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Short communication

Effect of *in situ* rainwater harvesting and mulching on growth, yield and fruit quality in mango var. Arka Neelachal Kesri in Eastern India

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ABSTRACT

A field study was conducted at Central Horticultural Experiment Station (ICAR-IIHR), Bhubaneswar, India, during 2007-2013 in a new mango orchard of the variety 'Arka Neelachal Kesri' at 5m x 5m spacing, to conserve rain-water and to enhance soil moisture availability during dry periods for augmenting plant growth and fruit production. Among the four *in situ* rain-water harvesting techniques (cup-and-plate, half-moon, full-moon, and trench) evaluated in combination with three types of mulch (no mulch, inorganic mulch, and organic mulch), the cup-and-plate system resulted in maximum annual increment in vegetative growth and fruit yield (4.67kg/plant), while, organic (paddy straw) and inorganic (black polythene, 100µ thickness) mulches improved vegetative growth, fruit yield and TSS in fruit significantly over no mulch.

Key words: Mango (*Mangifera indica* L.), Arka Neelachal Kesri, *in situ* rain-water harvesting, mulching

Though considered drought-hardy, mango (*Mangifera indica* L.) requires watering for orchard establishment and good fruiting, even in heavy rainfall zones like coastal Odisha, where soil moisture deficit occurs during February-May. *In situ* rain-water harvest by building trenches, bunds, circular basins, etc. can increase soil water content by reducing surface runoff (Panigrahi *et al*, 2008). Mulching conserves soil moisture and controls weeds (Lal *et al*, 2003). Therefore, the present study was undertaken to assess the effect of *in situ* rain-water harvesting structures and mulching on performance of the mango variety 'Arka Neelachal Kesri' under rain-fed conditions.

The experiment was conducted at ICAR-IIHR-Central Horticultural Experiment Station, Bhubaneswar, Odisha, during 2007-2013. The soil at the experimental site is red lateritic, with poor organic matter content (0.2%) and meagre water holding capacity. The orchard of 'Arka Neelachal Kesri' mango was developed *in situ*, on its own rootstock, by sowing seeds at 5m x 5m spacing with onset of monsoon in 2007, and top-grafting the seedlings so-raised a year later. The experiment was laid out in split-plot design, with 12 treatment combinations consisting of four *in situ* rain-water harvesting structures, viz., half-moon or semi-circular basin, full-moon or circular basin, cup-and-plate, and trench system as the main plot, and three levels of mulching (no mulch, organic mulch and inorganic mulch) as sub-plot treatments (Table 1) with five replications. The trees were maintained under rain-fed conditions from the inception of the experiment.

Initial growth parameters, i.e., plant height, canopy diameter, scion girth and primary girth, were recorded during November-December, 2009. Thereafter, annual increment in growth was noted for three consecutive years, from 2010 to 2012. Fruits were harvested at full maturity and observations were recorded on fruit yield and quality

Table 1. Treatment details with specification of *in situ* rain-water harvesting structures and measures of mulching

Treatment	Specification
Four *in situ* rain water harvesting structures as main plot treatments:	
Half-moon	Semi-circular basin at 1m distance from main trunk
Full-moon	Circular basin at 1m distance from main trunk
Cup-and-Plate	Circular pit of 0.5m width and 0.5m depth around the tree at 1m distance from main trunk
Trench	Trench of 2m length, 0.5m width and 0.5m depth at 1m distance from main trunk
Three levels of mulch as sub-plot treatments:	
No mulch	Without cover
Inorganic mulch	UV-stabilized black polythene (100µ thickness) around the tree at 1m radius
Organic mulch	10cm thick layer of paddy-straw around the tree at 1m radius

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Table 2. Effect of *in situ* rain-water harvesting and mulching on annual increase in vegetative growth in mango 'Arka Neelachal Kesri'

Treatment	Annual increase in vegetative growth															
	Plant height (cm)				Canopy diameter (cm)				Trunk girth (cm)				Primary girth (cm)			
	2010	2011	2012	Pooled	2010	2011	2012	Pooled	2010	2011	2012	Pooled	2010	2011	2012	Pooled
In situ rain-water harvesting structures:																
Half-moon	44.92	40.63	47.88	44.48	52.98	58.8	51.73	54.50	6.97	7.2	6.01	6.73	3.66	5.01	4.14	4.27
Full-moon	46.88	40.67	49.53	45.69	52.39	60.59	53.21	55.40	7.33	7.59	6.67	7.20	3.91	5.15	4.42	4.49
Cup-and-Plate	50.28	54.09	64.46	56.28	60.41	79.22	71.73	70.45	7.81	10.17	9.31	9.10	4.69	7.72	6.86	6.42
Trench	53.13	46.46	56.35	51.98	53.31	68.67	62.37	61.45	7.68	8.89	8.06	8.21	4.21	6.36	5.69	5.42
SE(m)±	2.38	2.29	2.13	1.05	5.06	2.03	2.59	1.55	0.29	0.37	0.36	0.18	0.35	0.38	0.32	0.16
CD *(P=0.5)*	NS	7.13	6.34	3.26	NS	6.33	8.06	4.83	NS	1.14	1.12	0.58	NS	1.18	1.00	0.51
Mulch:																
No mulch	46.12	40.31	50.19	45.54	50.56	58.75	51.84	53.72	6.76	7.63	6.55	6.98	3.93	5.24	4.43	4.53
Inorganic mulch	50.45	47.19	56.13	51.26	56.2	69.22	62.97	62.8	7.84	8.92	8.01	8.26	4.16	6.43	5.63	5.41
Organic mulch	49.83	48.89	57.35	52.02	57.57	72.48	64.47	64.84	7.75	8.83	7.98	8.19	4.26	6.51	5.77	5.51
SE(m) ±	2.45	1.99	1.8	1.81	3.09	2.44	3.27	1.36	0.36	0.36	0.26	0.14	0.31	0.36	0.24	0.11
CD *(P=0.5)*	NS	5.76	5.21	3.04	NS	7.05	9.47	3.94	NS	1.04	0.74	0.39	NS	1.04	0.69	0.32

Table 3. Effect of *in situ* rain-water harvesting and mulching on fruit yield and quality in mango 'Arka Neelachal Kesri'

Treatment	Fruit yield									Fruit quality				
	No. of fruits/tree			Average fruit weight (g)			Total weight of fruits (kg/tree)			Pulp (%)	Peel (%)	Stone (%)	TSS (°B)	Acidity (%)
	2012	2013	Pooled	2012	2013	Pooled	2012	2013	Pooled					
In situ rain-water harvesting structures														
Half-moon	11.33	15.91	13.62	165.72	151.97	158.85	1.87	2.41	2.14	68.32	13.59	18.10	20.01	0.25
Full-moon	13.44	18.73	16.09	156.78	169.27	163.03	2.09	3.10	2.59	68.16	14.80	17.05	19.91	0.26
Cup-and-Plate	23.27	32.55	27.91	164.97	167.98	166.48	3.87	5.46	4.67	67.53	14.11	18.36	19.71	0.27
Trench	18.22	27.18	22.7	167.01	157.70	162.35	2.94	4.28	3.61	69.20	13.92	16.89	18.80	0.28
SE(m)±	1.46	2.03	1.42	4.69	5.95	3.25	0.23	0.36	0.22	0.78	0.48	0.45	0.35	0.2
CD *(P=0.5)*	4.54	6.31	4.42	NS	NS	NS	0.71	1.11	0.69	NS	NS	NS	NS	NS
Mulching														
No mulch	12.65	17.55	15.10	158.10	158.87	158.48	1.99	2.79	2.39	68.30	14.48	17.23	18.74	0.29
Inorganic mulch	18.79	25.88	22.33	165.85	162.81	164.33	3.06	4.17	3.61	69.03	13.40	17.57	19.87	0.26
Organic mulch	18.27	27.35	22.81	166.92	163.52	165.22	3.03	4.47	3.75	67.57	14.43	18.00	20.22	0.25
SE(m)±	1.69	2.21	1.44	4.58	5.8	4.04	0.28	0.35	0.24	0.83	0.53	0.42	0.28	0.2
CD *(P=0.5)*	4.90	6.40	4.16	NS	NS	NS	0.80	1.01	0.69	NS	NS	NS	0.81	NS

parameters (pulp, peel and stone details, total soluble solids and titratable acidity) when fruiting started in the year 2012. Fruit and its fractions, namely, peel and stone, were weighed and their contents calculated as percentage. TSS was determined using a hand-held digital refractometer. Acidity was estimated by titrating fresh fruit-juice with 0.1N NaOH, using phenolphthalein as an indicator, and was expressed as per cent citric acid equivalents. Data generated on various parameters were tabulated and statistically analyzed.

Annual increase in vegetative growth for three consecutive years, along with pooled data, is presented in Table 2. Cup-and-plate system of *in situ* rain-water harvesting resulted in significant increase in plant height, canopy diameter, scion girth and primary girth. This treatment also gave the highest fruit yield (27.91 fruits weighing 4.67kg/tree) (Table 3). However, no significant differences were observed with use of various *in situ* rain-water harvesting structures for average fruit weight and fruit quality (Table 3). Better growth and yield observed in the cup-and-plate system, may be due to improved rain-water harvest using this structure, and consequent increased soil-water available to the plants for longer duration than with the other structures.

Mulching had significant influence on vegetative growth (Table 2), yield and TSS (Table 3). Maximum annual increase in plant height, canopy diameter and primary girth were recorded in the organic mulch, followed by inorganic mulch. Enhanced plant growth observed could be due to availability of sufficient moisture and enhanced lateral growth of roots in the upper layers of soil which, in turn, may have resulted in better nutrient uptake, as reported in citrus (Panigrahi *et al*, 2008). Beneficial effects of black polythene

and straw mulch on plant growth have also been reported in guava by Das *et al* (2010).

Use of organic mulch resulted in the highest yield, which was at par with yield recorded in the inorganic much treatment. Increase in the yield under these mulches was due to a significant increase in number of fruits, over no mulch. Average fruit weight under both organic and inorganic mulch was also high, although statistically at par with no mulch. Higher yield under mulching due to better conservation and improved availability of soil moisture, suppression of weed growth and decrease in soil temperature (which, in turn, resulted in better fruit retention and reduced fruit-drop) have been reported by Shirgure *et al* (2005) in acid lime, by Ghosh and Tarai (2007) in *ber,* and by Sharma and Kathiravan (2009) in plum.

TSS in the fruit was significantly influenced by application of organic and inorganic mulch, but not so for the other fruit-quality parameters. Improvement in TSS by use of mulch may be due to soil moisture conservation which, ultimately, may have caused mobilization of soluble carbohydrates to the fruit (Nath and Sharma, 1994). Improvement in fruit quality with application of mulch was also observed by Ghosh and Tarai (2007) in *ber*.

Cup-and-plate system of *in situ* rain-water harvesting and mulching either with paddy-straw or black polythene (100µ thickness) could, therefore, be useful for providing better growth, fruit yield and quality in rainfed mango in the humid tropics of Eastern India.

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