

Irrigation scheduling using computer softwares

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■ **ABSTRACT** : A study was carried out to develop irrigation schedule using CROPWAT and CRIWAR software for command area of Wadi Adampur distributory of Wan River Project. The analysis revealed that the actual amount of water applied during the year 2006-07 to 2010-11, except 2009-10 varied between 2.56 to 16.93 Mm³. On average 9.23 Mm³ water was applied annually. The irrigation schedules were prepared using CROPWAT and CRIWAR software. The estimated water requirement of the command with CROPWAT and CRIWAR varied between 4.89 to 6.92 and 9.80 to 12.90 Mm³, respectively. The average discharge required was estimated as 2.05 l/s/ha and 4.59 l/s/ha using CROPWAT and CRIWAR software, respectively. Average actual water applied was 53.06 % more and 14.77% less as compared to that estimated with CROPWAT and CRIWAR model. Though, average actual water applied is more than that estimated with CROPWAT, average actual area irrigated is less (*i.e.* only 730 ha). Using CROPWAT developed schedule, in less water significantly more area about 1111.88 ha is to be irrigated. Considering above findings, it is suggested to use CROPWAT developed schedule for proper scheduling of irrigation in the command.

■ **KEY WORDS** : Irrigation scheduling, Softwares

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Water become precious and scares with the increasing demand of growing population and rapid industrialization. Agriculture consumes the largest share of available water. The water requirements of crop vary widely from place to place, crop to crop and also during the entire crop period of individual crop. Therefore, the estimation of crop water requirements considering the crop pattern attracted attention of water resources planner and engineers.

The geographic area of Maharashtra is 30.7 Mha, of which 22.5 M ha is cultivable. 43 per cent of cultivable area is drought prone and 7 % area is flood prone. Irrigation potential of the state is estimated by State Irrigation Commission as 12.6 Mha. Numerous irrigation projects have been constructed in the state to tap the water resources at the cost of 71000 crores. As a result, the irrigation potential to the tune of 4.5 Mha has been created through 71 major, 243 medium and 2,940 minor state sector irrigation schemes.

There is still a wide gap between the irrigation potential developed and utilized. To reduce this gap and thereby increasing the water use efficiency, the water allocation to the field from canal network should be based on crop growing stages, as the water stress at a particular crop growth stage results adversely in yield. Thus there is a need to use

sophisticated computer softwares for determination of crop water requirement.

FAO (1992), Smith *et al.* (1991) and Smith (1992) reported that CROPWAT is meant as a practical tool to help agro meteorologists, agronomists and irrigation engineers to carry out standard calculations for evapotranspiration and crop water use studies, and more specifically the design and management of irrigation schemes. It allows the development of recommendations for improved irrigation practices, the planning of irrigation schedules under varying water supply conditions, and the assessment of production under rainfed conditions or deficit irrigation.

■ METHODOLOGY

Study area:

The study area comprised of command of Wadi Adampur distributory which takes off from branch canal of Wan River Project. The details of the command are given in Table 1. The command receives an average annual rainfall of 890 mm. The minimum and maximum temperatures range from 9.9 to 28.0°C and 28.6 to 46.5°C, respectively. The climate of area is semi-arid. The soils of command are clayey in nature. Two crop seasons, *viz.* *Kharif* (June to October) and *Rabi* extending

Name of distributory	Off take point at branch canal (km)	Length of distributory (km)	Design discharge at head of the distributory (m ³ /sec)	Irrigated command area (ha)
Wadi Adampur	12.05	6.47	2.79	1634

to summer (November to April) are followed in the command. Major crops grown are cotton, soybean, pigeonpea, wheat, chickpea and vegetable.

Development of irrigation schedule using CROPWAT and CRIWAR software:

CROPWAT model:

CROPWAT is a computer program developed by Land and Water Development Division of FAO that uses the FAO Penman-Monteith model to calculate reference evapotranspiration (ET_o), crop water requirement (ET_c) and crop irrigation requirement (FAO, 1992). The program allows for the development of irrigation schedules under various management and water supply conditions, rainfed production, drought effects and efficiency of irrigation practices (FAO, 2002).

CRIWAR model:

CRIWAR model is developed by Marinus G. Bos and Rob A. L. Kselik for estimation of crop irrigation water requirements. It calculates the irrigation water requirement for cropping pattern in an irrigated area based on various crop development stages throughout the growing season.

Both the models use the FAO Penman-Monteith model to calculate reference evapotranspiration (ET_o) *i.e.*

$$ET_o = \frac{0.408\Delta(R_n - G) + \frac{900}{T + 273} u_2 (e_s - e_a)}{+ (1 + 0.34u_2)}$$

Crop evapotranspiration (ET_c):

Crop evapotranspiration (ET_c) was determined as follows

$$ET_c = ET_o \times K_c$$

Net irrigation requirement (NIR):

The monthly net irrigation requirement in mm/day was calculated as:

$$IR = ET_c - Pe_{ff}, \text{ mm/day}$$

Gross irrigation requirements (GIR):

A gross irrigation requirement in mm/day was calculated by considering irrigation efficiency as 65%. (Doorenbos and Prutt, 1997).

$$GIR = \frac{IR}{\text{Application efficiency}}, \text{ mm/day}$$

Comparison of performance of models

The irrigation water requirement of the command estimated using CROPWAT and CRIWAR were compared with actual water released in the command.

RESULTS AND DISCUSSION

The results of comparative performance of CROPWAT and CRIWAR software for scheduling irrigation are discussed in the following sections.

Actually applied irrigation water:

The daily discharge data of Wadi Adampur distributory obtained from the Office of Sub-Divisional Irrigation Engineer, Akola District was analyzed. The analysis revealed that on an average irrigation was started on 9th December and closed on 30th April every year. The average total irrigation period is of 133 days, of which the canal was run for 88 days and closed for 45 days. The actual quantities of canal water applied are given in Table 1.

Irrigation schedule using CROPWAT and CRIWAR software:

Irrigation scheduling can be defined as a process by which the timing and amounts of irrigation water applications are determined.

Irrigation scheduling using CROPWAT:

Month wise gross irrigation requirement was calculated using CROPWAT and presented in terms of depth of irrigation in Table 2.

Sr. No.	Year	Irrigation water applied (Mm ³)	Area irrigated (ha)	Gross depth of water applied (mm)
1.	2006-07	16.93	970	1745
2.	2007-08	9.33	856	1090
3.	2008-09	8.09	784	1032
4.	2010-11	2.56	313	816
5.	Average	9.22	730.75	1170.50

Month / Years	2006-07	2007-08	2008-09	2010-11
June	5.54	0.46	4.15	4.92
July	0.00	1.85	17.54	2.00
August	28.62	36.77	28.62	0.00
September	21.08	30.46	26.00	70.77
October	77.08	119.23	99.85	66.46
November	76.77	60.92	71.69	49.69
December	71.85	69.54	64.62	62.77
January	60.00	52.31	57.85	55.23
February	67.23	62.31	58.00	56.62
March	72.46	64.15	67.69	67.54
April	50.62	56.00	49.69	37.54
May	14.92	16.31	12.77	15.38
Total (mm)	546.15	570.31	558.46	488.92

Table 2 revealed that the maximum water was required during the month of October, while minimum water was required during the month of June. It is also cleared that there was less requirement of water for crop production during *Kharif* season, due to availability of soil moisture from monsoon rains.

Month / Years	2006-07	2007-08	2008-09	2010-11
June	0.02	0	0.01	0.03
July	0	0.01	0.04	0.01
August	0.07	0.09	0.07	0
September	0.06	0.08	0.07	0.19
October	0.19	0.25	0.24	0.14
November	0.23	0.18	0.21	0.15
December	0.16	0.15	0.14	0.14
January	0.18	0.16	0.18	0.17
February	0.26	0.24	0.22	0.22
March	0.39	0.35	0.37	0.36
April	0.32	0.35	0.31	0.23
May	0.24	0.26	0.21	0.25
Total (l/s/ha)	2.12	2.12	2.07	1.89
Average (l/s/ha)		205		

Irrigation schedule developed using CROPWAT software is presented in Table 3. From Table 3, it is clear that maximum discharge was required during the month of March and no or minimum discharge was required during month of July. Average total discharge required was found to be 2.05 (l/s/ha).

Irrigation scheduling using CRIWAR:

Table 4 revealed that the maximum water was required

Month / Years	2006-07	2007-08	2008-09	2010-11
June	23.92	5.95	23.97	5.29
July	0.00	0.00	18.79	0.00
August	0.00	11.80	53.59	0.00
September	0.00	35.78	20.93	49.84
October	40.20	103.69	78.76	70.61
November	63.99	75.18	93.46	72.76
December	48.24	70.74	77.88	63.40
January	74.75	85.06	97.16	63.21
February	140.02	124.58	120.22	96.84
March	233.26	192.48	274.66	221.11
April	232.78	259.15	244.19	199.81
May	228.70	264.03	267.79	247.14
Total (mm)	725.68	894.12	1012.91	769.73

during the month of May, while minimum water was required during July. It was also clear that there was less requirement of water for crop production during *Kharif* season.

Irrigation schedule developed using CRIWAR software is presented in Table 5. From Table 5, it is clear that maximum discharge was required during month of May and no or minimum discharge was required during month of July. Average total discharge required was estimated as 4.59 l/s/ha.

Comparison of the actual water applied to water requirement estimated using CROPWAT and CRIWAR models:

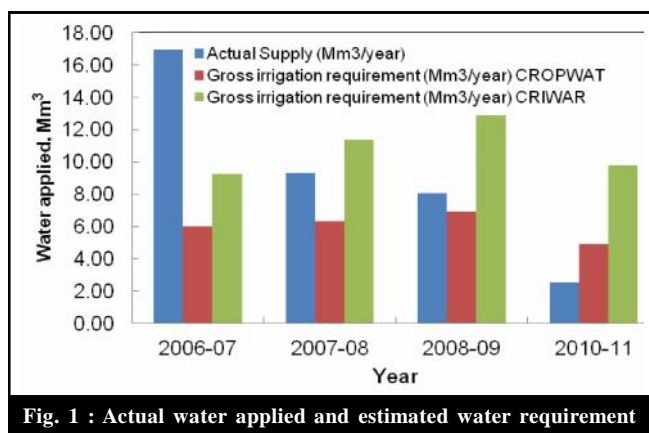
Actual water applied in the command varied between 2.56 to 16.93 Mm³ (Table 6 and Fig. 1). The estimated water requirement of the command with CROPWAT and CRIWAR varied between 4.89 to 6.92 and 9.80 to 12.90 Mm³, respectively.

On average, actual water applied was 53% more as

Month / Years	2006-07	2007-08	2008-09	2010-11
June	0.09	0.02	0.09	0.02
July	0	0	0.07	0
August	0	0.05	0.21	0
September	0	0.14	0.08	0.19
October	0.16	0.4	0.3	0.27
November	0.25	0.29	0.36	0.28
December	0.19	0.27	0.3	0.24
January	0.29	0.33	0.37	0.24
February	0.54	0.48	0.46	0.37
March	0.9	0.74	1.06	0.85
April	0.9	1.0	0.94	0.77
May	0.88	1.02	1.03	0.95
Total (l/s/ha)	4.2	4.74	5.27	4.18
Average(l/s/ha)		4.59		

Table 6 : Comparison of performance of models

Year	Irrigation water applied (Mm ³)			Area irrigated (ha)			Gross depth of water applied (mm)			Over / under water applied (%)	
	Actual	CROPWAT	CRIWAR	Actual	CROPWAT	CRIWAR	Actual	CROPWAT	CRIWAR	CROPWAT	CRIWAR
2006-07	16.93	5.99	9.24	970	1096.41	1273.78	1745	546.15	725.68	182.65	83.17
2007-08	9.33	6.33	11.39	856	1110.03	1273.78	1090	570.31	894.12	47.32	-18.12
2008-09	8.09	6.92	12.90	784	1239.42	1273.78	1032	558.46	1012.91	16.86	-37.30
2010-11	2.56	4.89	9.80	313	1001.70	1273.78	816	488.92	769.73	-47.82	-73.94
Average	9.22	6.03	10.83	730.75	1111.8	1273.78	1170.50	540.88	850.41	53.06	-14.77

**Fig. 1 : Actual water applied and estimated water requirement**

compared to that estimated with CROPWAT model; while it was 14.77% less as compared to that estimated with CRIWAR model.

On an average water requirement estimated with CROPWAT and CRIWAR was as 6.03 Mm³ and 10.83 Mm³. Approximately 79.6 per cent more water requirement was estimated by CRIWAR than that estimated with CROPWAT model.

Table 6 presented the gross depth of irrigation water and area irrigated over the period of study. It is clear that though about 53.06 % more water was actually applied, average actual area irrigated was less *i.e.* 730 ha. It is clear from Table 6, that more water was released in Wadi Adampur distributory than required. It might be due to mismanagement or improper irrigation scheduling. Using CROPWAT developed schedule, in less water significantly more area will be irrigated. Therefore, CROPWAT developed schedule could be used for irrigation scheduling/ irrigation planning of command of Wadi Adampur distributory.

Conclusion:

The irrigation schedules were prepared using CROPWAT and CRIWAR software. The estimated water requirement of the command with CROPWAT and CRIWAR varied between 4.89 to 6.92 and 9.80 to 12.90 Mm³, respectively. The average

discharge required was found to be 2.05 l/s/ha and 4.59 l/s/ha using CROPWAT and CRIWAR software, respectively.

Actual water applied was about 53.06 % more than that estimated with CROPWAT, average actual area irrigated was less *i.e.* 730 ha. Using CROPWAT developed schedule, in less water significantly more area will be irrigated. Considering above findings, it is suggested to use CROPWAT developed schedule for proper scheduling of irrigation in the command.

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