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Research Article

Response of Tomato to Irrigation Scheduling

Nadee Ntyaz[1], Arvind Kumar[2], Avadhesh Kumar Koshal[3]*, M Imtiyaz[1] and SK Srivastava[1]

[1]Department of Soil Water Land Engineering and Management, Vauge School of Agricultural and Technology, SHIATS, Allahabad, UP, India

[2]Assistant Professor, Faculty of Agricultural Sciences, Motherhood University, Roorkee, India

[3]Associate Professor, Faculty of Sciences, Motherhood University, Roorkee, India

***Corresponding Author:** Avadhesh Kumar Koshal, Associate Professor, Faculty of Sciences, Motherhood University, Roorkee, India.

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Abstract

Field experiment was conducted at Irrigation research station of Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, during winter crop season (Dec-May) of 2011 to 2012 on clay loam soil to examine the effect of irrigation levels on yield. Irrigation production efficiency and economic return of tomato under drip irrigation. The marketable tomato yield was significantly higher when irrigation during the crop seasonal was applied at 175% of pan evaporation replenishment. The irrigation of 175% of pan evaporation replenishment resulted in higher gross return, net return and benefit cost ratio of tomato. The seasonal water applied/irrigation levels and marketable yield and gross return, net return quadratic relationships, which return can be used for optimizing yield and economic return of tomato under variable water supply condition.

Keywords: Economic Analysis Marketable Yield; Drip Irrigation; Iirrigation Scheduling; Tomato

Introduction

India is a semi-arid country with limited surface and subsurface water resource. Water shortage is the major limiting factor for crop diversification and production. Due to rapid growth, the competition of limited water resources for domestic, industrial and agriculture needs is increasing considerably. For the ever growing population, water for irrigation is becoming both scarce and expensive due to fast depletion of surface and subsurface water resources, caused by over exploitation and erratic rainfall, it is therefore essential to formulate an efficient reliable and economically viable water and other input management strategies in order to irrigate more land area with existing water resources for crop production improper irrigation management practices not only waste expensive and scare water resources but also decrease crop yield quality, water use efficiency and economic return as well as it leads to water logging and salinity, which can be partly corrected by expensive drainage systems.

Irrigation scheduling is a critical management input to ensure optimum soil moisture status for proper plant growth and development as well as optimum yield, water use efficiency and economic benefit. It is defined as deciding when to irrigate and how much water to be applied and is governed by various complex factor of which microclimatic plays the most important role. Therefore, it is essential to develop irrigation scheduling strategies under prevailing climatic condition in order to utilize source water resources efficiently and effectively for crop production.

The irrigation scheduling techniques fall in the general categories of meteorological and physiological techniques. Meteorological approach of scheduling irrigation is relating the evapotranspiration from crop to evaporation from an open pan, as it is well known that the rate of evapotranspiration is related to open pan evaporation. Cumulative pan cumulative pan evaporation and ratio between irrigation water and cumulative pan evaporation for scheduling have been used by researches as it is easy for farmers to use and is adoptable.

In spite of some limitations, evaporations from USWB class. An open pan is the most common and simplest approach for scheduling of irrigation. Numerous studies have been carried out in the past on the development and evaluation of irrigation scheduling techniques under a wide range of irrigation system and management, soil, crop and climatic conditions [1-4].

Steele., *et al.* (1997) reported the significant difference in seasonal water application under five methods of irrigation schedules such as 40% depletion of root zone available water, scheduling based on plant temperature, soil metric potential and growth model estimate of water use without significant difference in corn yield. The meteorological approach such as pan evaporation replenishment, cumulative pan evaporation and ratio between irrigation water and cumulative pan evaporation were used by many researches due to it is simplicity data availability and adoptability at the farmer level [5-7]. Singh and Mohan [7] observed reduction in sugarcane yield when irrigation was applied beyond the IW/CPE ratio of 1.0. Imtiyaz., *et al.* [8] reported the higher marketable yield of broccoli, carrot, rape and cabbage with irrigation at 80% of pan evaporation replenishment did not influence the irrigation production efficiency of carrot. Imtiyaz., *et al.* [9] reported the higher yield of cabbage. Spinach, tomato, carrot and onion for irrigation scheduling at CPE (cumulative pan evaporation) of 22, 11, 33, 44 and 55mm respectively. Imtiyaz., *et al.* [10] observed the higher cobs yield and production efficiency at 120% of pan evaporation replenishment of green mealier under both sprinkler and drip irrigation system [11-18].

Materials and Methodology

Field experiment was conduct at the Irrigation Research Farm of Sam Higginbottom Institute Of Agriculture, Technology and Sciences, Allahabad, India which is situated about 7 km south of Allahabad city across the river Yamuna (25° 27° N, 81° 44' E, 98m above mean sea level) during the winter crop - growing season of 2010 - 2011 (November-April) in order to examine the effect of irrigation schedules and economic return of tomato. The climate in this part of country has been classified as semiarid with cold winters and hot summers. The climatic parameter such as air temperature, wind velocity, relative humidity, sunshine rainfall and evaporation during the crop growing season were recorded at the metrologies station adjacent to the irrigation research farm and presented in table 3.1. The soil in the experimental field was fertile clay loam (35.5% Sand, 25.8% Silt and 38.6% Clay). The soil loam moisture at field capacity (-1/3 bar) and wilting point (-15bar) was 19.5 and 9.1% on dry weight basis, respectively. The average bulk density of the soil was 1.3 g/cm^3. the plant available water was 136.2 mm/m.

The experiment was laid out in a single factor randomized block design with three replications. It comprises of five treatments with five water levels. The area of each experimental plot was 15.75m (4.5m × 3.5m). A buffer zone spacing of 0.5m and 0.5 was provided between the plots and blocks respectively. Tomato (F1- Naveen 2000) seedlings were transplanted on 26 December 2011 at a spacing of 0.5m × 0.5m Prior to transplanting the experimental plot received 94.3 kg/ha $P_2 O_5$ and 62.5 kg/ha K_2O. The experimental plot received 90 kg/ha of Nitrogen at the time of transplanting 5 weeks and 8 weeks after transplanting. Irrigation scheduling is defined as when and how much water to apply. It is critical management input to ensure adequate soil moisture for optimum yield, quality water use efficiency and economic return.

The experimental consistent are 5 irrigation schedules and one variety.

The treatment is presented below.

Irrigation Schedules

- I1 - Irrigation at 25% of pan evaporation replenishment.
- I2 - Irrigation at 75% of pan evaporation replenishment.
- I3 - Irrigation at 125% of pan evaporation replenishment.
- I4 - Irrigation at 175% of pan evaporation replenishment.
- I5 - Irrigation at 225% of pan evaporation replenishment.

The daily evaporation data is from USWB class. A pan for period of 6 yrs 2005-2011 were collected from meteorological station, Allahabad. The crop was irrigated when the sum of daily mean of pan evaporation reached approximately to predetermined value of 16.3 mm (rooting depth × plant available water × permissible soil moisture depletion in traction). The crop was irrigated by drip irrigation method. He system for vegetable production.

The drip irrigation system was designed and installed according to requirement for research work, it is explained in detail further. PVC pipes of 50mm and polyethylene pipes (LDPE) of 12 mm were used for main/sub main and lateral lines respectively plants were watered by an individual 4 liters per hour online drippers. Each experiment plot was connected by a control valve in order to deliver the desired amount of water. The sub main line was connected to a water mater and a control valve in order to monitor the amount of water application in respective treatments. The screen filter was installed on the main line to minimize dripper blockage. Standard cultural practices were adopted during the crop growing season.

In order to assess the economic viability for the different irrigation system under variable irrigations both fixed and operating cost were including. Total cost of production, gross return and net return and benefit cost ratio under different irrigation levels were estimated on the following assumption.

Salvage value of the component		
Useful life of tube well pump, motor and pump	-	0
house	-	
Useful life of drip irrigation system	-	25yrs
Useful life of open channel conveyance system	-	8yrs
Useful life of weeding and spraying equipments	-	5yrs
Internet rate	-	7yrs
Repair and maintenance	-	10%
Number of crops/year	-	2.5%
		2

Table a

Results and Discussion

Yield and irrigation production efficiency

The effect or irrigation schedules on marketable yield and irrigation production efficiency of tomato, shown in the table 1. The marketable yield of tomato of different ranged from 27.62 to 67.41 t/ha. The marketable yield of tomato increased significantly with an increase in irrigation level up to 175% of pan evaporation replenishment produced significant maximum marketable yield67.41 t/ha. A further level in irrigation levels resulting from 225% of pan evaporation replenishment reduced the marketable yield 63.19 t/ha significant due to reduction of fruits/plant and mean fruit weight induced by excessive soil moisture condition.

The irrigation levels significantly influenced the irrigation production efficiency of tomato (Table 1). The irrigation production efficiency decreased significantly with an increase in irrigation levels because increase in seasonal water application was higher as compared with marketable yield. The irrigation at 25% of pan evaporation replenishment resulted in significantly maximum irrigation production efficiency 24.02 kg/m^3 because reduction in seasonal water application was higher as compared with marketable yield.

Irrigation at 225% of pan evaporation replenishment resulted in significantly minimum irrigation production efficiency 6.11 kg/m^3 because it increases the seasonal water applied but at the same time decreased the marketable yield.

The overall results presented in (Table 1) clearly revealed that irrigation at 175% of pan evaporation replenishment resulted in higher yield but irrigation production efficiency was higher at 25% pan evaporation replenishment. Imtiyaz., *et at.* (2000a) reported the higher marketable yield and irrigation production efficiency at 80% of pan evaporation replenishment under agro climatic condition of northwestern.

Treatment pan evaporation replenishment (%)	Marketable yield (t/ha)*	Irrigation production efficiency (Kg/m^3)**
25	27.62	24.02
75	47.26	13.69
125	59.32	10.31
175	67.41	8.36
225	63.38	6.11
CD (0.05)	2.381	0.854

Table 1: Effect of irrigation scheduling on marketable yield and Irrigation Production Efficiency of tomato.

* & **Value calculated in manually in field

Economic Return

The total cost of production, gross return, net return and benefit cost ratio as influenced by irrigation levels are presented in (Table 2).

The gross return increased significantly with an increase in irrigation levels up to 175% of pan evaporation replenishment due to significant increase in marketable yield. A further increase in irrigation level resulting from 225% of pan evaporation replenishment reduced the gross return considerably due to significantly reduced in marketable yield. Similarly, the net return increased considerably with an increase in irrigation levels up to 175% of pan evaporation replenishment. The gross return ranged from 138133.33 to 316900. A further increase in irrigation level resulting from 225% of pan evaporation replenishment reduced the net return. The benefit cost ratio increased significantly with an increase in irrigation levels up to 175% of evaporation replenishment. A further increase in irrigation level from 225% of pan evaporation replenishment reduced benefit cost ratio considerably Botswana (Table 2).

Treatment (Pan Evaporation replenishment, %)	Total cost of production (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio (B/C)
25	84537	138133.33	53596.33	1.63
75	86982	236333.33	149351.33	2.71
125	89428	296600	207172	3.31
175	91873	337050	245177	3.66
225	94318	316900	222582	3.35

Table 2: Effect of irrigation schedule on total cost of production, gross return, net return, and benefit cost ratio of tomato.

Water supply and Marketable yield

The relationship between seasonal water applied and marketable yield of tomato the seasonal water applied for different irrigation levels ranged from 115 to 1035mm whereas the marketable yield ranged from 27.62 to 67.41 t/ha.

The relationship between pan evaporation replenishment and marketable yield of tomato Pan evaporation replenishment ranged from 25 to 225 pan evaporation replenishment whereas the marketable yield of tomato exhibited a strong quadratic relationship. The marketable yield increase with an increase in pan evaporation replenishment of 200% and there after yield tended to decline. The relationship between gross return and seasonal water applied are the seasonal water applied for different irrigation levels ranged from (138133.33- 337050) Rs/ha.

Conclusion

The following conclusions are drawn from the present studies.

- Irrigation at 175% of pan evaporation replenishment resulted in significantly higher marketable yield of tomato. Whereas irrigation production efficiency was higher with irrigation at 25% of pan evaporation replenishment. A further increase in irrigation level resulting from 225% of pan evaporation replenishment reduced both marketable yield and irrigation production efficiency.
- Irrigation at 175% of pan evaporation replenishment resulted in higher gross return. Net return and benefit cost ratio.
- The seasonal water applied/irrigation levels of marketable yield, gross return, net return, and Benefit cost ratio exhibited strong quadratic relationships. This can be used for optimizing marketable yield and economic return of tomato limited water resource condition.

Finally, the overall results revealed that in order to obtain higher marketable yield economic return of tomato. The crop should be irrigated at 175% of pan evaporation replenishment under t irrigation system of tomato production of highly profitable in this region. He is prevailing climatic condition of this region. Furthermore, in spite of the high initial.

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