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EFFECT OF IRRIGATION SCHEDULES ON GROWTH, YIELD, WUE AND ECONOMICS OF FODDER SUGAR BEET (*BETA VULGARIS* L.) VARIETIES UNDER COASTAL SALT AFFECTED SOILS

M. M. PATEL[1,*], H. K. JOSHI[2], V. A. PATEL[3] AND V. P. USADADIA[4]

Coastal Soil Salinity Research Station, Navsari Agricultural University,
Danti-Umbharat, Gujarat-396 450
**(e-mail : mmpatel_nau@rediffmail.com)*

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SUMMARY

A field experiment was conducted during *rabi* season of 2013-14 to 2015-16 at Danti-Umbharat, Gujarat to study the "effect of irrigation schedules on productivity, water use efficiency and economics of fodder sugar beet (*Beta vulgaris* L.) varieties". Total twelve treatment combinations comprising of three irrigation schedules *i.e.*, 0.6, 0.8 and 1.0 IW/CPE ratio and four varieties *viz.*, JK kuber, JK calixta, PAC-60008 and JK magnolia were evaluated in factorial randomized block design with four replications. Irrigation at 1.0 IW/CPE ratio recorded significantly higher growth and yield attributes *viz.*, plant height, number of leaves, root length and root weight as well as fresh root yield, fresh foliage yield and total fresh biomass yield. Significantly improved plant height, number of leaves, root length and fresh foliage yield was observed in JK magnolia, while root weight, fresh root yield and total fresh biomass yield were significantly higher in JK kuber. Maximum net realization was recorded with application of irrigation at 1.0 IW/CPE ratio (I3) followed by 0.8 IW/CPE ratio (I2). In case of varieties, JK kuber (V1) secured the maximum net realization. Increasing irrigation levels from 0.6 IW/CPE ratio (I1) to 1.0 IW/CPE ratio (I3), total fresh biomass yield of all the varieties was increased and water use efficiency was decreased.

Key words : Water use efficiency, Sugar beet, Irrigation schedules, Varieties, Net realization

India supports nearly 20 per cent of the world's livestock being the leader in cattle (16%), buffalo (55%), goat (20%) and sheep (5%) population. The livestock sector contributes 32 per cent of the agricultural output which is 22 per cent of the total GDP in India. Deficiency in feed and fodder has been identified as one of the major component in achieving the desired level of livestock production. The shortage in dry fodder is 21.8 per cent compared with requirement of 560 million tones for the current livestock populations (Anonymous, 2009). The low productivity and poor performance of the livestock are mainly due to unavailability of nutritious fodder in sufficient quantity. India faces a net deficit of 61 percent green fodder, 21.9 percent dry crop residues and 64 percent feed. The most important constraints in the fodder production and productivity are the non-availability of improved variety of fodder crop.

Sugar beet (*Beta vulgaris*) belonging to family *Amaranthaceae*, is a biennial crop grown for its fleshy and swollen roots. It is being cultivated in many parts of the world for sugar, fodder and vegetable purpose. It can be successfully grown as a fodder crop and used as valuable source of green fodder. The high crude protein and sugar content makes it more palatable, nutritious and energy feed and having a good scope for livestock industry in India (Dulphy *et al.*, 2000). However, its cultivation in India as fodder crop is not common.

Sugar beet (*Beta vulgaris*) is a salt tolerant crop which is grown well under coastal salt affected soils. It is a better option for fodder purpose in coastal salt affected areas. Hence, the present study was to evaluate the effect of irrigation schedules on growth, fresh biomass yield and economics of sugar beet varieties under coastal salt affected soils of south Gujarat.

MATERIALS AND METHODS

A field experiment was conducted during *rabi* seasons of 2013-14 to 2015-16 at the Coastal Soil Salinity Research Station, Navsari Agricultural University, Danti-Umbharat in the South Gujarat near

[1]Associate Research Scientist; [2, 3]Assistant Research Scientist; [4]Research Scientist; Coastal Soil Salinity Research Station, Soil and Water Management Research Unit, Navsari Agricultural University, Danti-Umbharat, Gujarat-396 450.

the Arabian Sea. Geographically, Danti- Umbharat is situated at 20^0 83' N latitude and 72^0 50' E longitudes with an elevation of 2.5 meter above mean sea level on the western coastal belt of India. The soil of the experiment plot was clayey in texture, saline in reaction {pH (8.51) and electrical conductivity (4.58 dSm^{-1})}, low in available N (242 kg/ha), medium in available P_2O_5 (48 kg/ha) and high in available K_2O (1488 kg/ha).

A field experiment was laid out in factorial randomized block design with four replications, comprising three irrigation schedules *i.e.*, 0.6, 0.8 and 1.0 IW/CPE ratio and four varieties *viz.*, JK kuber, JK calixta, PAC-60008 and JK magnolia. Sowing of fodder sugar beet was done manually at 45 x 20 cm (pair row) spacing on raised beds (60 cm breadth x 20 cm depth). Irrigations were given by keeping 50 mm depth of irrigation. The amount of water required for applying 50 mm depth was measured in open channel flow using parshall flume. Cumulative Pan Evaporation was recorded using open pan evaporimeter and the different IW/CPE levels 0.6, 0.8 and 1.0 were calculated. The measured amount of irrigation was given according to ratio of applied depth of irrigation (IW) (50mm) and Cumulative Pan Evaporation (CPE). The crop was fertilized uniformly with recommended dose of fertilizers *i.e.* 120:60:60 NPK kg/ha. along with 10 t/ha biocompost. Half dose of nitrogen and full dose of phosphorus and potash were applied at the time of sowing while remaining nitrogen was applied in two equal splits at 45 and 90 DAS. Bio compost was applied @ 10 t/ha at 20 days before sowing. Nitrogen, phosphorus and potash were supplied through urea, single super phosphate and muriate of potash, respectively. All other recommended practices were followed during crop growing seasons. The data recorded for different parameters were statistically analysed with the help of analysis of variance (ANOVA) technique for a factorial randomised block design.

RESULTS AND INTERPRETATION

Growth and yield attributes

Growth and yield attributes of fodder sugar beet like plant height, number of leaves, root length and root weight were significantly affected due to irrigation schedules and varieties (Table 1). Irrigation at 1.0 IW/CPE ratio (I_3) recorded significantly higher values of plant height, number of leaves, root length and root weight as compared to 0.6 and 0.8 IW/CPE ratio, except for number of leaves, where in treatment 1.0 (I_3) and 0.8 IW/CPE ratio (I_2) remained at par. Growth and yield parameters progressively increased with increase the IW/CPE ratio and frequency of water applied. Anonymous (2016) also reported similar beneficial effect of irrigation on growth and yield attributes of sugar beet.

JK calixta (V_2) and JK magnolia (V_4) were at par with each other and both recorded significantly higher plant height as compared to JK kuber (V_1) and PAC-60008 (V_3). JK magnolia (V_4) recorded significantly higher number of leaves than rest of the varieties. In case of root length, JK magnolia (V_4) and PAC-60008 (V_3) were at par with each other and both

TABLE 1

Effect of irrigation schedules on growth and yield attributes as well as yield of fodder sugar beet varieties (pooled data of three years)

Treatments	Plant height (cm)	No. of leaves	Root length (cm)	Root weight (g)	Fresh root yield (t/ha)	Fresh foliage yield (t/ha)
Irrigation schedules (IW/CPE ratio) (I)						
I_1 : 0.6	33.93	18.50	20.63	470	31.32	13.58
I_2 : 0.8	36.40	20.10	21.12	532	33.82	15.62
I_3 : 1.0	37.59	20.14	21.95	587	35.80	16.21
S. Em±	0.36	0.21	0.25	6	0.54	0.24
C. D. (P=0.05)	1.00	0.59	0.70	17	1.51	0.68
Varieties (V)						
V_1 : JK kuber	34.04	17.54	19.83	573	36.89	14.87
V_2 : JK calixta	38.55	19.81	20.38	528	33.96	15.68
V_3 : PAC 60008	32.82	18.99	22.03	497	30.34	14.19
V_4 : JK magnolia	38.50	21.97	22.69	522	33.40	15.80
S. Em±	0.41	0.24	0.29	7	0.62	0.27
C. D. (P=0.05)	1.14	0.70	0.81	19	1.74	0.77

recorded significantly higher value in comparison to JK kuber (V_1) and JK calixta (V_2). For root weight of fodder sugar beet, JK kuber (V_1) was found significantly higher than rest of the varieties. The difference in growth and yield attributes might be due to genetic make up of plant itself. These findings are in close agreement with those reported by Sanghera *et al.* (2016).

Fresh root and foliage yield

Significant differences in fresh root yield and fresh foliage yield were recorded with the different irrigation schedules and varieties (Table 1). Irrigation at 1.0 IW/CPE ratio (I_3) recorded significantly higher fresh root yield (35.81 t/ha) and fresh foliage yield (16.21 t/ha) over 0.6 IW/CPE ratio (I_1) and 0.8 IW/CPE ratio (I_2) for fresh root yield and 0.6 IW/CPE ratio (I_1) for fresh foliage yield.

Among the varieties, JK kuber (V_1) produced significantly higher fresh root yield (36.89 t/ha) as compared to rest of the varieties. Increased value of fresh root yield was attributed to higher value for root weight. In case of fresh foliage yield, JK magnolia (V_4) produced significantly higher (15.80 t/ha), but it remained statistically at par with JK calixta (V_2). This results might be due to overall improvement in vegetative growth as evidenced by higher plant height and number of leaves due to its genetic character of faster canopy development. These results are in line with those reported by Singh and Grag (2013).

Total fresh biomass yield

Total fresh biomass yield of fodder sugar beet was found significant due to individual effect of irrigation schedules and varieties during all the individual years as well as in pooled results. Irrigation at 1.0 IW/CPE ratio (I_3) recorded significantly higher total fresh biomass yield (53.49, 49.11, 53.45 and 52.02 t/ha., respectively) as compared to 0.6 IW/CPE ratio (I_1) and 0.8 IW/CPE ratio (I_2) during second and third year as well as in pooled analysis, but it remained at par with 0.8 IW/CPE ratio (I_2) during first year. Total fresh biomass yield was higher under frequent irrigation scheduling and reduced drastically in low frequency irrigation due to reduction in moisture availability. Similar results were obtained by Anonymous (2016).

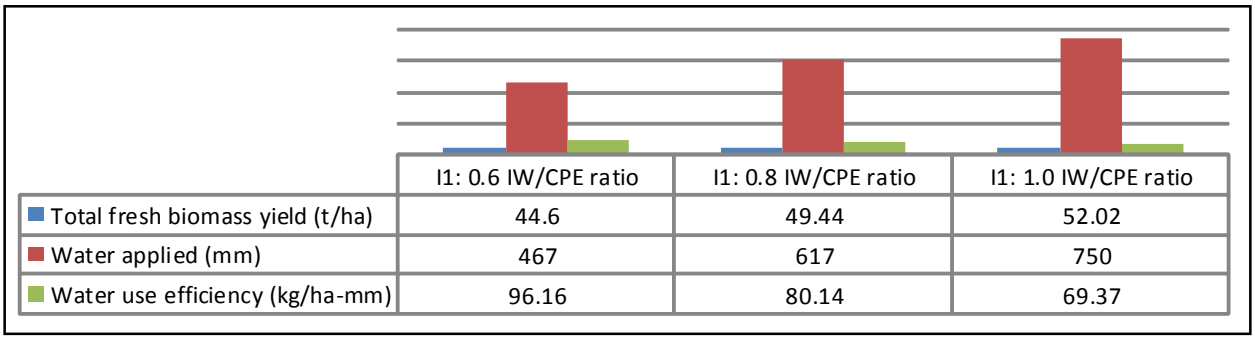
Among the varieties, JK kuber (V_1) produced significantly higher total fresh biomass yield (53.96, 49.23, 52.09 and 51.76 t/ha., respectively) as compared to rest of the varieties in pooled results, but it remained at par with JK calixta (V_2) and JK magnolia (V_4) during all the individual year. The relatively higher total fresh biomass yield under this variety might be owing to overall improvement in yield attributes as well as fresh root yield. These results are in line with those reported by Patel and Patel (2019).

Water Use Efficiency

The total amount of irrigation water applied was 467, 617 and 750 mm in 0.6, 0.8 and 1.0 IW/CPE ratio and corresponding WUE values were 96.16, 80.14 and 69.37 kg/ha-mm., respectively (Fig. 1). Around 24.31 and 37.73 percent irrigation water was saved due to 0.6 IW/CPE ratio (I_1) compared to 0.8 IW/CPE ratio (I_2) and 1.0 IW/CPE ratio (I_3),

TABLE 2
Effect of irrigation schedules on total fresh biomass yield and economics of fodder sugar beet varieties

Treatments	Total fresh biomass yield (t/ha)				Gross realization (Rs./ha)	Net realization (Rs./ha)	Benefit : cost ratio
	2013-14	2014-15	2015-16	Pooled			
Irrigation schedules (IW/CPE ratio) (I)							
I_1 : 0.6	46.28	42.86	45.56	44.90	1,34,712	74,008	1.22
I_2 : 0.8	51.00	45.87	51.45	49.44	1,48,335	84,431	1.32
I_3 : 1.0	53.49	49.11	53.45	52.02	1,56,069	85,765	1.22
S. Em±	1.18	1.06	0.68	0.57	-	-	-
C. D. (P=0.05)	3.39	3.06	1.98	1.60	-	-	-
Varieties (V)							
V_1: JK kuber	53.96	49.23	52.09	51.76	1,55,295	98,761	1.75
V_2 : JK calixta	50.74	46.90	51.29	49.64	1,48,938	81,154	1.20
V_3 : PAC 60008	45.69	41.41	46.52	44.54	1,33,629	65,845	0.97
V_4 : JK magnolia	50.64	46.25	50.71	49.20	1,47,621	79,837	1.18
S. Em±	1.36	1.22	0.79	0.65	-	-	-
C. D. (P=0.05)	3.92	3.53	2.28	1.83	-	-	-



	I1: 0.6 IW/CPE ratio	I1: 0.8 IW/CPE ratio	I1: 1.0 IW/CPE ratio
Total fresh biomass yield (t/ha)	44.6	49.44	52.02
Water applied (mm)	467	617	750
Water use efficiency (kg/ha-mm)	96.16	80.14	69.37

Fig. 1. Total fresh biomass, water applied and WUE as influenced by different irrigation schedules (Pooled of three years).

respectively. Frequent irrigation scheduled I_3 (1.0 IW/CPE ratio) promoted faster plant growth and yield attributes, consequently resulted in higher yield while the highest water use efficiency (WUE) was attained in irrigation scheduled I_1 (0.6 IW/CPE ratio) due to lower amount of irrigation water used.

ECONOMICS

The average economics for three years was worked out for individual treatments *viz.*, irrigation schedules and varieties (Table 2). Maximum net realization Rs. 85,765/ha was obtained with application of irrigation at 1.0 IW/CPE ratio (I_3) followed by 0.8 IW/CPE ratio (I_2) (Rs. 84,431/ha). Minimum net realization Rs. 74,008/ha was recorded with application of irrigation at 0.6 IW/CPE ratio (I_1). The maximum BCR value of 1.32 was recorded with application of irrigation at 0.8 IW/CPE ratio (I_2) as compared 1.0 IW/CPE ratio (1.22) and 0.6 IW/CPE ratio (1.22). Among the varieties, JK kuber (V_1) secured the maximum net realization Rs. 98,761/ha and BCR of 1.75 followed by JK calixta (V_2) with net realization Rs. 81,154/ha and BCR of 1.20.

Based on three years study, it can be concluded that fodder sugar beet variety JK kuber should be grown with application of irrigation at 1.0 IW/CPE ratio during *rabi* season to secure maximum fresh biomass yield and net return under coastal salt affected soils.

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