice with antitranspirant (Kaolin @ 6% solution) after 49 days (at maximum tillering stage) and 69 days after sowing (20 days after first spray). The spray was done on the surface of leaves at the rate of 600 and 1000 litres per ha. All the recommended management practices were followed regularly.

Soil moisture determination was done using gravimetric method from one replication. Soil samples were drawn with the help of screw auger from 0-15, 15-30 and 30-60 cm soil depth. In all the treatments soil samples were collected before sowing and before and after each irrigation. Soil samples for moisture determination were also collected after harvest of the crop. The moisture percentage from different soil depths were used to calculate consumptive use of water and soil moisture extraction pattern of the crop for irrigation treatments.

The results presented in table 1 revealed that significantly higher grain yield of wheat (2545 kg ha$^{-1}$) was obtained in $I_5$ (irrigation at CRI, tillering, late jointing,flowering and milk stage) over $I_1$ (irrigation at CRI), $I_2$ (irrigationat CRI and flowering stage) and $I_3$ (irrigation at CRI, late jointing and milk stage, but was on par with that of $I_4$ (irrigation at CRI, tillering, late jointing and milk stage. The higher grain yield observed in $I_5$ and $I_4$ irrigation schedules which is due to frequent irrigations provided in these treatments ($I_5$ and $I_4$) might have maintained adequate available soil moisture (ASM) in the root zone throughout the crop growth period. Among irrigation schedules, the highest (323 mm) consumptive use of water was recorded in $I_5$ irrigation schedule closely followed by $I_4$ (300), $I_3$ (256), $I_2$ (216) and $I_1$ (158 mm) irrigation schedules. The lowest (158 mm) consumptive use of water was noticed in $I_1$ irrigation schedule which received single irrigation at critical stage of crown root initiation. Consumptive use of water was higher in $I_5$ irrigation schedule due to more frequent irrigations resulting in more moisture available to the crop and soil surface remaining wet for longer duration resulting in more evapotranspiration. The observations are in agreement with Nayak and Sengupta (1981) and Rathore and Patel (1991).

Highest WUE (10.74 kg ha$^{-1}$ mm$^{-1}$) was observed in $I_1$ irrigation schedule closely followed by $I_2$, $I_3$, $I_4$ and $I_5$ (8.89, 7.86, 7.79 and 6.99 kg ha$^{-1}$ mm$^{-1}$) respectively. The lowest WUE was noticed in $I_5$ (6.99 kg ha$^{-1}$ mm$^{-1}$) irrigation schedule. The WUE was highest in treatment receiving single irrigations at crown root initiation (CRI), stage mainly due to conservative water use, which indicates the efficient water use at lower frequency of irrigation. Similar observations on WUE was made by several workers (Kumar *et al*., 1987; Rathore and Patel, 1991 and Deshmukh *et al.*, 1997).

Table 1. Number of irrigations, total depth of irrigation applied and grain yield, consumptive use and water use efficiency of wheat as influenced by irrigation schedules and application of mulch and antitranspirant

| Treatments | Number of irrigations | Total depth of irrigation applied (cm) | Grain yield ($kg\ ha^{-1}$) | | | | Consumptive use (mm) Mulch and antitranspirant | | | | Water use efficiency ($kg\ ha^{-1}\ mm^{-1}$) Mulch and antitranspirant | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $M_0$ | $M_1$ | $M_2$ | Mean | $M_0$ | $M_1$ | $M_2$ | Mean | $M_0$ | $M_1$ | $M_2$ | Mean |
| Irrigation schedules | | | | | | | | | | | | | | |
| $I_1$ | 1+1* | 12 | 1708 | 1819 | 1736 | 1754 | 154 | 155 | 166 | 158 | 11.04 | 10.49 | 10.69 | 10.74 |
| $I_2$ | 2+1* | 18 | 1820 | 2061 | 1890 | 1923 | 215 | 210 | 224 | 216 | 10.01 | 7.83 | 8.83 | 8.89 |
| $I_3$ | 3+1* | 24 | 2015 | 1866 | 2180 | 2020 | 255 | 249 | 266 | 256 | 8.21 | 7.34 | 8.02 | 7.86 |
| $I_4$ | 4+1* | 30 | 2226 | 2345 | 2631 | 2400 | 315 | 276 | 308 | 300 | 8.21 | 7.43 | 7.73 | 7.79 |
| $I_5$ | 5+1* | 36 | 2378 | 2618 | 2640 | 2545 | 375 | 348 | 247 | 323 | 6.83 | 6.97 | 7.17 | 6.99 |
| Mean | | | 2029 | 2141 | 2215 | | 263 | 248 | 242 | | 8.01 | 8.49 | 8.86 | |

| omparing the mean of | S.Em± | CD at 5% |
|---|---|---|
| Irrigation (I) | 79 | 259 |
| Mulch and antitranspirant (M) | 38 | 112 |
| Interaction (IxM) | 85 | NS |

Note: $I_1$ = Irrigation at crown root initiation (CRI), $I_2$ = Irrigation at CRI + flowering stage, $I_3$ = Irrigation at CRI + late jointing + milk stage
$I_4$ = Irrigation at CRI + tillering + late jointing + milk stage, $I_5$ = Irrigation at CRI + tillering + late jointing + flowering + milk stage
$M_0$ = Control, $M_1$ = Mulching (straw @ 6 tonnes $ha^{-1}$), $M_2$ = Antitranspirant (kaolin @ 6%)
* Common irrigation applied at 15 days after sowing

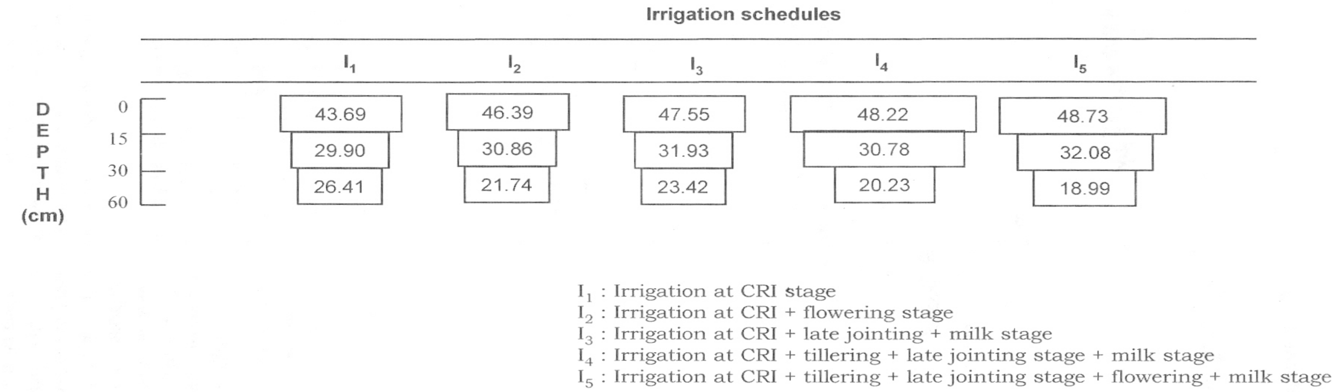


Fig 1. Soil moisture extraction pattern (%) of wheat as influenced by irrigation schedule and application of mulch and antitranspirant

Highest soil moisture was extracted from the surface layer (0-15 cm) in $I_5$ irrigation schedule (Fig 1.) and extraction from this layer decreased progressively in less frequent irrigation schedule i.e. $I_1$. In general, the crop extracted higher moisture (46.72 per cent) from surface layer of 0-15 cm and extraction decreased with increasing depth (21.74 per cent) in 30-60 cm. The $I_5$ irrigation schedule extracted higher (48.73) moisture from surface (0-15 cm) layer compared to $I_4$, $I_3$, $I_2$ and $I_1$ (48.22, 47.55, 46.39 and 43.69 per cent respectively). The soil moisture extraction decreased with increasing depths (30-60 cm soil layer) and was least (18.99 per cent) from 30-60 cm soil layer in wet regime ($I_5$ irrigation schedule) as compared to relatively higher (25.41 per cent) in dry regime ($I_1$). Higher moisture extraction from top layer in the treatment receiving frequent irrigations may be attributed to higher availability of soil moisture coupled with high root volume in these treatments. Since moist condition remained for longer period and higher concentration of roots in the surface layer resulted in relatively higher moisture depletion from the surface layer (Pratibha *et al.*, 1994).

Among the moisture conservation practices, the highest (263 mm) consumptive use of water was observed in $M_0$ (control) followed by $M_1$ (straw mulch) (248 mm) and $M_2$ (antitranspirant) (242 mm). The highest WUE was recorded with $M_2$ (antitranspirant) (8.86 $kg\ ha^{-1}\ mm^{-1}$) followed by $M_1$ (mulch) (8.49 $kg\ ha^{-1}\ mm^{-1}$) and least in $M_0$-control (8.01 $kg\ ha^{-1}\ mm^{-1}$). Beneficial effects of mulch on moisture conservation, soil physico-chemical and biological conditions in the dry season were reported by Kathmale *et al.* (2000), Mishra *et al.* (2000) and Rautaray (2005). Kaolin reduced transpirational loss from leaf surface and decreased consumptive use as compared to mulch (Mishra *et al.*, 1996 and Fujehara and Joshida, 2000). It can be concluded from the study that maximum grain yield of wheat and consumptive use of water were in five irrigations. However, maximum water use efficiency was obtained in one irrigation. Kaolin @ 6 per cent reduced the consumptive use of water and increased the water use efficiency of wheat to a greater extent over mulch and control treatment.

Department of Agronomy
College of Agriculture,
Dharwad – 580 005 Karnataka, India

RANJITA BHAHMA
A. D. JANAWADE
Y. B. PALLED

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**References**

DESHMUKH, M. R., INGLE, V. N. AND KOHALE, S. K., 1997, Response of late sown wheat variety AKW-381 under limited and optimum irrigation. *Punjabrao Krishi Vidyapeeth Research Journal*, **21**: 214-216.

FUJIHARA, S. AND JOSHIDA, M., 2000, Allelopathy of hairy vetch (*Vicia villosa*) and its application for crop production as mulching material. *Bulletin of Shikoku National Agricultural Experiment Station* (Japan), **66**: 17-32.

KATHMALE, D. K., KAMBLE, M. S. KHADTARE, S. V. AND PATIL, R. L. 2000, Polythene film mulch technology for yield maximization in summer groundnut (Arachis hypogaea). *Indian Journal of Agronomy*, **45**: 210-213.

KUMAR, V., LATHER, B. P. S. AND SHARMA, H. C., 1987, Response of wheat genotypes 'WH-147M' to levels of irrigations. *Journal of Research, Haryana Agricultural University*, **17**: 80-82.

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.

NAYAK AND SENGUPTA, A. K., 1981, Scheduling, irrigation to dwarf wheat on the basis of critical stages of growth under West Bengal condition. *Indian Agriculturist*, **25**: 119-174.

PRATIBHA, G., RAMAIAH, N. V. AND SATYANARAYANA, V., 1994, Studies on consumptive water use, water use efficiency, soil moisture extraction patterns by wheat genotypes under varying irrigations applied at different physiological stages. *Journal of Research, Andhra Pradesh Agricultural University*, **22**: 33-34.

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.

RATHORE, A. L. AND PATEL, S. L., 1991, Studies on nitrogen and irrigation requirements of late sown wheat. *Indian Journal of Agronomy*, **36**: 184-187.

ZHANG, X., PEI, D. AND HU, L., 2002, Conserving groundwater for irrigation in the north China plain. *Irrigation Science*, **21** : 159-166.