Original Research Article

Effect of Irrigation Frequencies and Date of Planting on Water Productivity of Two Potato Cultivars

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A B S T R A C T

A field experiment was conducted with two different potato (*Solanum tuberosum*) varieties (*i.e. Ashoka* and *Jyoti*) at "C" block farm of the Bidhan Chandra Krishi Viswavidyalaya at Kalyani during the period of November-March (2009-2010) to study the performance of different potato varieties under three different irrigation levels (I_1, I_2 and I_3) with 30 mm irrigation depth. The total experiment was conducted under two treatments (D_1 and D_2) during the above period. The soil was sandy-loam with medium land situation. The plot size was 4.5 m × 3.7 m. The maximum yield recorded under D_1 was 50.56 t ha^{-1} and the maximum yield under D_2 was 63.65 t ha^{-1}. Soil moisture content in the soil profile varied widely in the two varieties. Irrespective of variety and irrigation level, the highest average seasonal evapotranspiration (SET) (187.71 mm) was recorded under 2nd planting date (D_2: 29.11.09) and it was around 36.32 mm lower when the crop was planted 9 days earlier. Among two cultivars, the total water productivity (TWP) of *Ashoka* variety was at the highest level (40.82 kg m^{-3}) and it declined by about 6% under *Jyoti* variety.

Introduction

Agriculture supports human life and its mismanagement leads to acute shortage of food grain. The rise in population makes it imperative for agriculture to flourish so as to feed the teeming millions (Islam *et al.,* 1990). Along with this, shortage of fresh water resources makes irrigated agriculture in an alarming situation during dry season (Sharma *et al.,* 1992). The irrigation network in the country is not also well developed. The situation of low productivity and food shortage could be met with not only by using fertilizers, chemicals and high yielding varieties but also by putting all cultivable lands, if possible, under efficient irrigation and water management practices (Zavalin *et al.,* 1993). By this, even with the existing irrigation potential more land could be brought under irrigation with the minimization of losses during the conveyance and application of water (Dwyer and Boisvert, 1990). Agricultural scientists need to meet the challenge and plan for improving the irrigation potential and to conserve for its best

utilization at present and in future (Abdelghany, 2009; Nasare *et al.,* 2009). It is also necessary to innovate approaches to technology particularly those designed to meet the needs of the water and as such, a significant amount of water could be saved.

In designing new systems and rehabilitating old ones the need of user should be of paramount importance. The system must deliver the precise amount of water to the crop according to the needs and just sufficient to meet this demand (Ojala *et al.,* 1990; Kumar and Minhas, 1999). This will not only save the wastage but also will assure an increased yield (Nagaz *et al.,* 2008). Scientific irrigation in proper time, amount and at a desired depth is essential for the successful production of potato (Kang *et al.,* 2002), but the fertility status of the soil, variety, plant population, clump maturity and plant protection measures are also to be properly considered (Rasul *et al.,* 1989; Acharya and Kapur, 1993). Keeping these in view, the present investigation on potato under furrow systems of irrigation, 3 irrigation levels were planned to work out seasonal water requirement (seasonal evapotranspiration) and water productivities of two potato cultivars.

Materials and Methods

The experiment was carried out at "C" block farm (lat - 22.5^0 N, long - 89^0 E and altitude 9.75 m above msl) at Kalyani during the period of November-March, 2009-10. The soil of the study site is sandy-loam with medium land situation.

Experimental design and treatments

The treatments were distributed in a split plot design, where the date of sowing was considered as the main plot treatment, the irrigation levels as sub plot treatment and varieties as sub-sub plot.

The treatment combinations were as follows:

Main plot treatment (Dates of planting; D)

D_1 – 20th November
D_2 – 29th November

Sub plot treatment (Irrigation level; I)

IW/CPE

I_1 = 1.40
I_2 = 1.20
I_3 = 1.00

Total plot size was 4.5 m × 3.7 m. In a particular plot, the spacing is 45 cm × 15 cm.

Methods and Observation

Soil moisture content

Gravimetric soil moisture was measured before and after irrigation and also at the initial and harvest time of potato crop.

Yield and yield attributes

The crop was harvested on two phases. In the first phase, crops were harvested on 16th February. It was 88 dates after planting (DAP). In the other phase, crops were harvested on 3rd March. It was 95 DAP.

Crop water productivity (CWP)

The CWP was estimated by the following equation:

$$CWP\ (kg/m^3) = \frac{Yield\ (kg/ha)}{SET\ (m^3/ha)}$$

Total water productivity (TWP)

The TWP was estimated by the following equation:

$$TWP \ (kg/m^3) = \frac{Yield \ (kg/ha)}{Irrigation + Rainfall \ (m^3/ha)}$$

Results and Discussion

Estimation and analysis of seasonal evapotranspiration (SET) by soil water balance method

It was observed from Table 1 that the variation in SWS (change in soil moisture storage) value was more in case of D_1 than D_2. The maximum values of SWS were 52.14 under $I_3 V_1$ and 77.77 under $I_1 V_1$ for D_1 than D_2 respectively. The results again revealed that the maximum SET values were 162.14 mm under $I_3 V_1$ and 229.17 under $I_1 V_1$ for D_1 than D_2 respectively.

For SWS value the decreasing order is:

In case D_1: $I_3 V_1 > I_1 V_2 > I_2 V_2 > I_3 V_2 > I_2 V_1 > I_1 V_1$

In case D_2: $I_1 V_1 > I_3 V_1 > I_2 V_2 > I_2 V_1 > I_1 V_2 > I_3 V_2$

For SET value the decreasing order is:

In case D_1: $I_3 V_1 > I_1 V_2 > I_2 V_2 > I_3 V_2 > I_2 V_1 > I_1 V_1$

In case D_2: $I_1 V_1 > I_1 V_2 > I_3 V_1 > I_2 V_2 > I_2 V_1 > I_3 V_2$

Thus the values of SWS and SET varied from one treatment to another.

Yield, WUE, CWP and TWP of potato crop

In the present study, it was observed that average potato yield was at the highest level (50.15 t ha^{-1}) under 2nd planting date (D_2: 29.11.09) irrespective of variety and irrigation level and it declined by 5 t ha^{-1} (on an average) when the crop was planted 9 days earlier (Table 2).

Irrespective of date of planting and variety, the highest average yield (53.59 t ha^{-1}) was attained under I_1 treatment, which declined by 13% under I_2 treatment. The same was at its lowest peak (42.67 t ha^{-1}) under I_3 treatment. Among two cultivars, Ashoka variety produced the highest average yield (49.23 t ha^{-1}) and it declined by 6% under Jyoti variety.

Irrespective of variety and irrigation level, the highest average SET (187.71 mm) was recorded under 2nd planting date (D_2: 29.11.09) and it was around 36.32 mm lower when the crop was planted 9 days earlier (Table 1). Irrespective of date of planting and variety, the highest average SET (180.42 mm) was attained under I_1 treatment, which declined by 10% and 8% under I_2 and I_3 treatment respectively. Among two cultivars, the SET value of Ashoka variety was at the highest level (171.57 mm) and it declined by only 4 mm under Jyoti variety.

Table 2 depicted that irrespective of variety and irrigation level, the CWP was at the highest level (29.87 kg m^{-3}) under 1st planting date (D_1: 20.11.09) and it declined by 3.31 kg m^{-3} (on an average) when the crop was planted 9 days later (Table 2). Irrespective of date of planting and variety, the highest average CWP (30.09 kg m^{-3}) was attained under I_1 treatment, which declined by 4% under I_2 treatment and 15% under I_3 treatment. Among two cultivars, the CWP of Ashoka variety was at the highest level (28.97 kg m^{-3}) and it declined by 6% under Jyoti variety.

Table 2 also indicated that irrespective of variety and irrigation level, the TWP was at the highest level (41.10 kg m^{-3}) under 1st planting date (D_1: 20.11.09) and it declined by

3.02 kg m^{-3} (on an average) when the crop was planted 9 days later (Table 2). Irrespective of date of planting and variety, the highest average TWP (41.33 kg m^{-3}) was attained under I$_1$ treatment, which declined by 2% under I$_2$ treatment and 11% under I$_3$ treatment. Among two cultivars, the TWP of Ashoka variety was at the highest level (40.82 kg m^{-3}) and it declined by about 6% under Jyoti variety.

Table.1 Estimation of seasonal evapotranspiration (SET, mm) by soil water balance method

Treatment	SWS	Irrigation (mm)	Rainfall (mm)	SET (mm)
D$_1$ I$_1$ V$_1$	28.78	110	0	138.78
D$_1$ I$_1$ V$_2$	48.12	110	0	158.12
D$_1$ I$_2$ V$_1$	33.24	110	0	143.24
D$_1$ I$_2$ V$_2$	45.80	110	0	155.80
D$_1$ I$_3$ V$_1$	52.14	110	0	162.14
D$_1$ I$_3$ V$_2$	39.64	110	0	149.64
D$_2$ I$_1$ V$_1$	77.77	150	1.40	229.17
D$_2$ I$_1$ V$_2$	44.20	150	1.40	195.60
D$_2$ I$_2$ V$_1$	47.48	120	1.40	168.88
D$_2$ I$_2$ V$_2$	61.99	120	1.40	183.39
D$_2$ I$_3$ V$_1$	65.82	120	1.40	187.22
D$_2$ I$_3$ V$_2$	40.62	120	1.40	162.02

Table.2 Yield, CWP and TWP of Potato crop

Treatment	Yield (t ha^{-1})	CWP (kg m^{-3})	TWP (kg m^{-3})
D$_1$ I$_1$ V$_1$	45.17	32.55	41.06
D$_1$ I$_1$ V$_2$	50.28	31.80	45.71
D$_1$ I$_2$ V$_1$	44.27	30.90	40.25
D$_1$ I$_2$ V$_2$	48.97	31.43	44.52
D$_1$ I$_3$ V$_1$	50.56	31.18	45.96
D$_1$ I$_3$ V$_2$	31.98	21.37	29.07
Average	**45.21**	**29.87**	**41.10**
D$_2$ I$_1$ V$_1$	63.65	27.77	42.04
D$_2$ I$_1$ V$_2$	55.26	28.25	36.50
D$_2$ I$_2$ V$_1$	41.52	24.58	34.20
D$_2$ I$_2$ V$_2$	52.34	28.54	43.11
D$_2$ I$_3$ V$_1$	50.24	26.84	41.38
D$_2$ I$_3$ V$_2$	37.90	23.39	31.22
Average	**50.15**	**26.56**	**38.08**

In conclusions the varieties of a crop may require different amount of water for their maximum productivity and variety selection should be such that minimum water can

produce maximum, making the slogan 'more crop per drop'. The annual requirement of potato in West Bengal is much higher. Potato is sown in the month of November and harvest to March. In the light of the fact that in the present global scenario there is increasing deficit in the supply of irrigation water, this study concentrated on the determination of seasonal water requirement (seasonal evapotranspiration) and water productivities of two potato cultivars.

Based on the study, the following conclusions were drawn:

The average potato yield was at the highest level (50.15 t ha^{-1}) under 2nd planting date (D$_2$: 29.11.09) irrespective of variety and irrigation level and it declined by 5 t ha^{-1} (on an average) when the crop was planted 9 days earlier.

Irrespective of variety and irrigation level, the highest average SET (187.71 mm) was recorded under 2nd planting date (D$_2$: 29.11.09) and it was around 36.32 mm lower when the crop was planted 9 days earlier.

The CWP was at the highest level (29.87 kg m^{-3}) under 1st planting date (D$_1$: 20.11.09) and it declined by 3.31 kg m^{-3} (on an average) when the crop was planted 9 days later.

The TWP was at the highest level (41.10 kg m^{-3}) under 1st planting date (D$_1$: 20.11.09) and it declined by 3.02 kg m^{-3} (on an average) when the crop was planted 9 days later.

Among two cultivars, the TWP of *Ashoka* variety was at the highest level (40.82 kg m^{-3}) and it declined by about 6% under *Jyoti* variety.

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