



E-ISSN: 2278-4136

P-ISSN: 2349-8234

www.phytojournal.com

JPP 2020; 9(6): 344-348

Received: 18-09-2020

Accepted: 23-10-2020

SB Jadhav

Assistant Professor, Department
of IDE, College of Agricultural
Engineering and Technology,
VNMKV, Parbhani, Maharashtra,
India

UM Khodke

Associate Dean and Principal,
College of Agricultural
Engineering and Technology,
VNMKV, Parbhani, Maharashtra,
India

VK Ingle

Assistant Professor, Department
of IDE, College of Agricultural
Engineering and Technology,
VNMKV, Parbhani, Maharashtra,
India

HW Awari

Head, IDE, College of
Agricultural Engineering and
Technology, VNMKV, Parbhani,
Maharashtra, India

Corresponding Author:**SB Jadhav**

Assistant Professor, Department
of IDE, College of Agricultural
Engineering and Technology,
VNMKV, Parbhani, Maharashtra,
India

Water use efficiency of cabbage as influenced by irrigation schedules and fertigation levels

SB Jadhav, UM Khodke, VK Ingle and HW Awari

Abstract

The field experiment was conducted during 2016-2017 and 2017-2018 to investigate the effect of irrigation schedules and fertigation levels on water use efficiency of cabbage during the winter season at AICRP on Water Management, VNMKV, Parbhani. Drip method with alternate day irrigation was adopted for all the plots with five irrigation levels as main plot viz., 0.4 ETc (I₁), 0.6 ETc (I₂), 0.8 ETc (I₃), 1.0 ETc (I₄) and 1.2 ETc (I₅). Fertigation levels were 50% (F₁), 75% (F₂) and 100% (F₃) of recommended dose of fertilizers (120:60:60; N: P₂O₅:K₂O kg ha⁻¹) with eight splits during crop growth period. All the treatments were replicated thrice. Irrigation level 0.4 ETc (I₁) resulted to give the highest WUE of 165.97, 146.186 and 156.26 kg ha-mm⁻¹ during 2016-17, 2017-18 and in pooled results whereas the lowest WUE of 76.95, 68.66 and 72.89 kg ha-mm⁻¹ was observed under 1.2 ETc (I₅) irrigation level. Fertigation with 125% RDF (F₃) gave the highest water use efficiency of 116.39, 104.88 and 110.74 kg ha-mm⁻¹ by producing higher curd yields during 2016-17, 2017-18 and in pooled, respectively. The lowest WUE was noticed under 75% RDF (F₁) because of lower curd yields. The highest WUE was recorded in treatment combination I₁F₃ followed by I₁F₂.

Keywords: Drip irrigation, irrigation scheduling, fertigation, water use efficiency.

Introduction

Irrigated agriculture is the largest water requiring zone which faces competing demands from other sectors such as industrial, domestic and recreational sectors. The great challenge for the agricultural sector is to use produce more food from less water. Scarcity of water and increasing demand stresses need to utilize available water with more efficient and economic ways. Cabbage being a high yielding and a highly nutrient responsive crop requires heavy dose of nutrients. Drip fertigation can be a better way for maximizing its production through efficient use of irrigation water and applied nutrients. The multifarious benefits of drip fertigation in different crops including field crops have been reported. In general, the over or untimely irrigation water and nutrient losses resulting in low irrigation and nutrient use efficiency results in low productivity of cabbage. With these considerations in view, the present research work for cabbage (*Brassica Oleracea* var. *Capitata*) under semi-arid tropics of Maharashtra was planned to study the water use efficiency of cabbage under varying irrigation schedules and fertigation levels during the winter season at AICRP on Irrigation Water Management, Parbhani

Material and Methods

The field experiments were conducted consequently for two years (2016-17 and 2017-18) in *rabi* season at research farm of AICRP on Irrigation Water Management in Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani.

Yield per plant

The weight of individual curd after removing unfolded leaves in each plot was measured at the time of harvesting. The total weight of curds obtained from each plot was converted to get the total yield in term of q ha⁻¹ per plot and total yield (t ha⁻¹).

Total water use and water use efficiency

In the present study drip irrigation was scheduled at an alternate day with 0.4 ETc, 0.6 ETc, 0.8 ETc, 1.0 ETc and 1.2 ETc and the actual depth of water applied was measured. Total amount of water applied through irrigation during January 14 to April 13, 2017 for first season and during January 21 to April 17, 2018 for second season along with water use efficiency

under different irrigation schedules and fertigation levels was monitored.

Water use efficiency (WUE)

The water use efficiency was determined from the data on corresponding yield and volume of water applied using the following equation

$$WUE = \frac{\sum Y}{WR}$$

Where,

WUE = Water use efficiency (t ha⁻¹mm⁻¹)

Y = Yield of crop (t ha⁻¹)

WR = Irrigation water applied (mm)

Results and Discussion

Total water use and water use efficiency

Total amount of water applied through irrigation during January 14 to April 13, 2017 for first season and during January 21 to April 17, 2018 for second season along with water use efficiency under different irrigation schedules and fertigation levels are presented in Table 1 through Table 9.

Table 1: Water use efficiency of cabbage under different irrigation levels during 2016-2017

Treatment	Water applied (mm)	Total water applied (mm)*	Yield (q ha ⁻¹)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (q ha-cm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
I ₁ (0.4 ETc)	168.13	168.13	279.04	1.660	16.60	165.97
I ₂ (0.6 ETc)	252.20	252.20	346.80	1.375	13.75	137.51
I ₃ (0.8 ETc)	336.26	336.26	426.37	1.268	12.68	126.80
I ₄ (1.0 ETc)	420.33	420.33	438.79	1.044	10.44	104.39
I ₅ (1.2 ETc)	504.39	504.39	388.14	0.770	7.70	76.95
Mean	336.26	336.26	375.83	1.22	12.23	122.32

Table 2: Water use efficiency of cabbage under different fertigation levels during 2016-2017

Treatment	Water applied (mm)	Total water applied (mm)*	Yield (q ha ⁻¹)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (q ha-cm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
F ₁ (75% RDF)	336.26	336.26	351.09	1.044	10.44	104.41
F ₂ (100% RDF)	336.26	336.26	385.02	1.145	11.45	114.50
F ₃ (125% RDF)	336.26	336.26	391.37	1.164	11.64	116.39
Mean	336.26	336.26	375.83	1.12	11.18	111.77

Table 3: Water use efficiency of cabbage under different irrigation schedules during 2017-2018

Treatment	Water applied (mm)	Total water applied (mm)*	Yield (q ha ⁻¹)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (q ha-cm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
I ₁ (0.4 ETc)	162.02	162.02	236.85	1.462	14.62	146.186
I ₂ (0.6 ETc)	243.04	243.04	296.19	1.219	12.19	121.869
I ₃ (0.8 ETc)	324.05	324.05	371.48	1.146	11.46	114.637
I ₄ (1.0 ETc)	405.6	405.6	386.65	0.953	9.53	95.328
I ₅ (1.2 ETc)	486.07	486.07	333.75	0.687	6.87	68.663
Mean		324.16	324.98	1.09	10.93	109.34

Table 4: Water use efficiency of cabbage under different fertigation levels during 2017-2018

Treatment	Water applied (mm)	Total water applied (mm)*	Yield (q ha ⁻¹)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (q ha-cm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
F ₁ (75% RDF)	324.05	324.05	303.16	0.936	9.355	93.55
F ₂ (100% RDF)	324.05	324.05	331.93	1.024	10.243	102.43
F ₃ (125% RDF)	324.05	324.05	339.86	1.049	10.488	104.88
Mean	324.05	324.05	324.98	1.00	10.03	100.29

Table 5: Water use efficiency of cabbage under different irrigation levels (Pooled)

Treatment	Water applied (mm)	Total water applied (mm)*	Yield (q ha ⁻¹)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (q ha-cm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
I ₁ (0.4 ETc)	165.08	165.08	257.95	1.563	15.63	156.26
I ₂ (0.6 ETc)	247.62	247.62	321.49	1.298	12.98	129.83
I ₃ (0.8 ETc)	330.16	330.16	398.92	1.208	12.08	120.83
I ₄ (1.0 ETc)	412.97	412.97	412.72	0.999	9.99	99.94
I ₅ (1.2 ETc)	495.23	495.23	360.95	0.729	7.29	72.89
Mean	330.21	330.21	350.41	1.16	11.59	115.95

Table 6: Water use efficiency of cabbage under different fertigation levels (Pooled)

Treatment	Water applied (mm)	Total water applied (mm)*	Yield (q ha ⁻¹)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (q ha-cm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
F ₁ (75% RDF)	330.16	330.16	327.13	0.991	9.91	99.08
F ₂ (100% RDF)	330.16	330.16	358.47	1.086	10.86	108.58
F ₃ (125% RDF)	330.16	330.16	365.61	1.107	11.07	110.74
Mean	330.16	330.16	350.40	1.06	10.61	106.13

*There was no rainfall during both growing seasons

The influence of irrigation and fertigation levels on water use efficiency of cabbage during first season, second season and in pooled results is furnished in Table 7, Table 8 and Table 9, respectively and depicted in Fig. 1, Fig. 2 and Fig. 3, respectively. It is evident from the Tables that the highest

WUE was recorded in treatment combination I₁F₃ (174.75, 154.46 and 164.79 kg ha-mm⁻¹) followed by I₁F₂ (168.54, 148.57 and 158.74 kg ha-mm⁻¹). The lowest WUE of (74.16, 65.71 and 70.02 kg ha-mm⁻¹) was recorded in I₅F₁ during 2016-17, 2017-18 and in pooled, respectively.

Table 7: Water use efficiency of cabbage under different treatment combinations (2016-2017)

Treatment	Yield (q ha ⁻¹)	Water applied (mm)	Total water use (mm)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
I ₁ F ₁	259.97	168.13	168.13	1.546	154.62
I ₁ F ₂	283.37	168.13	168.13	1.685	168.54
I ₁ F ₃	293.80	168.13	168.13	1.747	174.75
I ₂ F ₁	314.43	252.20	252.20	1.246	124.67
I ₂ F ₂	362.93	252.20	252.20	1.439	143.91
I ₂ F ₃	363.03	252.20	252.20	1.439	143.95
I ₃ F ₁	395.80	336.26	336.26	1.177	117.71
I ₃ F ₂	445.13	336.26	336.26	1.323	132.38
I ₃ F ₃	438.17	336.26	336.26	1.303	130.31
I ₄ F ₁	411.20	420.33	420.33	0.978	97.83
I ₄ F ₂	448.63	420.33	420.33	1.067	106.73
I ₄ F ₃	456.53	420.33	420.33	1.086	108.61
I ₅ F ₁	374.07	504.39	504.39	0.741	74.16
I ₅ F ₂	385.03	504.39	504.39	0.763	76.34
I ₅ F ₃	405.33	504.39	504.39	0.605	80.36

Table 8: Water use efficiency of cabbage under different treatment combinations (2017- 2018)

Treatment	Yield (q ha ⁻¹)	Water applied (mm)	Total water use (mm)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
I ₁ F ₁	219.59	162.02	162.02	1.355	135.53
I ₁ F ₂	240.71	162.02	162.02	1.486	148.57
I ₁ F ₃	250.25	162.02	162.02	1.545	154.46
I ₂ F ₁	285.46	243.04	243.04	1.175	117.45
I ₂ F ₂	293.60	243.04	243.04	1.208	120.80
I ₂ F ₃	309.50	243.04	243.04	1.273	127.35
I ₃ F ₁	337.45	324.05	324.05	1.041	104.14
I ₃ F ₂	395.38	324.05	324.05	1.220	122.01
I ₃ F ₃	381.60	324.05	324.05	1.178	117.76
I ₄ F ₁	353.87	405.06	405.06	0.874	87.25
I ₄ F ₂	398.45	405.06	405.06	0.984	98.24
I ₄ F ₃	407.62	405.06	405.06	1.006	100.50
I ₅ F ₁	319.42	486.07	486.07	0.657	65.71
I ₅ F ₂	331.51	486.07	486.07	0.682	68.20
I ₅ F ₃	350.32	486.07	486.07	0.721	72.07

Table 9: Water use efficiency of cabbage under different treatment combinations (Pooled)

Treatment	Yield (q ha ⁻¹)	Water applied (mm)	Total water use (mm)	Water use efficiency (q ha-mm ⁻¹)	Water use efficiency (kg ha-mm ⁻¹)
I ₁ F ₁	239.78	165.08	165.08	1.453	145.26
I ₁ F ₂	262.04	165.08	165.08	1.587	158.74
I ₁ F ₃	272.02	165.08	165.08	1.648	164.79
I ₂ F ₁	299.94	247.62	247.62	1.211	121.13
I ₂ F ₂	328.26	247.62	247.62	1.326	132.57
I ₂ F ₃	336.26	247.62	247.62	1.358	135.80
I ₃ F ₁	366.62	330.16	330.16	1.110	111.04
I ₃ F ₂	420.26	330.16	330.16	1.273	127.29
I ₃ F ₃	409.89	330.16	330.16	1.242	124.15
I ₄ F ₁	382.54	412.70	412.70	0.927	92.63
I ₄ F ₂	423.54	412.70	412.70	1.026	102.56
I ₄ F ₃	432.07	412.70	412.70	1.047	104.63
I ₅ F ₁	346.75	495.23	495.23	0.700	70.02
I ₅ F ₂	358.27	495.23	495.23	0.723	72.34
I ₅ F ₃	377.82	495.23	495.23	0.763	76.29

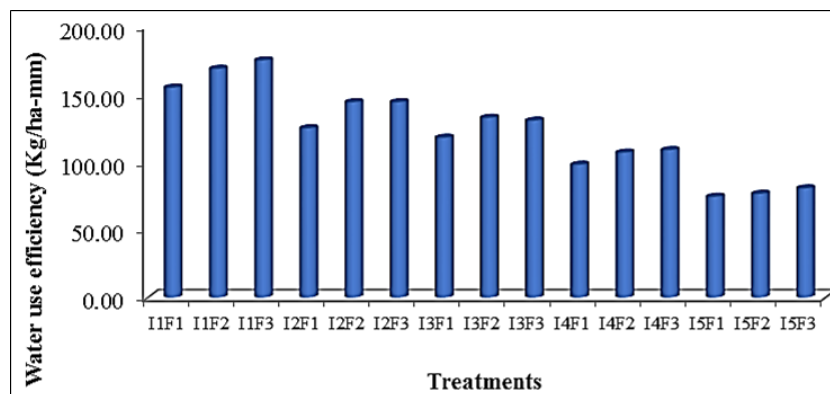


Fig 1: Water use efficiency ($\text{kg ha}^{-1}\text{mm}^{-1}$) of cabbage under different treatment combinations (2016-2017)

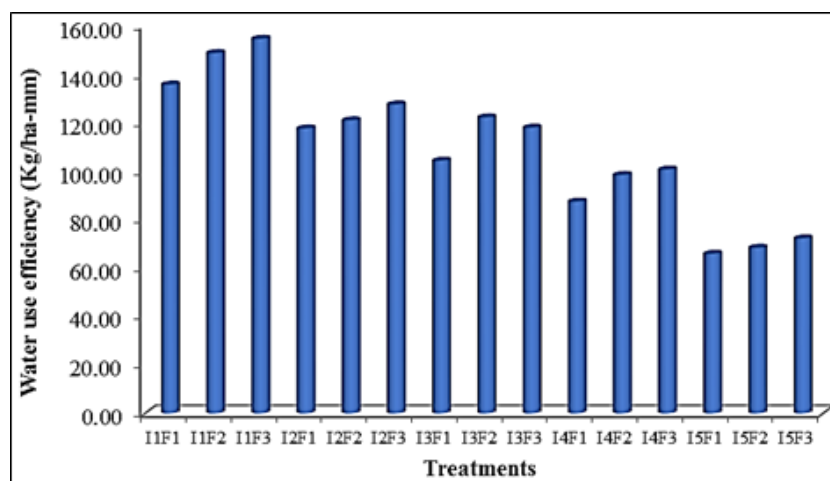


Fig 2: Water use efficiency ($\text{kg ha}^{-1}\text{mm}^{-1}$) of cabbage under different treatment combinations (2017-2018)

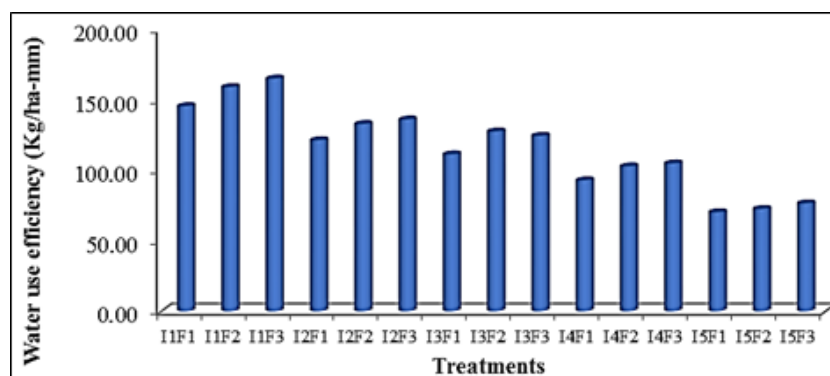


Fig 3: Water use efficiency ($\text{kg ha}^{-1}\text{mm}^{-1}$) of cabbage under different treatment combinations (Pooled)

Conclusions

The maximum water use by cabbage during 2016-17, 2017-18 and pooled average under irrigation level at 1.2 ETc (I_5) was turned out to be 504.39, 486.07 and 495.23 mm, respectively. The minimum water use of cabbage ranged between 162.02 to 168.13 mm under irrigation at 0.4 ETc (I_1). Increase in irrigation level decreased the water use efficiency (WUE). Consequently, irrigation level 0.4 ETc (I_1) resulted to give the highest WUE of 165.97, 146.186 and 156.26 $\text{kg ha}^{-1}\text{mm}^{-1}$ during 2016-17, 2017-18 and in pooled results whereas the lowest WUE of 76.95, 68.66 and 72.89 $\text{kg ha}^{-1}\text{mm}^{-1}$ was observed under 1.2 ETc (I_5) irrigation level. Although fertigation level did not have direct effect on WUE, the fertigation with 125% RDF (F_3) gave the highest water use efficiency of 116.39, 104.88 and 110.74 $\text{kg ha}^{-1}\text{mm}^{-1}$ by producing higher curd yields during 2016-17, 2017-18 and in pooled, respectively. The lowest WUE was noticed under 75% RDF (F_1) because of lower curd yields. The highest

WUE was recorded in treatment combination I_1F_3 followed by I_1F_2 . In order to have higher WUE, drip irrigation system should be scheduled at an alternate day with 0.4 ETc depth of irrigation whereas for the better yields and higher water use efficiency of cabbage drip irrigation be scheduled at 0.4 ETc depth of water with 125% of RDF.

References

- Chatterjee R. Physiological Attributes of Cabbage (*Brassica oleracea*) as Influenced by Different Sources of Nutrients under Eastern Himalayan Region. Research Journal of Agricultural Sciences 2010;1(4):318-321.
- Daleshwar Rajak, Mittal HK, Bhakar SR, Lakhawat SS, Jain HK, Yadav KK. Effect of drip irrigation and fertigation levels on growth, yield and water use efficiency of cabbage. Green Farming 2015;6(6):1287-1291.

3. Gupta AJ, Feza Ahmad N, Bhat FN. Studies on yield, quality, water and fertilizer use efficiency of capsicum under drip irrigation and fertigation. *Indian Journal of Horticulture* 2010;67(2):213-218.
4. Kashyap S, Phookan DP, Baruah P, Bhuyan P. Effect of drip irrigation and polythene mulch on yield, quality, water-use efficiency and economics of broccoli production. *Indian Journal of Horticulture* 2009;66(3):323-325.
5. Kumar P, Sahu RL. Effect of irrigation and fertigation levels on cabbage (*Brassica oleracea* var. *Capitata* L.) *Progressive Horticulture* 2013;45(2):366-372.
6. Mallareddy M, Padmaja B. Productivity and water use efficiency of no-till winter (rabi) maize (*Zea mays*) as influenced by drip-fertigation. *Indian Journal of Agronomy* 2014;59(1):96-100.