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Impact of irrigation and mulching on yield, water use efficiency and nutrient uptake of cucumber (*Cucumis sativus* L.) under polyhouse conditions

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Abstract
Investigation was taken up to assess the combined effects of drip irrigation and mulches on yield, water-use efficiency and nutrient uptake in cucumber. The treatments of the study comprised of different combinations of three drip irrigation levels (100, 80 and 60% of crop water requirement) and three mulches (white polyethylene sheet, black polyethylene sheet and no mulch). The yield of cucumber increased with the increasing amount of irrigation water in mulched treatment. Highest yield per plot (72.18 kg), yield per 1000 Sq. mt. (11.32 t) and yield per hectare (110.90 t ha^{-1}) was observed in the treatment consisting of 100% crop ET with white plastic mulch. The water use efficiency was highest in treatment consisting of drip irrigation at 60% crop ET with white plastic mulch (10.70 t $ha^{-1}cm^{-1}$). The nitrogen (48.12 kg ha^{-1}), phosphorus (10.36 kg ha^{-1}) and potassium (52.21 kg ha^{-1}) uptake was highest in treatment consisting of 100% crop ET with white plastic mulch. The study reveals that drip irrigation with mulch has an explicit role in increasing the yield and water productivity in cucumber.

Keywords: Drip irrigation, plastic mulching, polyhouse, water use efficiency and cucumber

Introduction
There is a need for efficient use of irrigation water for increasing agricultural production concomitant to the raise in population. The availability of irrigation water is emerging as a major constraint for agriculture. Hence, judicious use of available water resources through more efficient methods of water application like drip irrigation especially under conditions of protected cultivation has become a need, so as to enhance the yield and water use efficiency (Dunage *et al*., 2009) [4]. Cultivation of vegetables under protected conditions increases its productivity and quality, especially cucurbits. Naturally ventilated greenhouses are highly suitable for year round cultivation of parthenocarpic cucumber varieties. Drip irrigation meets the daily water requirement of each plant and maintains a high soil matric potential in the rhizosphere so as to reduce plant water stress (Nakayama and Bucks, 1986) [12]. Cucumber (*Cucumis sativus* L.) is an important vegetable belonging to the family cucurbitaceae. Cucumber is a highly basic vegetable which has tremendous economic importance as it reduces the acidity in the gastro intestinal tract due to consumption of acidic foods. The tender cucumber is consumed popularly as a salad. In view of the above facts, this study was taken up to determine the irrigation requirement of salad cucumber grown under naturally ventilated polyhouse.

Materials and Methods
The experiment was conducted in the naturally ventilated polyhouse of All India Coordinated Research Project (Plastic Engineering in Agriculture Systems and Environmental Management) fields at College of Agricultural Engineering, Raichur, University of Agricultural Sciences, Raichur. The design adopted was factorial RBD. The experiment consisted of two factors. Factor 1 consisted of irrigation levels (I) i.e., I_1: Drip irrigation at 60 percent of ET, I_2: drip irrigation at 80 percent of ET and I_3: drip irrigation at 100 percent of ET. Factor 2 consisted of mulching levels (M) i.e., M_1: mulching with white polythene sheet M_2: mulching with black

polythene sheet and M_3: without mulching (Control) The land inside the polyhouse was brought to fine tilth and raised beds of 1 m width, 15 m length and 15 cm height were prepared. A distance of 0.5 m was maintained in between the beds to facilitate the cultural operations such as spraying and harvesting. Drip laterals of 2 lph capacity, having the emitting point at every 50 cm were laid in the middle of the raised beds. The laterals were connected to the main line which were further connected to the pumping line. Screen filters were provided to prevent the impurities entering into the drip system. Separate valves were installed to each main line to regulate the water flow. White and Black LDPE sheets of 30 micron thickness were used to cover the beds as per the requirement of mulching treatments. After covering the beds with mulching sheet, 10 cm diameter holes were made on the sheet as per the treatment plan.

The first season crop was taken up during June, 2023-24 and the second season was taken up during June, 2024-25. The seeds were treated with trichoderma and one seed per hill were dibbled manually at 2-3 cm depth. Where the seeds failed to germinate, resowing was taken up after 5-6 days, so as to maintain the optimum plant density in each treatment. The recommended dose of fertilizers i.e., 60 kg N, 50 kg P and 80 kg K was applied through fertigation using water soluble fertilizers. The weight of fruits from tagged plants were recorded in each picking. Finally, yield from the total field in each picking were summed and average yield per plot was worked out and expressed in kg per plot. Total yield obtained from an area of 1000 Sq. mt. was computed and expressed in tonnes. Total yield obtained from an area of one hectare area was computed and expressed in t ha^{-1}. The WUE of each treatment was estimated by method suggested by Ram *et al*., (2013) [16] and the same was expressed in kg ha^{-1} cm^{-1}. The nutrient uptake by cucumber crop was estimated by taking their respective nutrient concentrations into consideration. The nutrient uptake was calculated using the following formula and was expressed in kg ha^{-1}.

$$\text{Nutrient uptake (kg ha}^{-1}) = \frac{\text{Nutrient concentration (\%) x Biomass (kg ha}^{-1})}{100}$$

The data were statistically analyzed by using two factorial experimental design. Wherever the results were significant, the critical difference at 5 percent level was worked out and presented. The data were analyzed by using 'OPSTAT' software.

Results and Discussion

Yield per plot

The data pertaining to yield per plot of cucumber is provided in Table 1. Among irrigation levels, 100 percent crop ET recorded significantly higher yield per plot (65.67 kg, 75.52 kg and 70.59 kg during 2023-24, 2024-25 and pooled data, respectively). Drip irrigation at 60% crop ET recorded lower yield per plot (57.67 kg, 58.74 kg and 58.20 kg during 2020-21, 2021-22 and pooled data, respectively). Among different mulching, maximum yield per plot was documented under white polythene mulch i.e., 63.37 kg, 69.58 kg and 66.47 kg during 2023-24, 2024-25 and pooled data, respectively. Whereas minimum yield per plot was documented under no mulch conditions i.e., 56.87 kg, 62.68 kg and 59.77 kg during 2023-24, 2024-25 and pooled data, respectively. When the interaction effect was noticed it was found that the yield per plot was maximum in treatment consisting of drip irrigation at 100% crop ET and white polythene mulch i.e., 67.85 kg, 76.52 kg and 72.20 kg during 2023-24, 2024-25 and pooled data, respectively. The yield per plot was minimum in treatment consisting of drip irrigation at 60% crop ET and un mulched condition i.e., 53.12 kg, 54.85 kg and 53.98 kg during 2023-24, 2024-25 and pooled data, respectively.

Availability of adequate moisture content in the soil might have increased various crop physiological processes, resulting in higher yield per plot. Better plant nutrient uptake and higher rates of photosynthesis resulted in more number of fruits and higher fruit weight. In addition to this, the combined influence of irrigation levels and mulching could have significantly influenced the fruit yield of cucumber under the protected structure. Fruit yield increases with higher irrigation levels. Irrigation level at 100% ET was found to be the best for producing higher fruit yield. Similar effect of irrigation levels was reported by Rincy *et al.* (2017) [17], Dillip Kumar *et al.* (2018) [3], Om Prakash *et al.* (2018) [13], Pawar *et al.* (2018) [14] and Karki *et al.* (2020) [8] in cucumber.

Yield per 1000 Sq. mt.

The data pertaining to yield per 1000 Sq.mt. of cucumber is provided in table 1. Among irrigation levels, 100 percent crop ET recorded significantly higher yield per 1000 Sq.mt. (10.26 t, 11.78 t and 11.02 t during 2023-24, 2024-25 and pooled data, respectively). Drip irrigation at 60% crop ET recorded lower yield per 1000 square meter (9.03 t, 9.19 t and 9.11 t during 2023-24, 2024-25 and pooled data, respectively). Among mulches maximum yield per 1000 Sq. mt. was documented under white polythene mulch i.e., 9.96 t, 10.92 t and 10.44 t during 2023-24, 2024-25 and pooled data, respectively. Whereas minimum yield per 1000 Sq.mt. was documented under no mulch conditions i.e., 8.96 t, 9.95 t and 9.40 t during 2023-24, 2024-25 and pooled data, respectively. When the interaction effect was noticed it was found that the yield per 1000 Sq. mt. was maximum in treatment consisting of drip irrigation at 100% crop ET and white polythene mulch i.e., 10.65 t, 11.98 t and 11.32 t during 2023-24, 2024-25 and pooled data, respectively. The yield per 1000 square meter was minimum in treatment consisting of drip irrigation at 60% crop ET and unmulched condition i.e., 8.38 t, 8.65 t and 8.51 t during 2023-24, 2024-25 and pooled data, respectively.

Total yield per hectare

The data pertaining to total yield per hectare of cucumber is provided in Table 1. Among irrigation levels 100 percent crop ET recorded significantly higher total yield per hectare (99.35 t ha^{-1}, 114.55 t ha^{-1} and 106.95 t ha^{-1} during 2023-24,2024-25 and pooled data, respectively). Drip irrigation at 60% crop ET recorded lower total yield per hectare (87.05 t ha^{-1}, 88.65 t ha^{-1} and 87.85 t ha^{-1} during 2023-24,2024-25 and pooled data, respectively). Among mulching, maximum total yield per hectare was documented under white polythene mulch i.e., 97.35 t ha^{-1}, 106.95 t ha^{-1} and 102.15 t ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. Whereas minimum total yield per hectare was documented under no mulch conditions i.e., 87.35 t ha^{-1},96.25 t ha^{-1} and 91.80 t ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. When the interaction effect was noticed it was found that the total yield per hectare was maximum in treatment consisting of drip irrigation at 100% crop ET and white polythene mulch i.e., 104.25 t ha^{-1},117.55 t ha^{-1} and 110.90 t ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. The total yield per hectare was minimum in treatment consisting of drip irrigation at 60% crop ET and un mulched condition i.e.,81.55 t ha^{-1}, 84.25 t ha^{-1} and 82.90 t ha^{-1} during 2023-24,2024-25 and pooled data, respectively.

Table 1: Effect of drip irrigation and plastic mulching on yield per plot, yield per 1000 Sq. mt. and yield per hectare

Treatment details	Yield per plot (kg)			Yield per 1000 Sq. mt. (t)			Yield (t ha^{-1})		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
Irrigation levels (I)									
I_1	57.67	58.74	58.20	9.03	9.19	9.11	87.05	88.65	87.85
I_2	62.64	68.27	65.45	9.79	10.66	10.22	94.65	103.35	99.00
I_3	65.67	75.52	70.59	10.26	11.78	11.02	99.35	114.55	106.95
S.Em. ±	0.89	1.66	1.27	0.34	0.47	0.40	1.25	2.55	1.90
CD @ 5%	2.15	4.48	3.31	0.54	0.90	0.72	3.25	6.85	5.05
Mulches (M)									
M_1	63.37	69.58	66.47	9.96	10.92	10.44	97.35	106.95	102.15
M_2	62.74	67.27	65.01	9.86	10.56	10.21	96.35	103.35	99.85
M_3	56.87	62.68	59.775	8.96	9.85	9.40	87.35	96.25	91.8
S.Em. ±	0.89	1.66	1.27	0.34	0.47	0.40	1.15	2.45	1.80
CD @ 5%	2.15	4.48	3.31	0.54	0.90	0.72	3.15	6.75	4.95
Interaction (I x M)									
I_1M_1	58.32	60.92	59.62	9.18	9.58	9.38	89.55	93.55	91.55
I_1M_2	58.58	57.45	58.01	9.22	9.05	9.13	89.95	88.25	89.1
I_1M_3	53.12	54.85	53.98	8.38	8.65	8.51	81.55	84.25	82.9
I_2M_1	63.95	71.32	67.63	10.05	11.18	10.62	98.25	109.55	103.9
I_2M_2	63.52	68.72	66.12	9.98	10.78	10.38	97.55	105.55	101.55
I_2M_3	57.45	61.78	59.61	9.05	9.72	9.39	88.25	94.95	91.60
I_3M_1	67.85	76.52	72.18	10.65	11.98	11.32	104.25	117.55	110.90
I_3M_2	66.12	75.65	70.88	10.38	11.85	11.12	101.55	116.25	108.90
I_3M_3	60.05	71.40	65.72	9.45	11.2	10.33	92.25	109.75	101.00
S.Em. ±	1.35	2.70	2.02	0.41	0.63	0.52	1.94	4.05	2.99
CD @ 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

I_1:Drip irrigation @ 60% ET	M_1:White polythene mulch
I_2:Drip irrigation @ 80% ET	M_2:Black polythene mulch
I_3:Drip irrigation @100%ET	M_3:Without mulching (Control)

Higher soil moisture condition under mulched treatment and better control of weeds when compared to unmulched plots resulted in good vegetative and yield parameters. Mulch is a covering placed over the soil around the plants. Plastic mulch on the surface of the soil causes change in the microclimatic conditions around the plants. This results in moisture conservation, less soil compaction of soil and higher CO_2 levels around plants (Mane and Umrani, 1981) [10]. Mulching is an effective method of manipulating the crop growing environment to increase crop yield and improve product quality by controlling soil temperature, retaining soil moisture and reducing soil evaporation Chakraborty *et al.* (2008) [2]. These results are in concurrance with the results documented by Rincy *et al.* (2017) [17], Dillip Kumar *et al.* (2018) [3], Om Prakash *et al.* (2018) [13], Pawar *et al.* (2018) [14] and Karki *et al.* (2020) [8] in cucumber.

Table 2: Effect of drip irrigation and plastic mulching on water use efficiency in cucumber

Treatments	Water use efficiency (t ha^{-1}cm^{-1})		
	2023-24	2024-25	Pooled
Irrigation treatments (I)			
I_1	11.46	9.19	10.33
I_2	9.59	8.16	8.88
I_3	8.19	7.35	7.77
S.Em. ±	0.09	0.17	0.15
CD @ 5%	0.26	0.50	0.44
Mulching treatments (M)			
M_1	10.07	8.58	9.33
M_2	10.00	8.30	9.15
M_3	9.16	7.81	8.49
S.Em. ±	0.09	0.17	0.15
CD @ 5%	0.26	0.50	0.44
Interactions (I x M)			
I_1M_1	11.76	9.64	10.70
I_1M_2	11.81	9.15	10.48
I_1M_3	10.80	8.78	9.79
I_2M_1	9.91	8.59	9.25
I_2M_2	9.85	8.31	9.08
I_2M_3	9.00	7.57	8.29
I_3M_1	8.54	7.52	8.03
I_3M_2	8.35	7.44	7.90
I_3M_3	7.67	7.08	7.38
S.Em. ±	0.15	0.29	0.25
CD @ 5%	NS	NS	NS

I_1:Drip irrigation @ 60% ET	M_1:White polythene mulch
I_2:Drip irrigation @ 80% ET	M_2:Black polythene mulch
I_3:Drip irrigation @100%ET	M_3:Without mulching (Control)

Water use efficiency

The data pertaining to water use efficiency of cucumber is provided in table 2. Among irrigation levels, 60 percent crop ET recorded significantly higher water use efficiency (11.46, 9.19 and 10.33 t ha^{-1}cm^{-1} during 2023-24, 2024-25 and pooled data, respectively). Drip irrigation at 100% crop ET recorded lower water use efficiency (8.19, 7.35 and7.77 t ha^{-1}cm^{-1} during 2023-24, 2024-25 and pooled data, respectively). Among three levels of mulching maximum water use efficiency was documented under white polythene mulch i.e., 10.07, 8.58 and 9.33 t ha^{-1}cm^{-1} during 2023-24, 2024-25 and pooled data, respectively. Whereas minimum water use efficiency was documented under no mulch conditions i.e., 9.16, 7.81 and 8.49 t ha^{-1}cm^{-1} during 2023-24, 2024-25 and pooled data, respectively. When the interaction effect was noticed it was found that the water use efficiency was highest in treatment consisting of drip irrigation at 60% crop ET and white polythene mulch i.e., 11.76, 9.64 and 10.70 t ha^{-1}cm^{-1} during 2023-24, 2024-25 and pooled data, respectively. The water use efficiency was lowest in treatment consisting of drip irrigation at 100% crop ET and un mulched condition i.e., 7.67, 7.08 and 7.38 t ha^{-1}cm^{-1} during 2023-24, 2024-25 and pooled data, respectively. Drip irrigation significantly increased the crop yield of cucumber and there by improved WUE due to consumption of less water. However, integrated use of drip irrigation and plastic mulch was more appropriate and profitable. Therefore, drip irrigation in combination with plastic mulch was found to be more effective in improving WUE and increasing crop yield of cucumber. Mulches reduced the rate of water loss through evaporation from soil surface. So, the soil-water-plant relationship was better in low irrigation regime than high irrigation regime that might have helped to produce higher yield and thereby higher WUE. In general, the trends for the WUE related to the total water use showed that lower the amount of water use, higher was the WUE. Besides, low irrigation regime reduced deep percolation and increased water use from soil root zone (Ayars *et al.*, 1999) [1]. These results are also in agreement with the results of Jain *et al.* (2000) [7], who concluded that drip irrigation and plastic mulch markedly affects applied water and water use efficiency. The percent of water use reduction was 65%, 64% and 57% for the white colour mulched drip irrigation, black colour mulched drip irrigation and no mulch drip irrigation, respectively compared to the furrow surface irrigation. Dunage *et al*. (2009) [4], Huimeng *et al*. (2017) [6], Parameshwara Reddy *et al*. (2018) [15] and Yaghi *et al*. (2013) [18], recorded similar results in cucumber.

Nutrient uptake

The data pertaining to nutrient uptake of cucumber is provided in Table 3. Among irrigation levels, 60 percent crop ET recorded significantly higher nitrogen uptake (46.56, 47.05 and 46.80 kg ha^{-1} during 2023-24, 2024-25and pooled data, respectively). Nitrogen uptake at 100% crop ET recorded lowest value (37.45, 34.29 and 35.87 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively). Among three levels of mulching maximum uptake of nitrogen was documented under white polythene mulch i.e., 48.44, 47.96 and 48.20 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. Whereas minimum nitrogen uptake was documented under no mulch conditions i.e., 40.94, 42.77 and 41.85 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. When the interaction effect was noticed it was found that the uptake of nitrogen was highest in treatment consisting of drip irrigation at 60% crop ET and white polythene mulch i.e., 49.77, 46.47 and 48.12 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. The uptake of nitrogen was lowest in treatment consisting of drip irrigation at 100% crop ET and un mulched condition i.e., 35.05, 33.72 and 34.38 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively.

Among irrigation levels, 60 percent crop ET recorded significantly higher phosporous uptake (9.25, 9.34 and 9.29 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively). The phosporous uptake at 100% crop ET recorded lowest value (6.95, 6.54 and 6.74 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively). Among three levels of mulching maximum uptake of phosporous was documented under white polythene mulch i.e., 10.15, 9.75 and 9.95 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. Whereas minimum phosporous uptake was documented under no mulch conditions i.e., 8.54, 8.79 and 8.66 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. When the interaction effect was noticed it was found that the uptake of phosporous was highest in treatment consisting of drip irrigation at 60% crop ET and white polythene mulch i.e.,10.44, 10.29 and 10.36 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. The uptake of phosporous was lowest in treatment consisting of drip irrigation at 100% crop ET and un mulched condition i.e.,7.15, 6.87 and 7.01 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively.

Among irrigation levels, 60 percent crop ET recorded significantly higher potasium uptake (49.22, 49.45 and 49.33 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively). potasium uptake at 100% crop ET recorded lowest value (46.13, 47.54 and 46.83 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively). Among three levels of mulching maximum uptake of potasium was documented under white polythene mulch i.e.,51.66, 50.22 and 50.94 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. Whereas minimum potasium uptake was documented under no mulch conditions i.e.,46.56, 45.23 and 45.89 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. When the interaction effect was noticed it was found that the uptake of potasium was highest in treatment consisting of drip irrigation at 60% crop ET and white polythene mulch i.e.,52.67, 51.76 and 52.21 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively. The uptake of potasium was lowest in treatment consisting of drip irrigation at 100% crop ET and un mulched condition i.e., 42.65, 42.34 and 42.49 kg ha^{-1} during 2023-24, 2024-25 and pooled data, respectively.

Fertigation allows nutrient placement directly to the plant root zone, thus facilitating its uptake by the plants. Plastic mulch application on the surface of soil ameliorates the microclimatic conditions around the plant root zone. This results in moisture conservation, less soil compaction and higher CO_2 levels around the plants. (Mane and umrani, 1981) [10]. Optimal root zone temperature improves the root functioning including proper uptake of nutrients (EL-Shinawy, 1997) [5]. The solar radiations entering the white colour plastic mulch reaches the raised beds, but very little amount of solar radiation goes back to the environment and this slightly improves the soil temperature underneath. the white mulch. Thus, these could be the reasons for irrigation and mulch treatment exhibiting higher nutrient uptake. Similar trend was reported by Kishor *et al*., (2018) [9] in tomato and Manjunatha *et al*., (2022) [11] in chrysanthemum.

Table 3: Effect of drip irrigation and plastic mulching on nutrient uptake in cucumber

Treatment details	N uptake (kg ha^{-1})			P uptake (kg ha^{-1})			K uptake (kg ha^{-1})		
	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled	2023-24	2024-25	Pooled
Irrigation Levels (I)									
I_1	37.45	34.29	35.87	6.95	6.54	6.74	46.13	47.54	46.83
I_2	41.80	40.78	41.29	8.05	7.92	7.98	47.92	48.22	48.07
I_3	46.56	47.05	46.80	9.25	9.34	9.29	49.22	49.45	49.33
S.Em. ±	1.23	1.40	1.32	0.09	0.22	0.15	2.20	1.00	1.65
CD @ 5%	3.66	4.20	3.92	0.29	0.65	0.47	6.50	3.10	4.90
Mulching treatment (M)									
M_1	48.44	47.96	48.20	10.15	9.75	9.95	51.66	50.22	50.94
M_2	42.73	43.45	43.09	9.35	9.05	9.20	49.54	48.67	49.10
M_3	40.94	42.77	41.85	8.54	8.79	8.66	46.56	45.23	45.89
S.Em. ±	0.76	0.87	0.81	0.10	0.18	0.16	1.43	1.26	1.36
CD @ 5%	2.25	2.58	2.41	0.28	0.45	0.51	4.33	3.52	3.94
Interaction (I x M)									
I_1M_1	36.85	38.92	37.88	8.25	7.98	8.11	47.66	48.24	47.95
I_1M_2	35.27	34.68	34.97	7.65	7.54	7.59	46.78	46.25	46.51
I_1M_3	35.05	33.72	34.38	7.15	6.87	7.01	42.65	42.34	42.49
I_2M_1	40.54	39.27	39.90	8.46	8.22	8.34	44.95	44.65	44.80
I_2M_2	37.68	36.15	36.91	7.95	7.75	7.85	43.21	42.97	43.09
I_2M_3	35.44	35.95	35.69	7.35	7.12	7.23	44.34	44.08	44.21
I_3M_1	49.77	46.47	48.12	10.44	10.29	10.36	52.67	51.76	52.21
I_3M_2	44.76	44.95	44.85	9.72	9.85	9.78	50.66	50.75	50.70
I_3M_3	46.92	45.05	45.98	9.25	9.34	9.29	48.24	49.85	49.04
S.Em. ±	1.23	1.32	1.29	0.13	0.17	0.16	1.41	1.38	1.40
CD @ 5%	3.76	4.02	3.91	0.40	0.48	0.45	4.23	4.16	4.20

I_1:Drip irrigation @ 60% ET	M_1:White polythene mulch
I_2:Drip irrigation @ 80% ET	M_2:Black polythene mulch
I_3:Drip irrigation @100%ET	M_3:Without mulching (Control)

Conclusion

The yield per plot, yield per 1000 Sq. mt. and yield per ha was higher with drip irrigation at 100% crop ET and white polythene mulch. The water use efficiency was highest in treatment consisting of drip irrigation at 60% crop ET with white polythene. The nutrient uptake (N,P and K) was highest with drip irrigation at 100% crop ET and white polythene mulch

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