Karnataka J. Agric. Sci.,15 (1):(104-108) 2002

Water use Efficiency, Consumptive Use and Soil Moisture Depletion Pattern of Cabbage as Influenced by Irrigation Schedules and Methods*

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(Received : October, 2000)

Abstract : An investigation was carried out to study the effect of irrigation schedules and methods on yield, consumptive use, soil moisture depletion pattern and water use efficiency in cabbage. The crop irrigated at 1.6 IW/CPE ratio (33.40 t ha^{-1}) and through furrow method of irrigation (31.28 t ha^{-1}) recorded significantly higher yields compared to other treatments. The maximum consumptive use was found with weekly irrigation (56.05 cm) and 1.6 IW/CPE ratio (50.18 cm) while the least consumptive use was registered with 1.0 IW/CPE ratio. Similarly among the different methods alternatively alternate furrow method is found promising in least consumptive use. Cabbage is a surface feeder, the maximum amount of moisture was depleted in shallow depth than deeper layer of soil. The maximum water use efficiency was found with the crop irrigated at 1.0 IW/CPE ratio with alternatively alternate furrow method and 1.6 IW/CPE ratio with alternatively alternate furrow method.

Introduction

Cabbage is one of the important winter vegetable crops of India. It is cultivated both for home as well as truck gardens. Normally the crop is cultivated under irrigated conditions. The crop grown under soil moisture stress result in low yield. Jadhav and Srinivas (1968) reported that cabbage is very sensitive to soil moisture, the better growth and yield can be obtained when plentiful supply of water is made available to the plants throughout the growth period. Sharma (1993) obtained significantly higher cabbage yield when crop irrigated at 2.00 IW/CPE ratio. Som *et al.* (1978) reported that consumptive use of water was increased with increase in soil moisture in cabbage. It was maximum (359 mm) with irrigation at 0.25 bar. The water use efficiency was lowest (56.82 kg ha-1 mm) with the irrigation at 0.25 bar and it was increased with delayed irrigation. The crop depleted about 40-47 per cent moisture from first foot of soil layer. Hence, an attempt is made to determine the consumptive use, water use efficiency and soil moisture depletion pattern and yield of cabbage grown in Northern transitional zone of Karnataka.

Material and Methods

The field experiment was conducted in the Division of Horticulture, University of Agricultural Sciences, Dharwad (Karnataka) on red sandy clay loam soils during rabi season of 1997-98 and 1998-99. Mean values of field capacity, permanent wilting percentage and bulk density of the soil to a depth of 90 cm were 23.01 per cent, 11.05 per cent (dry weight basis) and 1.40 g/CM^3, respectively. The water table contribution was nil. The study included four irrigation schedules viz; irrigation at 1.0, 1.3, 1.6 IW/CPE ratio and weekly interval (control) as main Plots and four irrigation methods viz; furrow, alternate furrow, alternatively alternate

*Part of the Ph.D. thesis submitted by the senior author to the University of Agricultural Sciences, Dharwad -580 005

furrow and check basin as subplots. The study was conducted in split plot design in three replications. The irrigation water of 60 mm depth was applied at each irrigation with the help of Parshall flume. The treatments and replications were separated by buffer channels of 1.5 and 2.0 m respectively to avoid movement of water from one plot to another. The number of irrigations given to the crop in control (weekly interval) was 12 where as it was 7, 9 and 1 1 respectively in IW/CPE ratios 1.0, 1.3 and 1.6. The soil moisture content was determined gravimetrically after oven drying the soil samples at 105°C to a constant weight.The moisture percentage obtained were used to calculate consumptive use of water (Dastane, 1972). The cultivar used for the experiment was Pride of India.

Results and Discussion

The results obtained from the present investigation on yield of cabbage, soil moisture depletion, consumptive use and water use efficiency. The data on yield of cabbage as influenced by different irrigation schedules and methods of irrigation are presented in Table 1. The different irrigation schedules had significant influence on the yield of cabbage. Irrigation at IW/CPE ratio of 1.6 (I_3) recorded significantly highest yield of cabbage (33.40 t ha^{-1}) over I_4 (29.76 t ha^{-1}), I_2 (27.57 t ha^{-1}) and I_1(25.94 t ha^{-1}). The yields recorded during 1997-98 and 1998-99 seasons also showed a similar trend. Scheduling of irrigation at 1.6 IW/CPE ratio resulted in significantly higher yield of cabbage (33.40 t ha^{-1}) over other irrigation schedules, which is 28.76 per cent more than obtained with irrigation at 1.0 IW/CPE ratio. The increase in yield could be attributed to higher consumptive use of water (50.18 cm in 1.6 IW/CPE ratio compared to 38.04 cm in 1.0 IW/CPE ratio) (Table 2). These results are in conformity with the findings of Jadhav *et al.*(1992) and Subramanian *et al.* (1993), who recorded higher consumptive use of water with increase in the IW/CPE ratio in tomato and brinjal, respectively. Yield of cabbage varied significantly due to irrigation methods (Table 1). Furrow method of irrigation recorded significantly higher yield of cabbage (31.28 t ha^{-1}) over check basin (29.52 t ha^{-1}), alternatively alternate furrow (28.40 t ha^{-1}) and alternate furrow (27.47 t ha^{-1}) methods of irrigation, that is, the yield in furrow method was 9.21 per cent higher than that in alternatively alternate furrow method. This increase in yield might be attributed to the higher consumptive use of water (56.08 cm) as compared to alternatively alternate furrow method (37.09 cm). Even though the yield in furrow irrigation was 9.21 per cent higher than that in alternatively alternate furrow, the consumptive use was 18.99 cm more than alternatively alternate furrow method. Further, the water use efficiency was much higher in alternatively alternate furrow (782.67 kg ha^{-1} cm) as compared to furrow (579.78 kg ha^{-1} cm), that is, water use efficiency was 202.96 kg ha^{-1} cm higher than furrow method of irrigation. These results are in conformity with the findings of Sharma (1985).

The percentage of soil moisture depletion by cabbage crop at different depths of soil as influenced by irrigation schedules is presented in Table 2. Cabbage crop extracted 33.78, 31.81, 25.76 and 8.65 per cent moisture from the soil depth of 0-15, 15-30, 30-60 and 60-90 cm respectively with irrespective of irrigation schedules. Crop irrigated at weekly interval (I_4) extracted the highest per cent of 35.73 and 33.31 per cent soil moisture from shallow depth of 0-15 and 15-30 cm surface layer respectively. While the lowest quantity of moisture was extracted by the crop irrigated at 1.0 IW/CPE ratio treatment (31.68 and 29.93% respectively). While in case of deeper layer of 30-60 and 60-90 cm, the crop irrigated at 1.0 IW/CPE ratio (27.32 and 11.09%) was also extracted relatively higher soil moisture followed by 1.3 IW/CPE

Table 1. Yield (t ha^{-1}) of cabbage as influenced by irrigation schedules and methods of irrigation

Irrigation	Irrigation methods														
	1997-98					1998-99					Pooled*				
Schedules	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean	M_1	M_2	M_3	M_4	Mean
I_1- Irrigation at 1.0 IW/CPE	24.71	22.44	24.17	24.53	23.96	28.61	26.35	28.18	28.51	27.91	26.66	24.40	26.18	26.25	25.24
I_2- Irrigation at 1.3 IW/CPE	25.89	24.36	25.25	25.89	25.35	30.39	29.22	29.77	29.78	29.79	28.14	26.79	27.51	27.84	27.57
I_3 - Irrigation at 1.6 IW/CPE	32.16	28.19	29.24	30.55	30.04	45.41	32.20	33.27	36.12	36.75	38.79	30.20	31.26	33.34	33.40
I_4 - Irrigation at weekly interval	29.25	26.31	26.47	28.18	27.55	33.78	30.69	30.84	32.57	31.97	31.52	28.50	28.66	30.38	29 76
Mean	28.00	25.32	26.28	27.29	26.73	34.55	29.62	30.52	31.74	31.61	31.28	27.47	28.40	29.52	29.17

For comparing the means of	S.Em±	CD (0.05)	S.Em±	CD (0.05)	S.Em±	CD (0.05)
Irrigation schedule(I)	0.51	1.76	1.22	4.23	0.66	2.03
Irrigation method(M)	0.39	1.13	1.08	3.17	0.58	1.65
M means at same I	0.78	NS	2.17	NS	1.15	NS
I means at same or different M	0.84	NS	2.24	NS	1.20	NS

*Mean of two years
NS = Non -significant
M_1 = Furrow
M_2 = Alternate furrow
M_3 = Alternatively alternate furrow
M_4 = Check basin

Table 2. Soil moisture depletion (%) consumptive use (cm) and water use efficiency (kg ha^{-1} cm) as influenced by irrigation schedules and methods of irrigation in cabage (pooled*)

Irrigation Schedules	Soil moisture depletion (%) at different depths (cm) 0-15	15-30	30-60	60-90	Consumptive use(cm) M_1	M_2	M_3	M_4	Mean	Water use efficiency (kg ha^{-1}cm) M_1	M_2	M_3	M_4	Mean
I_1 - Irrigation at 1.0 IW/CPE	31.68	29.93	27.32	11.09	43.67	33.23	31.33	43.94	38.04	617.74	739.70	841.66	610.87	702.49
I_2 - Irrigation at 1.3 IW/CPE	32.90	32.13	26.22	8.76	52.15	37.22	35.31	52.42	44.28	553.19	731.55	791.70	543.74	655.05
I_3 - Irrigation at 1.6 IW/CPE	34.81	31.90	25.67	7.63	60.17	40.81	39.08	60.64	50.18	679.40	756.99	817.86	570.62	706.22
I_4 - Irrigation at weekly interval	53.73	33.31	23.84	7.13	68.33	44.44	42.65	68.77	56.05	468.77	649.05	679.75	448.60	561.54
Mean	33.78	31.81	25.76	8.65	56.08	38.93	37.09	56.44	47.14	579.78	719.32	782.74	543.46	656.33

*Mean of two years M_1 = Furrow

M_2 = Alternate furrow M_3 = Alternatively alternate furrow M_4 = Check basin

ratio treatment (26.22 ; 8.76%). The least soil moisture depletion was registered in the crop irrigated at weekly interval (23.84 ; 7.13%). It could be attributed to the cabbage crop is a shallow rooted and maximum feeder roots at a depth of 0-30 cm, hence the crop extracted maximum amount of water than deeper layer of soil.

Among the irrigation schedules, the maximum consumptive use of water (56.05 cm) was recorded with weekly irrigation (I_4) which was closely followed by the treatment receiving irrigations at 1.6 IW/CPE ratio (50.18 cm) (Table 2).The minimum consumptive use of water (38.04 cm) was registered in the treatment where irrigations were scheduled at 1.0 IW/CPE ratio. In irrigation methods, the maximum consumptive use of water was recorded in check basin method of irrigation (56.44 cm), followed by furrow irrigation method (56.08 cm).The minimum consumptive use of water (37.09 cm) was noticed in the alternatively alternate furrow method of irrigation treatment. This could be attributed to more frequency and maximum available of water when crop is irrigated at weekly intervals compared to other treatments. With regard to interaction, the maximum consumptive use of water (68.77 cm) was recorded in the treatment combination where irrigations were given at weekly interval through check basin method of irrigation. The minimum consumptive use of water (31.33 cm) was registered in the treatment receiving irrigation at 1.0 IW/CPE ratio with alternatively alternate furrow method of irrigation. These results are in agreement with the findings of Sharma (1985) who recorded highest consumptive use of water by cabbage crop irrigated through check basin method.

The treatment receiving irrigation at 1.6 IW/CPE ratio recorded the highest water use efficiency of 706.22 kg ha^{-1} cm which was closely followed by 1.0 and 1.3 IW/CPE ratio (702.49

and 655.05 kg ha^{-1} cm respectively) (Table 2). Among the irrigation methods, alternatively alternate furrow recorded highest water use efficiency of 782.74 kg ha^{-1}cm followed by irrigation through alternate furrow, furrow and check basin methods (719.32, 579.78 and 543.46 kg ha^{-1}cm respectively). The interaction effects between irrigation schedules and methods of irrigation revealed that, the maximum water use efficiency (841.66 kg ha^{-1}cm) was registered by the treatment receiving irrigation at 1.0 IW/CPE ratio with alternatively alternate furrow method closely followed by the treatment of 1.6IW/CPE ratio with alternatively alternate furrow method of irrigation (817.86 kg ha^{-1}cm). Similar findings are reported by Som *et al.* (1978) in cabbage.

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