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Effect of Irrigation Schedule and Fertilizer Levels on Growth and Yield of Sweet Potato (*Ipomoea batatas* L.)

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Abstract

The field experiment was conducted for two *rabi* seasons (2002-03 and 2003-04) at the Instructional Farm, Krishi Vigyan Kendra, Orissa University of Agriculture and Technology, Barachana, Odisha to study the irrigation schedule and fertilizer levels on growth and yield of sweet potato (*Ipomoea batatas* L.). The experiment was conducted in a split plot design with three replications. The irrigation levels were assigned to the main plots (I_1 = IW/CPE 0.6, I_2 = IW/CPE 0.8, I_3 = IW/CPE 1.0 and I_4 = IW/PE 1.2) and fertility levels to the sub plots (F_1 = N-P_2O_5-K_2O @ 0-0-0 kg ha^{-1}, F_2 = N-P_2O_5-K_2O @ 50-50-50 kg ha^{-1}, F_3 = N-P_2O_5-K_2O @ 50-50-75 kg ha^{-1}, F_4 = N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1}, F_5 = N-P_2O_5-K_2O @ 75-50-100 kg ha^{-1} and F_6 = N-P_2O_5-K_2O @ 75-50-125 kg ha^{-1}). The variety Sankar was used. The results revealed that different growth parameters (vine length, number of leaves and LAI) and vine yield were greater with frequent irrigation at IW/CPE 1.2 (I_4). Application of N-P_2O_5-K_2O @ 75-50-125 kg ha^{-1} (F_6) resulted in greater vine length, leaf number, LAI and vine yield. Application of irrigation at IW/CPE 0.8 (I_2) resulted in greater yield attributes (tuber length, girth and weight per plant), tuber yield, harvest index and water use efficiency. Greater yield attributes (tuber length, girth and weight per plant), tuber yield, harvest index and water use efficiency were recorded with application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} (F_4). The maximum tuber yield with optimum vine yield was obtained with the application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} at IW/CPE 0.8.

Key words: Consumptive use, fertility level, irrigation, sweet potato, tuber yield, water use efficiency

Introduction

Sweet potato (*Ipomoea batatas* L.), a starchy tuber crop has versatile uses. Fresh tubers are consumed after boiling or baking or as vegetable. The tuber being rich in starch is increasingly used as a raw material for industries, as well as fish, poultry and animal feed. Nearly 87% of world sweet potato area is confined to Asia, 10% in Africa and 3% in rest of the world. It is cultivated in 8.4 million ha globally with an annual production of 106.6 million tonnes with the productivity of 12.8 t ha^{-1} (FAOSTAT, 2014). Among the Asian countries, China is the largest producer. In India, it is grown in 1.06 lakh ha producing 0.94 million tones with a productivity of 8.89 t ha^{-1} (FAOSTAT, 2014); more than 80% area is confined to the states like Odisha, Bihar, West Bengal and Uttar Pradesh (Nedunchezhiyan and Byju, 2005). It occupies an inevitable position in the socio-economic scenario of small and marginal farmers in the southern, eastern and north-eastern regions of India.

Sweet potato is grown in *kharif* under rainfed and *rabi* with supplemental irrigation. It has the capacity to withstand drought. But, tuber development and bulking is extremely sensitive to both deficit as well as excess water. Sweet potato is unique for its abundant vegetative growth in a conducive environment like unlimited water availability, rich sunshine and fertile edaphic conditions. Ravindran and Nambisan (1987) reported that excess as well as deficit water adversely affected the tuber yield. Therefore water relation is of prime importance in regulating the tuber yield in sweet potato. Sweet potato is an irrigation responsive crop (Hammett et al., 1982). Both high and low levels of irrigation restricted dry matter production rate in early tuber initiation and bulking phase resulting in reduction of tuber yield (Ravi and Saravanan, 2001). Ghuman and Lal (1983) observed that application of irrigation at IW/CPE 1.0 has resulted in maximum dry matter production. But, increasing the soil moisture status beyond at IW/CPE 1.0 resulted in reduction of dry matter production.

Crops which build large food reserves in a short period require nutrients in large quantities. Therefore, the nutrient requirement of sweet potato is fairly high because of its high dry matter production per unit area per time. It is estimated that approximately 41 kg N, 13 kg P, 68 kg K, 22 kg Ca and 18 kg Mg are required to produce 18 tonnes of sweet potato per ha (Mohankumar and Nair, 1990). Sweet potato does not respond to fertilizer unless adequate amount of moisture is available in the soil. Excess water in combination with nitrogen increases the vine growth resulting in reduction of tuber yield (Prasad and Rao, 1986).

The available literature revealed that there is not much information on the effect of fertilizer levels at excess or deficit moisture levels in sweet potato. Hence, the present investigation was carried out to find out the effect of irrigation schedule and fertilizer levels on growth and yield of sweet potato.

Materials and Methods

The field experiment was conducted for two *rabi* seasons (2002-03 and 2003-04) at the Instructional Farm, Krishi Vigyan Kendra, Orissa University of Agriculture and Technology, Barachana, Odisha (20°41'5" N latitude and 86°7'8"E longitude at an elevation of 25.1 m above mean sea level). The site is in the East and South Eastern Coastal Plain agroclimate zone and falls under the East Coastal Plains and Hills zone of humid tropics. The location is characterized by warm and moist climate with hot and humid summer with short and mild winter. The total amount of rainfall received during the cropping seasons were 42 mm (2 rainy days) in 2002-03 and 10 mm (3 rainy days) in 2003-04. The soil of the experimental site is clay loam with 1.42 g cm^{-3} bulk density, 28.7% moisture at field capacity and 13.9% moisture at permanent wilting point, 7.2 soil pH, 0.36% organic carbon, 189.1 kg ha^{-1} available nitrogen, 16.9 kg ha^{-1} phosphorus and 187.4 kg ha^{-1} potassium.

The experiment was conducted in a split plot design with three replications. The irrigation levels were assigned to the main plots (I_1 = IW/CPE 0.6, I_2 = IW/CPE 0.8, I_3 = IW/CPE 1.0 and I_4 = IW/CPE 1.2) and fertility levels to the sub plots (F_1 = N-P_2O_5-K_2O @ 0-0-0 kg ha^{-1}, F_2 = N-P_2O_5-K_2O @ 50-50-50 kg ha^{-1}, F_3 = N-P_2O_5-K_2O @ 50-50-75 kg ha^{-1}, F_4 = N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1}, F_5 = N-P_2O_5-K_2O @ 75-50-100 kg ha^{-1} and F_6 = N-P_2O_5-K_2O @ 75-50-125 kg ha^{-1}). Well decomposed FYM @ 5 t ha^{-1} was incorporated in the soil before ridges and furrows making. Half dose of nitrogen, full dose of phosphorous and half dose of potassium are to be applied at the time of planting as basal. The remaining half dose of nitrogen and potassium was applied 30 days after planting (DAP). The variety Sankar was used. Two hand weeding was carried out at 30 and 60 DAP. Scheduling of irrigation was done on the basis of the ratio of irrigation water depth (IW) to the cumulative pan evaporation (CPE) recorded from USWB class-A open pan evaporimeter. A fixed quantity of 40 mm water was applied at each irrigation. The irrigation water was introduced to each plot through a poly-pipe connected to an overhead preloaded tank installed at one corner of the experimental site at a height of about one meter, whose inner periphery was graduated to monitor the quantity of irrigation water. Initially only one irrigation was provided on the day following planting to facilitate root initiation. Irrigation was withdrawn a week before harvesting. The crop was harvested at 120 DAP.

Consumptive use of water was calculated as per Dastane (1972)

$$CU = \sum_{1}^{N} (Ep \times 0.6) + \sum_{i=1}^{n} \frac{M1_i - M2_i}{100} \times As_i \times D_i + ER + GWC$$

Where,

CU = consumptive use of water (mm), Ep = pan evaporation value (mm) from the USWB Class I open pan evaporimeter for the period from the date of irrigation to the date of soil sampling after each irrigation, 0.6 = pan coefficient for obtaining ET value from Ep value for given period of time, $M1_i$ = percent soil moisture (w w^{-1}) of the i^{th} layer of the soil at the time of sampling after irrigation, M2i = per cent soil moisture (w w^{-1}) of the i^{th} layer of the soil at the time of sampling before next irrigation, As_i = apparent specific gravity of the i^{th} layer of the soil (g cm^{-3}), D_i = depth of the i^{th} layer of soil (mm), EF = effective rainfall during the period under consideration (mm), GWC = Ground water contribution to the root zone moisture during the given period of time, n = number of soil layers and N = number of days between pre and post irrigation soil moisture samplings.

Water use efficiency (WUE) was estimated by using the following formula

$$\text{WUE (kg ha}^{-1}\text{mm)} = \frac{\text{Tuber yield (kg ha}^{-1}\text{)}}{\text{Water utilized during crop period (mm)}}$$

The data were subjected to analysis of variance (ANOVA) for split plot using Genstat software. Comparison of treatment means for significance at 5% was done using the critical differences (CD) as suggested by Gomez and Gomez (1984).

Results and Discussion

Plant requires water to meet the evaporation demand, build up tissues and carryout biochemical and physiological activities (Majumdar, 2000). Discerning difference in growth was observed with respect to irrigation and fertility levels (Table 1). Different growth indicators such as vine length, number of leaves and LAI were greater with frequent irrigations at IW/CPE 1.2 (I_4). This might be due to better moisture availability at important phenological stages, which induces better uptake of nutrients improving the growth parameters. With less frequent irrigation at IW/CPE 0.6 (I_1) these parameters declined due to loss of turgor, as reflected in relative water content, which restricted the cell division and enlargement resulting in reduced meristematic activity, shoot elongation and leaf expansion (Indira and Kabeerathumma, 1990). Application of N-P_2O_5-K_2O @ 75-50-125 kg ha^{-1} (F_6) resulted in greater vine length, leaf number and LAI (Table 1) due to the complimentary effects of nutrients. The vine length, leaf number and LAI was reduced with reduction in fertility levels. The minimum vine length was observed with the control (F_1) receiving no fertilizer (Table 1). Improvement in growth attributes with higher fertility levels have been reported by Satapathy et al. (2005).

Table 1. Effect of irrigation schedule and fertilizer levels on growth of sweet potato

Treatment	Vine length (cm)		Number of leaves plant^{-1}		LAI	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Irrigation (IW/CPE)						
I_1 = 0.6	80	85	58	60	2.33	2.39
I_2 = 0.8	99	103	78	81	2.41	2.47
I_3 = 1.0	123	129	90	91	3.09	3.18
I_4 = 1.2	138	144	106	106	3.21	3.30
SEm ±	0.24	0.20	0.25	0.19	0.01	0.01
CD (0.05)	0.82	0.69	0.85	0.67	0.04	0.03
Fertility level (N-P_2O_5-K_2O kg ha^{-1})						
F_1 = 0-0-0	42	42	54	47	1.97	2.01
F_2 = 50-50-50	83	85	64	68	2.45	2.51
F_3 = 50-50-75	112	117	84	87	2.71	2.87
F_4 = 75-50-75	133	139	95	97	2.95	3.20
F_5 = 75-50-100	140	146	98	101	3.13	3.21
F_6 = 75-50-125	153	160	102	106	3.35	3.21
SEm ±	0.46	0.35	0.36	0.25	0.01	0.01
CD (0.05)	1.32	1.00	1.03	0.72	0.02	0.02

The yield attributes were significantly influenced by irrigation and fertility levels (Table 2). The length and girth of the tubers were maximum with irrigation at IW/CPE 0.8 (Table 2). Tuber length and girth decreased significantly with an increase or decrease in irrigation frequency with respect to IW/CPE 0.8. Tuber length and girth was minimum with IW/CPE 0.6 (Table 2). Application of irrigation at IW/CPE 0.8 produced heavier tubers (Table 2). But it was statistically at par with IW/CPE 1.0 in both the years. Lesser weight tubers were produced by irrigation at IW/CPE 0.6. The weight of tuber per plant was lower by 21 g and 45 g at IW/CPE 1.2 and 0.6, respectively than at IW/CPE 0.8. Increase in fertility level increased the tuber length, girth and weight per plant (Table 2). But application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} resulted in greater tuber length, girth and weight per plant. Further increase in fertility level beyond F_4 reduced tuber length, girth and weight per plant. The lowest tuber length, girth and weight per plant were recorded with control plants (F_1) (Table 2).

The tuber yield was significantly influenced by irrigation and fertility levels (Table 3). Scheduling irrigation at IW/CPE 0.8 produced greater tuber yield and it was statistically at par with irrigation at IW/CPE 1.0 (Table 3). This was due to more yield attributes such as higher number of tubers, tuber length, girth and weight (Table 2) than the other treatments. Oommen (1989) obtained higher tuber yield at IW/CPE 0.75. Most of the crop plants have an optimum moisture regime beyond which their growth and yield are affected adversely due to poor oxygen availability in the effective root zone. On the other hand moisture absorption lags behind transpiration under moisture stress condition resulting in reduction of plant growth and yield (Gomes and Carr, 2003). Further increase in irrigation level reduced the tuber yield. The lowest tuber yield was recorded at IW/CPE 0.6 (Table 3). The tuber formation was considerably influenced by the level of moisture around the root zone. The yield decreased due to shortage of moisture at IW/CPE 0.6. Increase in irrigation frequency at IW/CPE 06 to 0.8 increased the tuber yield by 30%, which was at par with irrigation at IW/CPE 1.0. Further increase in irrigation frequency at IW/CPE 1.2 (I_4) reduced the tuber yield by 12%. At excess moisture level, higher leaf production led to poor light interception and lower photosynthetic activity leading to reduced tuber yield (Nair et al., 1996). Chowdhury (1996) also reported decreased tuber yield by 62% by increase in irrigation level from IW/CPE of 1.0 to 0.2. Roy Chowdhury et al. (2001) reported an increase in tuber yield with increase in irrigation levels IW/CPE from 0.3 to 0.9.

An increase in fertility level increased the tuber yield significantly (Table 3). Greater tuber yield was recorded with the application of N-P_2O_5-K_2O @ 75-50-75 kg

Table 2. Effect of irrigation schedule and fertilizer levels on yield attributes of sweet potato

Treatment	Tuber length (cm)		Tuber girth (cm)		Tuber weight (g $plant^{-1}$)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Irrigation (IW/CPE)						
I_1 = 0.6	8.80	8.92	5.12	5.25	150	153
I_2 = 0.8	10.29	10.88	6.45	6.57	195	199
I_3 = 1.0	10.07	10.46	6.25	6.37	194	197
I_4 = 1.2	9.95	10.04	6.07	6.19	175	178
SEm ±	0.09	0.06	0.02	0.01	0.93	0.77
CD (0.05)	0.32	0.21	0.08	0.02	3.22	2.67
Fertility level (N-P_2O_5-K_2O kg ha^{-1})						
F_1 = 0-0-0	6.89	6.92	4.16	4.24	83	84
F_2 = 50-50-50	8.75	9.23	5.47	5.58	175	178
F_3 = 50-50-75	10.29	10.61	5.94	6.05	192	195
F_4 = 75-50-75	11.99	12.32	7.27	7.44	209	215
F_5 = 75-50-100	10.93	11.25	6.79	6.93	207	211
F_6 = 75-50-125	9.83	10.11	6.21	6.32	207	209
SEm ±	0.08	0.04	0.04	0.02	0.79	0.57
CD (0.05)	0.23	0.10	0.11	0.07	2.26	1.64

Table 3. Effect of irrigation schedule and fertilizer levels on tuber and vine yield of sweet potato

Treatment	Tuber yield (t ha^{-1})		Vine yield (t ha^{-1})	
	2002-03	2003-04	2002-03	2003-04
Irrigation (IW/CPE)				
$I_1 = 0.6$	11.88	12.10	14.35	15.36
$I_2 = 0.8$	15.44	15.71	16.59	17.78
$I_3 = 1.0$	15.29	15.57	17.64	18.82
$I_4 = 1.2$	13.84	14.02	19.96	21.14
SEm ±	0.18	0.16	0.16	0.13
CD (0.05)	0.62	0.55	0.55	0.45
Fertility level (N-P_2O_5-K_2O kg ha^{-1})				
F_1 = 0-0-0	6.53	6.63	7.66	7.82
F_2 = 50-50-50	13.79	14.02	16.91	17.83
F_3 = 50-50-75	15.14	15.39	18.49	19.66
F_4 = 75-50-75	16.49	16.95	19.36	20.86
F_5 = 75-50-100	16.38	16.63	19.78	21.24
F_6 = 75-50-125	16.35	16.47	20.16	21.74
SEm ±	0.15	0.11	0.04	0.09
CD (0.05)	0.43	0.31	0.12	0.26
Interaction (I x F)				
I_1F_1	5.20	5.29	6.95	7.11
I_1F_2	11.83	12.06	14.66	15.55
I_1F_3	12.77	13.01	15.60	16.84
I_1F_4	14.05	14.31	15.75	17.23
I_1F_5	13.79	14.04	16.55	17.90
I_1F_6	13.62	13.88	16.50	17.44
I_2F_1	6.07	6.19	7.73	7.99
I_2F_2	14.82	15.09	17.01	18.08
I_2F_3	16.63	16.93	18.06	19.35
I_2F_4	18.73	19.05	18.69	20.12
I_2F_5	18.32	18.64	18.96	20.14
I_2F_6	18.05	18.37	19.00	20.90
I_3F_1	6.29	6.41	7.27	7.31
I_3F_2	14.55	14.81	17.05	17.83
I_3F_3	16.41	16.70	18.95	19.96
I_3F_4	18.46	18.78	20.42	22.01
I_3F_5	18.09	18.42	20.69	22.35
I_3F_6	17.96	18.28	21.38	23.34
I_4F_1	8.54	8.63	8.74	8.95
I_4F_2	13.95	14.13	19.09	20.05
I_4F_3	14.74	14.93	21.44	22.71
I_4F_4	15.47	15.67	22.99	24.43
I_4F_5	15.20	15.42	23.43	24.91
I_4F_6	15.15	15.34	23.93	25.62
SEm ±	0.30	0.22	0.08	0.18
CD (0.05)	0.86	0.62	0.23	0.52

ha^{-1} (F_4) (Table 3). Further increase in fertility level reduced the tuber yield by 0.67% and 0.85% during *rabi* 2002-03 and by 1.92% and 2.91% during *rabi* 2003-04 with successive addition of K_2O @ 25 and 50 kg ha^{-1}, respectively which was statistically at par with tuber yield due to application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} (F_4). Nedunchezhiyan and Byju (2005) and Nath et al., (2007) reported maximum number of tubers and yield at N 75 kg ha^{-1}. George and Mitra (2001) reported potassium application beyond 100 kg ha^{-1} was insignificant. Nair and Nair (1992) obtained maximum tuber yield with the application of K_2O @ 75 kg ha^{-1}. Application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} (F_4) resulted in maximum tuber yield which was at par with higher levels of fertility (F_5 and F_6) (Table 3). This might be due to more number of tubers, greater tuber size and weight. Balanced application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} contributed maximum tuber yield at New Delhi (Dayal and Sharma, 1993) and Bhubaneswar (CTCRI, 1977).

The interaction effect of irrigation and fertility levels on tuber yield was significant during both the *rabi* seasons (Table 3). The maximum tuber yield was obtained with the application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} at IW/PE 0.8 (I_2F_4) (Table 3). It was statistically at par with the tuber yield obtained at the same level of fertility at IW/CPE 1.0 (I_3F_4) and with higher level of fertility at the same level of irrigation (I_2F_5). The yield of I_2F_4 was also found statistically at par with higher fertility levels (I_2F_5 and I_2F_6) at the same level of irrigation (Table 3). Application of irrigation at IW/CPE

0.8 along with N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} (I_2F_4) resulted in maximum number of tubers, tuber length, girth and weight resulting in maximum tuber yield. This is because of adequate moisture use and nutrient uptake. The tuber yield was statistically at par with I_2F_5, I_2F_6 and I_3F_4. This may be due to similar pattern of moisture and nutrient utilization. Higher tuber yield in these treatments might be due to early tuber initiation under congenial micro-environment with perfect air-water balance facilitating greater nutrient and energy transport for tuber growth. Low moisture at IW/CPE 0.6 must have reduced the tuber growth due to high compactness led penetration resistance (Chowdhury et al., 2002). At higher irrigation level energy shift for vegetative growth (Table 1) might have adversely affected the tuber growth (Table 2). Inadequate supply of oxygen at high moisture level and poor absorption and translocation due to path way resistance at low moisture level might have reduced the nutrient uptake. It adversely affected the tuber bulking rate by poor cell division and expansion through low starch accumulation resulting in lower tuber yield (Chowdhury, 1995).

Vine yield is an indicator of vegetative growth in terms of vine length, number of leaves and aerial dry matter production. The vine yield was significantly influenced by irrigation and fertility levels (Table 3). Frequent irrigation at IW/CPE 1.2 (I_4) has produced maximum vine yield (Table 3). Varughese et al. (1987) also reported maximum vine yield production irrigation at IW/CPE 1.2. Increasing fertility level increased vine yield. The maximum fertility level of N-P_2O_5-K_2O @ 75-50-125 kg ha^{-1} (I_6) resulted in maximum vine yield (F_6) (Table 3). The interaction effect of irrigation and fertility levels on vine yield was significant during both the *rabi* seasons (Table 3). The treatment I_4F_6 resulted in maximum vine yield and it was 27.3-28.0 % greater than that of I_2F_4 during *rabi* 2002-3 and 2003-04, respectively due to partitioning of more dry matter to aerial parts than to the tubers (Jana, 1982 and Nair et al., 1996). At higher irrigation levels more mobile N and K favoured more vegetative growth (Chowdhury et al., 2002). Dayal and Sharma (1993) observed that liberal application of irrigation at IW/CPE 1.0 along with N and K_2O @ 100 kg /ha resulted in maximum vegetative growth.

Translocation of photosynthates towards tuber as soon as it is initiated was at a higher rate than towards leaf. The source-sink balance regulates the production of dry matter, translocation, partitioning and yield (Kays, 1985). The diversion of dry matter to tuber is indicated by harvest index. The harvest index was significantly influenced by irrigation and fertility levels (Table 4). Application of irrigation at IW/CPE 0.8 (I_2) resulted in maximum harvest index (Table 4). It was 17.7% higher than I_4. Application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} (F_4) resulted in maximum harvest index (Table 4). It was 1.5 and 2.7 % greater than F_5 and F_6 during *rabi*

Table 4. Effect of irrigation schedule and fertilizer levels on consumptive use, water use efficiency and harvest index of sweet potato

Treatment	Consumptive use (mm)		Water use efficiency (kg ha^{-1} mm)		Harvest index (%)	
	2002-03	2003-04	2002-03	2003-04	2002-03	2003-04
Irrigation (IW/CPE)						
$I_1 = 0.6$	92	115	129	105	45.29	44.06
$I_2 = 0.8$	120	143	129	109	48.20	46.91
$I_3 = 1.0$	138	155	110	101	46.43	45.27
$I_4 = 1.2$	152	183	91	77	40.95	39.87
SEm ±	1.90	2.00	1.90	1.70	0.34	0.23
CD (0.05)	6.50	6.90	6.60	5.90	1.19	0.78
Fertility level (N-P_2O_5-K_2O kg ha^{-1})						
F_1 = 0-0-0	121	145	54	46	46.02	45.88
F_2 = 50-50-50	124	147	111	95	44.92	44.02
F_3 = 50-50-75	126	149	120	103	45.02	43.91
F_4 = 75-50-75	127	150	130	113	46.00	44.83
F_5 = 75-50-100	128	151	128	110	45.30	43.91
F_6 = 75-50-125	128	152	128	108	44.78	43.10
SEm ±	0.10	0.10	1.10	0.90	0.05	0.16
CD (0.05)	0.30	0.30	3.30	2.60	0.13	0.46

2002-03, and 2.1 and 4.0 % greater than F_5 and F_6 during *rabi* 2003-04, respectively.

The consumptive use of water was significantly influenced by irrigation and fertility levels (Table 4). Application of irrigation at IW/CPE 1.2 resulted in maximum consumptive use of water (153 mm during *rabi* 2002-03 and 183 mm during *rabi* 2003-04) (Table 4). It was 10.1 to 65.2% greater than that of the other ratios during *rabi* 2002-03 and 18.0 to 59.1% greater than that of the other ratios during *rabi* 2003-04. High moisture status in the root zone due to frequent irrigations increased evaporation and enhanced consumptive use. At low irrigation level the soil moisture stress caused increase in resistance to the flow of water, which reduced the consumptive use (Kramer, 1969). Increase in consumptive use of water with increase in irrigation frequency has also been reported by Biswas et al. (1980) and Chowdhury (1996). Maximum consumptive use of water noticed in F_6 and minimum was observed in F_1 (control) (Table 4). This might be due to higher vegetative (vine) growth.

The WUE was significantly influenced by irrigation and fertility levels (Table 4). The WUE increased with the increase in irrigation level from IW/CPE 0.6 to IW/CPE 0.8 (Table 4). Further increase of frequency of irrigation (beyond at IW/CPE 0.8) reduced the WUE. Thus maximum WUE was noticed at IW/CPE 0.8 and minimum at IW/CPE 1.2 (Table 4). Chowdhury (1996) recorded high water use efficiency at IW/CPE 1.0. Increasing fertility level increased WUE up to N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} (F_4), further increasing the fertility level decreased WUE. This might be due to decrease in tuber yield (Table 3) and increase in consumptive use of water (Table 4) at higher fertility levels (F_5 and F_6) (Table 4).

Conclusion

Irrigation and fertility levels significantly influenced sweet potato growth, tuber and vine yields. Application of irrigation at IW/CPE 0.8 was found optimum for greater tuber yield, harvest index and water use efficiency. The consumptive use of water was optimum with the application of water at IW/CPE 0.8. Application of higher level of irrigation at IW/CPE 1.2 resulted in maximum vegetative growth, vine yield and consumptive use of water. Increasing fertility level increased growth, vine yield and consumptive use of water. However, greater tuber yield, harvest index and water use efficiency were recorded with the application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1}. The maximum tuber yield was obtained with the application of N-P_2O_5-K_2O @ 75-50-75 kg ha^{-1} at IW/CPE 0.8.

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