Indian J. Hort. 67(3), September 2010: 396-398

Short communication

Performance of various rainwater conservation treatments in Nagpur mandarin growing in vertisols

P. Panigrahi*, A.K. Srivastava and A.D. Huchche
National Research Centre for Citrus, Nagpur 440 010, Maharashtra

Management of natural resources, including soil and water is one of the key factors for sustainable production of any farming system. The uneven distribution of rain in space and time induces abundant runoff and soil erosion, results in bulk loss of available nutrients from cultivated lands, affecting the productivity. Around 1,52,000 ha area is under Nagpur mandarin (*Citrus reticulata* Blanco), which is mostly established on vertisols on gently sloppy lands in Central India is also affected by runoff (Huchche *et al.*, 5). The higher runoff in monsoon period and soil moisture shortage in post monsoon during critical growth stages induces the poor growth and establishment of young plants in this region. Hence, it is utmost essential to conserve the rainwater in orchards for better performance of the plants in this water scarce region. Though, some rainwater conservation measures were earlier advocated in *ber* (Sharma *et al.*, 6), lemon (Ghosh, 4), sweet orange (Arora and Mohan, 1) and cashew (Badhe and Magar, 2), for better growth and productivity, the information in this regard is lacking for Nagpur mandarin. Therefore, a field experiment was conducted to evaluate the influence of some conservation measure in relation to runoff, soil and nutrients loss reduction, besides plant growth in Nagpur mandarin.

The field experiment was carried out at Research Farm of the National Research Centre for Citrus, Nagpur, during 2003 to 2006.The Nagpur mandarin plants budded on rough lemon rootstock under the study were established on Vertic Ustochrept, with a spacing of 6 m × 6 m. The experimental soil type was clay loam with field capacity and permanent wilting point of 24.8% and 15.7%, on weight basis, respectively. The initial mean available plant nutrients in upper 20 cm soil were N at 89.6 mg/ kg, P at 11.8 mg/kg, K at 244 mg/kg. The treatments imposed were continuous bunding, continuous trenching, staggered trenching between rows and control (C), without any soil and water conservation practice, in randomized block design with seven replications, in blocks of size 36 × 18 m^2 on 3.2% slope. The cross section was trapezoidal with 45 cm bottom width, 15 cm top width and 25 cm height incase of bunds and 15 cm bottom width, 45 cm top width and 30 cm depth incase of trenches. The staggered trenches were made in ziz-zag manner, having length of 1 m with 1 m spacing. Recommended dose of fertilizers (Srivastava and Singh, 7) and irrigation water as per plant water requirement (Doorenbos and Pruitt, 3) through drip system were applied uniformly in all treatments. The rainfall data was collected from the meteorological observatory of Research farm. Runoff was measured through multi-slot divisor and well-stirred runoff samples were collected for estimation of sediment yield and nutrients loss after each rainfall under different treatments. Run-off sample analysis consisted of alkaline $KMNO_4$ distillation for available N (Subbiah and Asija, 8), $NaHCO_3$ (pH 8.3) extractable-P as Olsen-P, 1N neutral NH_4OAc-K (Tandon, 9). The moisture content at 0-30 cm depth of soil was recorded each week by neutron moisture probe (Troxler Model-4300, USA) in various treatments. The vegetative growth parameters such as plant height (from ground surface to the highest point of crown), stem height (from ground surface to base of the first stem), canopy diameter (N-S and E-W), rootstock and scion girth were measured and their mean incremental magnitudes under different treatments were compared. The canopy volume was calculated based on the formulae 0.5233 H W^2, where H = (tree height – stem height) and W the average canopy width of the plants (Obreza, 10).

The total runoff and soil loss observed under different treatments indicates that the mean maximum runoff (34.47%) and soil loss (3.81 t/ha) were recorded in control, where as minimum (runoff, 21.79%; soil loss, 2.59 t/ha) was observed under continuous trenching followed by continuous bunding (Table 1). Over all, continuous trenching conserved 36.77% runoff and 32.02% soil loss over control. The reduction of runoff and soil loss in continuous trenching is due to runoff harvesting in trenches between the rows.

Runoff samples analysis under different treatments for various available nutrients *viz.*, N, P, and K shows that the quantum of all nutrients was highest (0.827 kg N/ha, 0.188 kg P/ha and 1.44 kg K/ha) in control, respectively and lowest (0.547 kg N/ha, 0.114 kg P/ha and 0.918 kg K/ha) under continuous trenching (Table 1). The lowest nutrients loss under continuous trenching was attributed to lowest soil loss in this

*Corresponding author's present address: IARI, Pusa, New Delhi 110 012; E-mail: pravukalyan@rediffmail.com

Table 1. Runoff and soil loss under different soil and water conservation treatments in Nagpur mandarin.

Treatment	Run off (mm)	Soil loss (t/ha/yr)	Nutrients (kg / ha)		
			N	P	K
Continuous bunding	171.83 (23.28)*	2.81	0.621	0.123	1.065
Continuous trenching	160.84 (21.79)	2.59	0.547	0.114	0.918
Staggered trenching	201.59 (27.31)	3.10	0.725	0.149	1.611
Without conservation measure (Control)	254.4 (34.47)	3.81	0.827	0.188	1.44

(Mean Annual Rainfall = 738 mm; *Figures in parenthesis indicate runoff as % of mean annual rainfall.

treatment. Moreover, it was observed that the nutrient concentration in eroded soil was higher than the original plot soil, irrespective of treatments due to loss of upper fertile soil through runoff.

Determination of moisture content at 0-30 cm soil profile each week and its monthly average data revealed that the conservation of rainwater through different treatments improved soil moisture status considerably (Table 2). Among different treatments, highest soil moisture content (24.55-33.72%, v/v) was observed under continuous trenching followed by continuous bunding and lowest (20.33-25.88%, v/v) under control. The higher moisture content in continuous trenching was due to maximum rainwater conservation in monsoon period under this treatment. Other conservation measures were also significantly effective in improving soil moisture status compared to control. The difference between moisture contents under various conservation measures reduced with time except the month of January, February and June, in which some unseasonal rainfall took place. The reduction of soil moisture content with time may be due to more consumptive use of water by plants under increased soil moisture content. Moreover, the moisture content under different treatments did not vary significantly at initial period (October) of observation. But during the period from November to February, the moisture content under continuous trenching was significantly higher over control.

The observed mean incremental vegetative growth parameters such as plant height, canopy spread, stock and scion girth of Nagpur mandarin plants shows that all the conservation treatments were effective in inducing better vegetative growth of plants than control (Table 3). The highest vegetative growth was recorded under continuous trenching followed by continuous bunding. The magnitude of incremental plant height, stock girth, scion girth, and canopy volume were 1.58 m, 66 mm, 43 mm and 0.783 m^3, respectively, in continuous trenching as compared to 1.14 m, 31 mm, 24 mm, and 0.568 m^3, respectively, in control. However, the quarterly observation of vegetative growth parameters indicated that growth parameters did not show any significant variation under different conservation treatments during July to September except stock girth in all the years, might be due to frequent and uniform rainfall in all treatments in monsoon period. Same trend was also observed during January to March and April to June with exception to plant height and stock girth, probably due to uniform

Table 2. Soil Moisture content (%, v/v) at 0-30 cm under different soil and water conservation treatments in Nagpur mandarin.

Treatment	Month								
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Continuous bunding	30.53	28.49	26.76	31.06	27.25	27.45	26.45	26.15	25.25
Continuous trenching	33.72	31.88	27.90	31.90	27.30	27.75	26.35	25.85	24.55
Staggered trenching	26.91	25.25	24.20	27.70	26.69	26.92	25.88	24.2	23.43
No conservation measure (Control)	25.24	22.73	20.33	24.78	25.10	25.88	23.85	22.8	22.33
CD (P = 0.05)	NS	1.15	2.34	1.76	1.56	NS	NS	NS	NS

NS = Not significant.

Table 3. Incremental vegetative growth of Nagpur mandarin under different soil and water conservation treatments.

Treatment	Plant height (m)	Stock girth (mm)	Scion girth (mm)	Canopy volume (m^3)
Continuous bunding	1.33 (0.82)*	45.0 (15)	31.0 (12)	0.640 (0.086)
Continuous trenching	1.58 (0.84)	66.0 (16)	43.0 (13)	0.783 (0.088)
Staggered trenching	1.21 (0.79)	44.0 (14)	35.0 (12)	0.613 (0.087)
No conservation measure	1.14 (0.85)	31.0 (13)	24.0 (11)	0.568 (0.088)
CD (P = 0.5)	2.34	0.64	0.42	0.009

*Data in parenthesis is initial growth data.

soil moisture status during these periods. Moreover, the growth parameters were significantly affected during October to December under different treatments and were highest in continuous trenching. The over all better vegetative growth under continuous trenching was due to better soil moisture support to plants during post monsoon period.

The superiority of continuous trenching over rest of the conservation treatments in terms of soil, runoff, and nutrients loss along with plant growth provides a greater opportunity to exploit the results in improving the quality production of Nagpur mandarin without bringing any sizeable reduction in soil fertility. The information such as this could later serve as a base data to develop a sound citrus-based watershed programme in the long run.

REFERENCES

1. Arora, Y.K. and Mohan, S.C. 1985. Water harvesting and water management for fruit crops in waste lands. 3rd *National Workshop on Arid Zone Fruit Research* held during 5-8 July, 1985 at Mahatme Phule Agricultural University, Rahuri, India. *Tech. Doc. No.* **17**: 104-12.

2. Badhe, V.T. and Magar, S.S. 2004. Influence of different conservation measures on runoff, soil and nutrient loss under cashew nut in lateritic soils of south Konkan region. *Indian J. Soil Conserv.* **32**: 143-47.

3. Doorenbos, J. and Pruitt, W.O. 1977. *Guidelines for Predicting Crop Water Requirements*. Irrigation and Drainage, Paper No. 24, FAO, United Nations, Rome, Italy.

4. Ghosh, SP. 1982. Water harvesting for fruit orchards in Dehradun valley. **In**: *Proc. Int. Symp. Hydrological Aspects of Mountainous Watersheds*, 4-6 November, 1982 at Roorkee, India. pp. 31-33.

5. Huchche, A.D., Srivastava, A.K., Ram, Lallan and Singh, S. 1999. Nagpur mandarin orchard efficiency in central India. Hi-tech citrus management. **In**: *Proc. Int. Symp. Citriculture,* November 23-27, 1999, National Research Centre for Citrus, Nagpur, Maharashtra, pp. 24-28.

6. Sharma, K.D., Pareek, O.P. and Singh, H.P. 1982. Effect of runoff concentration on growth and yield of jujube. *Agric. Water Mangt.* **5**: 73-84.

7. Srivastava, A.K. and Singh, S. 1997. Nutrients management in Nagpur mandarin and acid lime. *Extension Bull. No.* ***5***, National Research Center for Citrus, Nagpur, Maharashtra, India.

8. Subbiah, B.V. and Asija, G.L. 1956. A rapid procedure for determination of available nitrogen in soils. *Curr. Sci.* **25**: 259.

9. Tandon, H.L.S. 1998. *Methods of Analysis of Soils, Plant, Water and Fertilizers*. Fertilizer development and Consultation Organization, New Delhi, pp. 42-44.

10. Obreza, T.A. 1991. Young Hamlin orange tree fertilizer response in south-west Florida. *Proc. Florida Sta. Hort. Soc.* **103**: 12-16.

Received: October, 2008; Revised: May, 2010;
Accepted : June, 2010