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Short communication

Effect of drip irrigation and polythene mulch on the fruit yield and quality parameters of mango (*Mangifera indica* L.)

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ABSTRACT

A field experiment was carried out at Horticultural Research Farm, Precision Farming Development Centre, Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during the year 2009-2010 in Randomized Block Design with three replications and ten treatment combinations (100%, 80%, 60%, and 40% water through drip irrigation system with and without polythene mulch + Basin irrigation with and without mulch). Fruits characters, yield and yield attributing parameter were higher under drip irrigation with 0.6 V volume of water + polythene mulch (T8) and the same characters were lowest under control (Basin irrigation with V- volume of water). Application of black plastic mulch with drip irrigation system can conserve moisture, check the growth of weeds and improve the fruit yield and quality. Water use efficiency was higher under drip irrigation with 0.6 V volume of water + polythene mulch and low under basin irrigation with V volume of water. The net income and benefit cost ratio was also higher under the treatment T_8 as compared to surface method of irrigation.

Key words: Mango, drip irrigation, mulching

Mango (*Mangifera indica* L.) is one of the most important tropical fruits of India. It is known as king of fruits. It is the premier and choicest fruit of India. In Mango production, India ranks first in the world with respect to area (2.20 m.ha) and production (13.79 m.t) with productivity of 6.3 t/ha (Indian horticulture Database, 2008). Mango shares 38 % in area and 21.7% in production of total fruit production of India and this offers bright prospects for boosting the exports.

Chhattisgarh is one of the important mango growing States of India. Most of the area of Chhattisgarh is rainfed and has an immense potential to improve the mango production. Under Chhattisgarh conditions, North Indian varieties mature 15 to 20 days earlier, which results in better market price. Most of the areas are under mango grown as rainfed; it is therefore proposed to find out the optimum water requirement under drip irrigation for mango and to evaluate its effect on fruit yield & quality. Increasing demand for highly efficient irrigation system calls for the use of drip irrigation, which has also been found suitable under adverse conditions of climate, soil and irrigation water (Singh *et al.*, 1989). Keeping the above in mind, the study was carried out to understand the response of mango to drip irrigation with and without polythene mulch.

Layout of Experiment

The study was a part of field experiment designed to compare drip and conventional method of basin irrigation at Precision Farming Development Centre, Department of Horticulture, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh during the year 2009-2010. The experiment consisted of using treatments *i.e.*, 100%, 80%, 60% and 40% of water (percentage in respect to water requirement of crop) through drip irrigation system having with and without plastic mulch (100 micron) and a control. The distance between lateral-to-lateral was fixed as 10 m and four emitters of different LPH in each plant is placed according to recommended spacing of mango plants (10 m row to row and plant to plant spacing). Experiment was conducted on fifteen years old trees of mango cultivar Dashehari. The treatments were replicated three times in randomized block design. The soil of experimental field was clay-loam which is locally known as *Dorsa* in the region in which available N, P & K were 321.27, 30.83 and 200.02 kg/ha and soil pH was 7.31. The fertilizer doses of N: P: K 200:200:200 (g/tree/year) was applied through irrigation water (fertigation) in two split doses whereas, for surface irrigation system the fertilizer was sprayed after mixing with water in two split doses. Standard cultural practices were also followed for mango cultivation. The observations on yield and physico-chemical parameters of mango were recorded to know the effect of drip irrigation and mulch. The details of ten treatments are given below:

T_1: Basin irrigation with 1.0 V-volume of water (control)

T_2: Basin irrigation with 1.0 V-volume of water + polythene mulch

T_3: Drip irrigation with 1.0 V-volume of water

T_4: Drip irrigation with 1.0 V-volume of water + polythene mulch

T_5: Drip irrigation with 0.8 V-volume of water

T_6: Drip irrigation with 0.8 V-volume of water + polythene mulch

T_7: Drip irrigation with 0.6 V-volume of water

T_8: Drip irrigation with 0.6 V-volume of water + polythene mulch

T_9: Drip irrigation with 0.4 V-volume of water

T_{10}: Drip irrigation with 0.4 V-volume of water + polythene mulch

Where V = Irrigation water requirement

Estimation of Emission Uniformity

Field emission uniformity takes into account the uniformity of emitter discharge through the system. Keller and Karmeli (1975) defined the emission uniformity as:

$$\text{Emission Uniformity} = \frac{\text{Average of lowest ¼ flow}}{\text{Average of all emitter flow}} \times 100$$

Estimation of Irrigation Water Requirement (V)

The depth of irrigation water for different treatments was calculated depending on the potential evaporation. Reference crop evapotranspiration (ET_0) was calculated using Modified Penman Method (Doorenbos, and Pruitt, 1977). The crop co-efficient (Kc) for different growth stages of mango was selected. The actual crop evapotranspiration was estimated by multiplying the reference crop evapotranspiration, crop co-efficient, area under each plant and wetting fraction.

The quantity of water to be applied was estimated by using the following equation:

$$V = ETo \times Kc \times Ap - (Ap \times Re)$$

Where,

V = Net depth of irrigation (litre/day/plant)

ETo = Reference crop evapotranspiration (mm/day)

Kc = Crop co-efficient

Ap = A x W = Effective area to be irrigated (Sq.m)

A = Area allocated to each plant, 36 sqm apprx.

W = Wetting fraction (0.3-0.5 for fruit crop)

Re = Effective rainfall (mm/day).

Drip irrigation was scheduled on alternate days; hence total quantity of water delivered was cumulative water requirement of two days minus effective rainfall (if rain occurred). The duration of delivery of water to each treatment was controlled with the help of gate valves provided at the inlet of each lateral. In case of basin irrigation, irrigation was scheduled at weekly interval. The cumulative depth of water required for seven days was estimated and supplied to each plant. The water (through surface method of irrigation) was directly applied in the basin with the help of PVC pipes.

Benefit-Cost Analysis

Benefit-cost analysis was carried out to determine the economic feasibility of using the drip irrigation. The interest rate and repair and maintenance cost of the system were 12% and 1% per annum of the fixed cost respectively. The useful life of drip system was considered to be 8 years. The cost of cultivation includes expenses incurred in field preparation, cost of grafted plants, fertilizer, weeding, crop protection, irrigation water and harvesting charges. The income from produce was estimated using prevailing average market price as Rs. 2000 /quintal for drip irrigated with polythene mulch, Rs. 1500/ quintal for drip irrigated without mulch and Rs. 1200/ quintal for surface irrigated, the difference in rates was due to better quality of produce found through drip with mulch as compared to without mulch and surface irrigation. The benefit–cost ratio, from mango cultivation over 1 ha was estimated. The data were analysed statistically as per standard procedure.

Fruit yield and quality

Data on yield with different irrigation treatments are presented in Table –1. Drip irrigation with 60 % V-volume of water + mulch (T_8) recorded the maximum yield (59.92 q/ha) as compared to other treatments and the yield was lowest in control (26.95 q/ha). The yield

Table 1. Effect of irrigation levels on the yield and yield parameters of mango

Treatments	Water applied (cm)	Length of fruits (cm)	Breadth of fruits (cm)	No. of fruits/ plant	Av. Fruit Weight(g)	Yield (q/ha)	Increase in yield (%)	Water use efficiency (q/ha-cm)	Emission Uniformity(%)
T_1	27.50	6.81	4.53	194.31	138.70	26.95	-	0.98	85.10
T_2	27.28	6.95	4.95	222.67	142.15	31.65	17.43	1.16	85.25
T_3	26.32	6.98	4.04	360.27	125.68	45.27	67.99	1.72	87.24
T_4	25.67	8.71	5.13	293.14	153.25	44.92	66.60	1.75	90.25
T_5	23.95	7.07	4.68	278.71	146.12	40.72	51.12	1.70	90.80
T_6	23.12	8.82	5.24	328.53	161.18	52.95	96.47	2.29	93.12
T_7	23.32	8.01	4.90	239.30	148.19	35.46	31.53	1.52	92.72
T_8	18.67	8.89	5.82	366.17	163.65	59.92	122.26	3.21	95.35
T_9	25.70	8.14	4.45	225.23	141.55	31.88	18.27	1.24	91.43
T_{10}	23.09	8.04	4.85	262.08	145.39	38.10	41.37	1.65	93.40
CD at *(P=0.05)*	0.954	0.378	0.210	27.96	4.41	1.12	-	0.102	0.962

Table 2. Effect of irrigation levels on physico-chemical composition of fruits

Treatments	Pulp (%)	TSS (Brix)	Peel (%)	Stone (%)	Acidity (%)	Weed Control (%)
T_1	64.25	17.50	19.25	20.32	0.268	13.67
T_2	65.98	19.50	14.68	19.31	0.210	54.35
T_3	67.98	18.50	12.98	19.04	0.230	34.56
T_4	70.33	20.25	14.08	19.00	0.209	65.39
T_5	68.24	19.98	14.70	19.10	0.228	29.62
T_6	71.58	22.65	13.10	15.32	0.190	85.98
T_7	67.95	21.05	13.02	17.06	0.223	32.10
T_8	72.60	23.35	12.95	14.38	0.178	90.20
T_9	64.00	18.98	15.68	16.50	0.216	30.73
T_{10}	61.72	20.98	15.68	15.54	0.226	68.32
CD at *(P=0.05)*	1.42	0.840	0.903	0.945	NS	12.29

increase was 122.26% over control. This could be due to the water stress the plant has to undergo before the next irrigation. But in case of drip irrigation water is made available in the root zone there by reducing the water stress pressure directly near (Bankar *et al*, 1993).

The variation in water applied for different treatments was due to the variation in pan evaporation and rainfall pattern, as the quantity of water applied was based on pan evaporation. It was observed from the Table-1, that drip irrigation treatments with replenishing 60% of water requirement or the depth of water (18.67cm) given to the plant was optimum for the growth and fruit yield as compared to the surface irrigation. Water required for drip irrigation was lower than that of surface irrigation.

Water Use Efficiency

The irrigation water use efficiency for different treatments was computed from fruit yield and water applied (Table–1). The irrigation water use efficiency in drip irrigation treatments with 0.6 V-volume of water with polythene mulch was maximum (3.21 q/ha-cm) followed by drip irrigation with 0.4 V (1.75 q/ha-cm), 0.6V (2.29 q/ha-cm) and 0.8 V (1.65 q/ha-cm) volume of water. The water use efficiency was lowest in control treatment (0.98 q/ha-cm). The irrigation water use efficiencies of 60% water through drip with black polythene mulch was nearly 3.27 times the water use efficiencies of surface irrigation treatment. Srivastava *et al* (1999) reported that with the highest water application it recorded the lowest water use efficiency. The emission uniformity was highest under drip irrigation with 0.6 V-volume of water + polythene mulch (95.35%) and lowest in basin irrigation with V-volume of water (85.10%).

Fruit quality attributes

The TSS, pulp and moisture content were highest under drip irrigated treatment of 0.6 V volume of water with black polythene mulch and lowest in control. But the peel, stone and acidity were lowest in the same treatment and highest in control, which is better in reference to quality for any fruit crop. Patel and Patel (1998) reported that the increase in yield was mainly because of better growth, bigger size and more juice content in the fruits under drip-irrigated plants. Similarly the weed control percentage was higher under treatment T_8 (90.20%) and lowest in control (13.67%).

Economic-Feasibility

Maximum net returns of Rs. 88,709/ha with B: C ratio of 2.84 was recorded when mango crop were irrigated with 0.6 V-volume of water through drip irrigation + polythene mulch (Table–3). However, in drip irrigated polythene mulch treatments $T_{4,}$ T_6 and $T_{10,}$ the net returns of Rs. 58,709/ha, Rs. 74,769/ha and Rs. 45,069/ha were obtained with B: C ratio of 1.88, 2.40 and 1.45 respectively. While in case of surface irrigation without mulch the net return of Rs. 12,340/ha was lowest with B: C ratio of 0.61.

Table 3. Cost analysis of mango

S.No.	Particular/Treatment	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
1.	Fixed costa. Cost of system	-	-	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000
	b. Life (yrs.)	-	-	8	8	8	8	8	8	8	8
	c. Depreciation	-	-	3375	3375	3375	3375	3375	3375	3375	3375
	d. Interest cost@ 12 %	-	-	3240	3240	3240	3240	3240	3240	3240	3240
2.	Operation coste. Repair & Maintenance @ 1 %	-	-	2700	2700	2700	2700	2700	2700	2700	2700
3.	Total operational cost (Rs.)	-	-	9315	9315	9315	9315	9315	9315	9315	9315
4.	a. Cost of mulching	-	7816	-	7816	-	7816	-	7816	-	7816
	b. Cost of cultivation	14,000+6,000*	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000	14,000
5.	Total cost of cultivation (Rs.) 3+4(a+b)	20,000	21,816	23,315	31,131	23,315	31,131	23,315	31,131	23,315	31,131
6.	Yield (q/ha)	26.95	31.65	45.27	44.92	40.72	52.95	35.46	59.92	31.88	38.10
7.	Selling price (Rs./q.)	1200	1200	1500	2000	1500	2000	1500	2000	1500	2000
8.	Income from produce (Rs.)	32,340	37,980	67,905	89,840	61,080	1,05900	53,190	1,19,840	47,820	76,200
9.	Net Return (Rs.)	12,340	16,164	44,590	58,709	37,765	74,769	29,875	88,709	24,505	45,069
10.	B: C Ratio	0.61	0.74	1.91	1.88	1.62	2.40	1.28	2.84	1.05	1.45

* In surface irrigation without mulch labour charges are extra for weeding, fertilizer application etc.

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REFERENCES

Banker, M.C., Mane, M.C., Khade, K.K. and Kanjle, S.T. 1993. Comparative performance of drip vs conventional method of irrigation on banana. *Procs. All India Symposium on Sprinkler and drip irrigation*, 9-10 IEI: 89-92

Doorenbos, J. and Pruitt, W.O. 1977. Guidelines for predicting crop water requirements. FAO, Irrigation and Drainage, Paper no. 24, Rome, Italy

Keller, J. and Karmeli, D. 1975. Trickle irrigation design Rain Bird Sprinkler Manufacturing Company. California, USA

Patel, N.M. and Patel, M.M. 1998. Water requirement of pomegranate (*Punica granatum L.*) cv. Ganesh for better yield under resources limited situations. *National Seminar on new horizons in production and post harvest management of tropical and subtropical fruits*, Delhi, Dec. 8-9

Singh, S.D. and Singh, 1978. Value of drip irrigation compared with conventional irrigation for vegetable production in hot and arid climate. *Agron.*, **70** : 23-27

Singh, R.K., Sulieman, A.D. and Karim 1989. Movement of salt and water under trickle irrigation and its field evaluation. *J. Agric. Engg*., **26**: 49-51

Sivanappan, R.K. 1993. Increased production and income in banana crop through drip irrigation-a case study. Technical Journal, All India Symp. on Spriakla and drip irrigation IEI, 21 Jan: 105-106, 112

Srinivas, K. and Hedge, D.M. 1990. Drip irrigation studies in Banana. *Procs. XI International Congress*. pp. 151-157

Subramanian, P., Krishnaswamy, S. and Devasagayam, M.M. 1997. Studies on the evaluation of drip irrigation in comparison with surface irrigation in coconut. *South Ind. Hort*., **45**: 255-58

Srivastava, P.K., Parikh, M.M., Sawani, N.G. and Raman, S. 1999. Response of banana to drip irrigation, mulches and irrigation scheduling in South Gujarat. *Agril. Engg. Today*, **23** : 29-38

*Wolf, P.1982. Zwei Jahrzehnte Tropfbewasserungeiner Zwishenbilanz, Zeitshrift far, Bewasserung-swirtschaft, **17**: 3-16

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