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Response of Acid Lime to Various Soil and Water Conservation Measures in Central India

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Abstract: *Two different soil and water conservation treatments i.e., continuous trenching and staggered trenching between the rows were laid out in 11 year-old acid lime (Citrus aurantifolia Swingle) orchard and compared with control (without rainwater conservation treatment) at Nagpur, India. Both the treatments were effective in improving soil water status in orchards and reduced soil loss (2.15–2.89 t ha^{-1} yr^{-1}) over control. Continuous trenching was the better treatment and conserved 38% runoff, reduced 32% soil loss, 32% N, 28% P, and 29% K, besides produced 18% higher fruit yield (17.2 kg $plant^{-1}$) over control. Among different fruit quality parameters (TSS, Juice percentage and acidity), juice percentage was significantly higher in continuous trenching (43%) over control (35%). Overall, the study indicates that adoption of continuous trenching is a viable soil-water conservation practice in acid lime in vertisol.*

Keywords: *acid lime; drainage, rainwater conservation; vertisols*

1. Introduction

Acid lime, one of the important commercial citrus cultivars of India is grown on around 1.28 lakh hectares with an annual production of 10.24 lakh tones (Singh and Srivastava 2004). The productivity (8 t ha^{-1}) of acid lime is low in India as compared to the higher productivity (20 t ha^{-1}) in other countries. The low productivity of acid lime is attributed to low water availability in the soil profile at flowering and fruit growth stages during post monsoon period. Hence, conservation of rainwater in dry land horticulture is one of the options for sustainable production. The irrigation through drip (Panigrahi *et al*. 2012a and 2012 b), deficit irrigation (Panigrahi *et al*., 2011; Panigrahi *et al*., 2014) and conservation of soil water through mulching (Panigrahi *et al*., 2008; Panigrahi et al., 2010) are the better options for citrus production. The rainwater conservation for various fruit crops such as cashew (Badhe and Magar 2004), ber (Sharma *et al*. 1982), lemon (Ghosh 1982), sweet orange (Arora and Mohan 1985) and mandarin (Panigrahi *et al.* 2006 and 2009) was found better for tree growth and higher quantity of fruit production per unit area. Hence, an attempt was made through a field experiment to study the effect of rainwater conservation measures on performance of acid lime grown on black clay soil of Central India.

2. Materials and Methods

The experiment was conducted at Research Farm of National Research Centre for Citrus, Nagpur during 2003-06. The acid lime plants in the study were 11 year-old, planted at 5 m × 5 m apart in plot having 4.8% slope. Continuous trenching and staggered trenching across the slope and without rainwater conservation measure (control) were the treatments imposed in seven replications in randomized block design in runoff blocks of size 35 m × 15 m each. The cross section of both continuous bunds and trenches was trapezoidal having 45 cm bottom width, 15 cm top width and 25 cm height of bund, and 15 cm bottom width, 45 cm top width and 30 cm depth of trench. The staggered trenches were laid out in chessboard pattern between rows having 1 m length and 1 m spacing with cross section of continuous trench. The horizontal interval (H.I.) and vertical interval (V.I.) for all the conservation measures were 5.99 m and 29 cm, respectively. The texture of experimental soil was clay loam with 25.4% field capacity and 16.2% permanent wilting point on weight basis. The annual fertilizer rate of 600 g N through urea + 200 g P_2O_5 through single super phosphate + 100 g K_2O through murate of potash per plant was applied (Srivastava and Singh 1997).

Runoff was measured through multi-slot divisor and well-stirred runoff samples were collected for estimation of sediment yield and loss of nutrients after each rainfall in different treatments. Runoff sample analysis was consisted of alkaline potassium permanganate method for available N (Subbiah and Asija 1956), sodium bicarbonate ($NaHCO_3$) at a pH of 8.3 for extractable-P as Olsen-P, neutral 1 *N* ammonium acetate (NH_4OAc) method for available K (Tandon 1998). The soil water content in 0-30 cm depth was recorded at weekly interval by neutron moisture probe (Troxler model-4300) in all the treatments. The initial and final vegetative growth components i.e., plant height, canopy spread and stem girth were measured and the fruit yield and quality (juice, acidity and TSS) were recorded in different treatments. The canopy volume was determined based on the formulae 0. 5233 H W^2, where H=(tree height – stem height) and W the average canopy width of the tree (Obreza 1990). Data generated were statistically subjected to analysis of variance (ANOVA) and Critical Difference (CD) at 5% probability level was obtained according to the methods described by Gomez and Gomez (1984).

3. RESULTS AND DISCUSSION

3.1. Runoff, Soil and Available Nutrients Loss

The mean annual runoff and soil loss data indicated that lower runoff (16.5% of rainfall) and soil loss (1.97 t ha^{-1}) were observed in continuous trenching as compared to higher runoff (23.9% of rainfall) and soil loss (2.81 t ha^{-1}) in control (Table 1). The higher reduction of runoff and soil loss in continuous trenching was attributed to greater runoff conservation in trenches between the rows. The nutrients losses (N, P and K) followed the similar trend of runoff and soil loss (Table 1). Due to higher loss of upper fertile soil through runoff, the nutrient concentration in eroded soil was higher.

Table 1. *Runoff, soil and nutrients losses in different treatments in acid lime*[*]

#MARF 738 mm

Treatment	Runoff (mm)	Soil loss (t ha^{-1} yr^{-1})	Nutrients loss (kg ha^{-1})		
			N	P	K
Continuous trenching	122.01 (16.5)	1.967	0.397	0.079	0.614
Staggered trenching	151.27 (20.5)	2.456	0.441	0.068	0.680
Without conservation measure (Control)	176.81 (23.9)	2.812	0.569	0.090	0.878

[*]*Mean data during the year 2003-2006.*

[#]*MARF, Mean Annual Rainfall during 2003-2006.*

[+]*Figures in parenthesis indicate runoff as % of mean annual rainfall.*

3.2. Soil Water Content

The mean monthly soil water content at 30 cm depth indicated the higher soil water (7.7 – 9.4 cm) in continuous trenching followed by continuous bunding (7.6 – 8.8 cm), and was attributed to more rainwater conservation during monsoon (Table 2). In addition, other conservation measures also conserved more rainwater and increased the soil water content as compared to control. The differences between soil water content in conservation measures and control were reduced from rainy to post rainy season. This was attributed to more consumptive use of water by the plants. The soil water content in continuous trenching was significantly higher from November to March over control.

Table 2. *Soil water content (cm) at 0-30 cm profile in different treatments in acid lime**

Treatment	Months							
	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.
Continuous trenching	9.4	9.1	8.9	8.7	8.6	8.4	8.0	7.7
Staggered trenching	7.7	7.7	7.5	7.4	7.3	7.3	7.3	7.0
Without conservation measure (Control)	7.4	7.4	7.3	7.2	7.1	7.1	6.9	6.9
CD (P = 0.05)	0.23	0.49	0.37	0.28	0.08	NS	NS	NS

**Mean data during the year 2003-2006.*

NS; not significant

3.3. Vegetative Growth, Fruit Yield and Quality

Among the growth components (plant height, stem girth, canopy volume), fruit yield and quality, the plant canopy was significantly higher in continuous trenching (7.22 m^3) over control (4.98 m^3) (Table 3). Similarly, fruit yield was higher in continuous trenching (32.30 kg $plant^{-1}$), which was 35% more over control. Quality assessment of fruits also indicated that the juice content (43.8%) was higher and acidity (5.98%) was lower in continuous trenching. The better yield and quality of fruits in continuous trenching was attributed to higher soil water supply to plants during flowering and fruiting stages.

Table 3. *Annual incremental vegetative growth, fruit yield and quality of acid lime under different treatments**

Treatments	Vegetative growth			Fruit yield			Fruit quality		
	Plant height (m)	Stem girth (cm)	Canopy volume (m^3)	No. of fruits/ plant	Fruit weight (g)	Total yield (kg/plant)	Juice (%)	TSS (^{0}Brix)	Acidity (%)
Continuous trenching	0.43	2.68	7.22	1098	29.41	32.29	43.8	7.68	5.98
Staggered trenching	0.32	1.97	5.84	910	28.24	25.69	38.7	7.82	6.31
Without conservation measure (Control)	0.26	1.47	4.98	865	27.68	23.94	35.4	6.83	6.43
CD (P = 0.05)	NS	NS	0.14	11.4	2.03	2.03	1.52	NS	0.06

** Mean data during the year 2003-2006.*
NS; not significant

4. CONCLUSION

The continuous trenching conserved greater rainwater, reduced runoff and soil and nutrients losses and increased the soil water in the profile. Growth during rainy and post rainy season i.e., during vegetative and reproductive stages resulted in better plant growth and higher dry matter translocation to fruits with higher fruit yield. Due to higher soil water and nutrient content in profile resulted in better quality fruits with greater size. Adoption of rainwater conservation measures also reduces the soil and nutrients losses and maintains the soil productivity as sustainable basis in the citrus orchards. The information generated in this study will serve as base data to develop a sound citrus-based watershed programme in the region.

REFERENCES

Arora, Y. K. and Mohan, S. C. 1985. Water harvesting and water management for fruit crops in wastelands. Third National Workshop on Arid Zone Fruit Research, Mahatme Phule Agricultural University, Rahuri, July 5-8,1985. Tech. Document No. 17, 104 –112.

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 Cons*. 32 (2): 143-147.

Gomez, K.A. and Gomez, A. A. 1984. *Statistical Procedures for Agricultural Research,*
2nd Edition, Wiley, New York.

Ghosh, S.P. 1982. Water harvesting for fruit orchards in Dehra Dun valley. *Proc. Intern. Symp. Hydrological Aspects of Mountainous Watersheds,* Roorke, November 4 –6, 1982.

Obreza T. A. 1990. Young Hamlin orange tree fertilizer response in south-west Florida.
Proc. Flo. state Hort. Soc. 103: 12-16.

Panigrahi, P., Srivastava, A.K. and Huchche, A.D. 2006. In situ soil and water conservation in Nagpur mandarin (*Citrus reticulata* Blanco) grown in central India. *Indian J. Soil Cons.* 34 (1): 80-82.

Panigrahi, P., Huchche, A. D., Srivastava, A. K and Singh, S. 2008. Effect of drip irrigation and plastic mulch on the performance of Nagpur mandarin (*Citrus reticulata* Blanco) grown in central India. *Indian Journal of Agricultural Sciences*, 78(12): 1005-1009.

Panigrahi, P., Srivastava, A. K. and Huchche, A. D. 2009. Influence of *in-situ* soil and water conservation measures on performance of Nagpur mandarin. *Journal of Agricultural Engineering (ISAE)*, 46(3):37-40.

Panigrahi, P., Srivastava, A. K. and Huchche, A. D. 2010. Optimizing growth, yield and water use efficiency (WUE) in Nagpur mandarin (*Citrus reticulate* Blanco) under drip irrigation and plastic mulch. *Indian Journal of Soil Conservation*, 38 (1): 42-45.

Panigrahi, P. and Srivastava, A. K. (2011). Deficit irrigation scheduling for matured Nagpur mandarin (*Citrus reticulate* Blanco) trees of central India. *Indian Journal of Soil Conservation*, 39 (2): 149-154.

Panigrahi, P., Srivastava, A. K. and Huchche, A. D. 2012a. Effects of drip irrigation regimes and basin irrigation on Nagpur mandarin agronomical and physiological performance. *Agricultural Water Management*, 104: 79-88.

Panigrahi, P., Srivastava, A. K., Huchche, A. D. and Singh, S. 2012b. Plant nutrition in response to drip versus basin irrigation in young Nagpur mandarin on Inceptisol. *Journal of Plant Nutrition*, 35: 215-224.

Panigrahi, P., Sharma, R. K., Hasan, M., and Parihar, S. S. 2014. Deficit irrigation scheduling and yield prediction of ‘Kinnow’ mandarin (Citrus reticulate Blanco) in a semi arid region. *Agricultural Water Management*, 140: 48-60.

Sharma, K.D., Pareek, O.P. and Singh, H.P. 1982. Effect of runoff concentration on growth and yield of Jujube. *Agricultural Water Management* 5 (1): 73-84.

Singh, S. and Srivastava, A. K. 2004. Citrus industry of India and overseas. In: *Advances in Citriculture* (Eds. S. Singh, V. J. Shivankar, A. K. Srivastava and I. P. Singh) Jagmander Book Agency, New Delhi. p. 9.

Srivastava, A. K. and Singh, S. 1997. *Nutrient Management in Nagpur Mandarin and Acid lime*. Extension Bulletin No. 5, National Research Center for Citrus, Nagpur.

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

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