Prog. Hort., 30 (3-4): 168-174, 1998

PROFILE MODIFICATION FOR SURVIVAL, GROWTH AND NUTRIENT UPTAKE IN MANGO PLANTS UNDER DEGRADED LANDS - A PARTICIPATORY APPROACH

P.L. SAROJ*, S.C. MOHAN, A.S. MISHRA, S.S. SHRIMALI AND B.L. DHYANI

Central Soil and Water Conservation Research and Training Institute, Dehradun (UP)-248 195

ABSTRACT

An on-farm-research (OFR) was conducted during 1996-97 to 1997-98 under users conditions to see the effect of profile modification on survival, growth and leaf nutrient contents in grafted mango plants under rainfed gravely land (64% gravels by weight) in foothills of north-western Himalayan region. The investigation was carried out in participatory mode by involving 13 farm families at all the stages of experimentation. The pit profile (1 m^3) was manipulated by different pit filling mixtures along with farmers practice i.e. pit filling by excavated soil only as control. Among different treatments, the pit filling by good soil and farm yard manure (FYM) in the ratio of 2:1 + 2 kg dry leaves (T_5) gave best response in term of plant survival (72.17%) and growth prarameters. The next best treatment was T_4-good soil + FYM closely followed by T_3-good soil only having 70.50 and 69.08 per cent field survival, respectively. However, the leaf nutrient content did not make any impact at this stage but it showed positive trend with moisture holding capacity of the profile. As the extent of participation, most of the field activities were carried out by the family members while plant material, chemicals and technical guidance were given by the core team under the pilot project "Institution-Village-Linkage Programme (IVLP)". Therefore, the cost of establishment was practically very low but it was Rs. 11,868/ha for the best treatment (T_5) when computed by converting all the establishment inputs in monetary value. The present investigation was not only conducted to identify a suitable pit filling mixture for gravely land but it has also served as field demonstration block for quick adoption of desired findings by the farmers.

INTRODUCTION

Mango (*Mangifera indica* L) is a fruit known for its delicious taste and multiple utility. It is grown over an area of 1.23 million hectares in the country and annually producing 10.99 million tonnes of fruits. It accounts for 22.1 per cent of total area (5.57 million hectare) and 22.9 per cent of total production of fruits (47.94 million tonnes) in the country. Uttar Pradesh has the largest area under mango. In Doon valley also, mango is most liked fruit crop of the locality and rank first (57.8%) among various fruits grown in the valley (Saroj and Arora, 1994). In recent years, there is very high demand of mango both raw and ripe in the locality because of fast urbanization and tourist demand during the season. However, in future to fulfill the demand of consumers, it is essential to increase the area under mango plantation but further extension in area under mango on good land is not possible due to reduction in land:man ratio. The possible alternative seems to utilize degraded lands for further extension in area under fruits by adopting suitable site specific

*Present address: NRC for Arid Horticulture, Beechwal, Bikaner (Rajasthan) - 334 006.

agrotechniques. In Doon Valley, large area characterized as gravely riverbed land (35% of total geographical area of the valley) is lying unutilized (Singh, 1980) which can be used for the purpose after desired treatments.

On the other hand, it is often observed that most of the technologies do not perform similar results in users conditions as they were reported under research stations. This gap may be due to differences in the site conditions of technology generation and technology adoption, improper dissemination of technology, even imperfection with technology itself etc. Keeping these facts in view, an on-farm-research (OFR) was conducted under users conditions to identify suitable pit filling mixtures for survival, growth and leaf nutrient content of grafted mango plants under rainfed gravely lands in Doon valley.

Materials and Methods

The experimental area comes in Raipur block of Dehradun district, located in foot hills of north-western Himalayan region at an elevation of 640m asl. It has a unique physical feature as it is surrounded by natural boundaries of Himalayan mountain in north, the Shiwaliks in south, the Ganges in the east and the Yamuna in the west, thereby it is popularly known as Doon valley. The geographical situation of the area is humid subtropical with 1778 mm/ annum average rainfall, temperature in summer varies from 16.7 °C to 40 °C while in winter 0 °C to 23.4 °C. The experimental site is gravely riverbed lands formed by debris deposition coming from hills during monsoon. These lands consists of varying size of gravels with low soil fractions (36%), hence posses high infiltration rate and poor water holding capacity. The soil pH is slightly acidic in nature. The nutritional status of the soil was also very poor (Table 1).

Table 1 : Physcio-chemical properties of profile (<2mm fractions)

Parameters	Profile depth (cm)					
	0-15	15-30	30-45	45-60	60-100	Mean
A. Physical						
Coarse sand (%)	24.8	35.5	42.0	43.5	47.4	38.6
Fine sand (%)	46.7	41.5	37.7	37.2	37.5	40.1
Silt (%)	18.0	13.0	10.5	10.7	8.2	12.1
Clay (%)	10.5	10.0	9.8	8.6	6.9	9.2
WHC (%)	34.6	35.3	27.3	31.5	31.5	32.0
B. Chemical						
Total N (%)	0.16	0.12	0.07	0.03	0.03	0.08
Av. P (Kg/ha)	40.0	70.0	62.0	76.0	66.0	62.80
Av. K (kg/ha)	130.0	180.0	160.0	180.0	220.0	174.0
OC (%)	1.05	1.02	0.69	0.38	0.38	0.70
pH	5.9	5.9	6.5	6.5	6.5	6.3

OC = Organic carbon, WHC = Water holding capacity

The experiment was formulated as a bottom-up approach and problem was identified by farmers themselves. Under a pilot project of technology assessment and refinement through Institution-Village-Linkage Programme (IVLP), several problems were identified and prioritized by the farmers. Poor horticulture development in the locality was one of them. The main cause of poor horticulture development were poor plant establishment under gravely land, lack of true to type of plant materials and poor technological awareness among the farmers. These factors were considered as intervention points and accordingly experiment was formulated. The cost effective treatments by using locally available plant materials were decided after proper interactions with the farmers.

The investigation was carried out under farmers fields as a part of IVLP project during 1996-97 to 1997-98. For the purpose, 13 farm families were selected to conduct the study in OFR mode. The pits of $1m^3$ were dug out during summer at 8m apart. Five pit filling mixture i.e. T_1 - excavated soil only as farmers practice (FP), T_2-T_1 + FYM (2:1) + 2 kg dry leaves at bottom, T_3 - good soil, T_4-T_3 + FYM (2:1) and T_5-T_3 + 2 kg dry leaves were used as treatments. The experiment was conducted in RBD having 13 replications and 10 plants were used as treatment unit. In this type of research individual farm family was considered as replication to minimize the error. The plantation has been done during middle of July, 1996 after filling the pits by desired mixture. The dry leaves and/or crop residues were also used as mulch materials in the plant basin for *in-situ* moisture conservation during post monsoon as the experiment was conducted under rainfed conditions.

The contribution of farmers were in term of field preparation, pit digging, pit filling, cost of FYM, mulching, thatching and all other labour works while grafted Dashehari plants, plant protection chemicals and technical guidance were given by the project. The data on survival and plant growth were recorded after one year of plantation by involving concerned farmers. The leaf sampling was done to assess the nutritional status of leaves under different treatments. The cost of establishment was also worked out to know the economic feasibility of the system.

Results and Discussion

Profile improvement: In fact, improvement of pit profile by different pit filling mixtures is an age old practice for cultivation of fruit trees in problem soils but the kind of mixture and their efficacy are site specific (Pathak *et al.*, 1990 and Saroj *et al.*, 1994). The basic purpose of profile modification was to create congenical conditions to the plants at initial stage for better establishment under resource poor conditions. In present investigation also, the experimental site was gravely land which was modified upto $1m^3$ pit size by different pit filling mixtures as per treatment. The comparison of physicochemical characteristics of modified pit profile have been given in the Table 2. It is obvious that the modified pit profile was superior in term of N,P,K content, organic carbon and to a great extent water holding capacity, however there was not much variation in soil pH.

Plant Survival: The observation on plant survival was recorded at four month interval i.e. July, 1997; November, 1997 and March, 1998 starting after one year of plantation and data were given in Table 3. There was significant differences in survival percentage of

Table 2 : Characteristics of modified profile under different treatments

Parameters	Orginal profil/ T1	After modification				
		Tm2		T3	T4	T5
		T1+FYM	Leaves			
N (%)	0.08	0.146	0.497	0.089	0.316	0.385
P (%)	0.031	0.025	0.168	0.026	0.023	0.024
K (%)	0.077	1.051	0.325	0.046	1.742	1.745
OC (%)	0.705	1.427	4.72	0.865	2.825	3.625
pH	6.26	6.00	-	6.21	6.12	6.00
WHC (%)	32.08	39.24	-	49.59	55.48	56.15

OC = Organic carbon, WHC = Water holding capacity

mango plants under different treatments. At final stage of observation (March 1998) the highest percentage of plant survival was recorded in T_5 (72.15) followed by T_4 (70.50), T_3 (69.08), T_2 (46.08) and minimum in T_1 (45.00). There was more than 60 per cent increase in survival percentage of T_5 over T_1 (control). It was also observed that there were close proximity with high percentage of survival in T_5, T_4 and T_3 as compared to low survival percentage in T_2 and T_1 indicating that the filling of pits by gravely excavated soil is not desirable. However, pit filling either by good soil or by soil + FYM and/or dry leaves created more congenial conditions for plant survival under gravely land situations. In conformity of this finding; Andersena and Odneal (1984), Sharhandeh (1986) and Singh *et al.* (1997) have also reported positive response of profile modification in various fruit crops under problem soils. The summer rains have additional advantages in survival of plants under gravely rainfed conditions.

Plant Growth: The optimum growth of newly planted plants is a function of congenial edaphoclimatic conditions which can be modified upto some extent. The immediate plant microclimate and condition of rooting zone depth can be manipulated through mechanical, chemical and biological methods to create an environment suitable for above ground plant growth (Bathke *et al.*, 1992). In this study, the various growth parameters like plant height, stock and scion diameter and crown spread were recorded at 4 month interval. Data presented in Table 3 showed that the pits filled with good soil + FYM + 2kg dry leaves gave overall best response with respect to growth parameters except for scion diameter closely followed by T_4, T_3, T_2, T_1 respectively. Infact, the profile modification under T_5 not only created better microclimatic conditions for root growth but also high nutritional status contributed favourable effect on above ground growth of plants. Whereas, the pits filled with gravely soils (T_1) have low moisture holding capacity and poor nutritional status resulting poor plant establishment and lesser vegetative growth under similar climatic conditions.

Leaf Nutrient Status: The mature and fully expanded forth order leaves from top were collected

Table 3 : Survival and growth of mango plants under different pit filling mixtures

Treatment	July, 1997				November, 1997				March, 1998				
	Survival (%)	Plant height (m)	Stock dia (cm)	Scion dia (cm)	Survival (%)	Plant height (m)	Stock dia (cm)	Scion dia (cm)	Survival (%)	Plant height (m)	Stock dia (cm)	Scion dia (cm)	Crown sperad (m)
T_1	58.75	0.54	1.48	1.00	56.00	0.58	1.49	1.03	45.00 (---)	0.71	1.50	1.03	0.30
T_2	64.66	0.52	1.49	1.04	60.00	0.61	1.49	1.05	46.80 (4.00)	0.70	1.52	1.06	0.30
T_3	78.08	0.56	1.47	1.04	76.25	0.59	1.49	1.05	69.08 (53.51)	0.86	1.52	1.05	0.32
T_4	79.33	0.54	1.49	1.02	78.75	0.60	1.50	1.02	70.50 (56.66)	0.88	1.54	1.06	0.35
T_5	80.00	0.53	1.46	1.01	76.66	0.64	1.48	1.04	72.15 (60.33)	0.90	1.54	1.05	0.35
Mean	74.16	0.54	1.48	1.02	69.53	0.60	1.49	1.04	60.71 (43.69)	0.81	1.52	1.05	0.35
SEm±	0.396	0.046	0.173	0.009	0.792	0.012	0.012	0.010	0.922	0.102	0.011	0.009	0.014
CD (p=0.05)	0.913	NS	NS	NS	1.827	NS	NS	NS	2.126	NS	NS	NS	NS

T_1 = Excavated soil, T_2 = T_1 + FYM (2:1) + 2kg dry leaves at bottom, T_3 = Good soil, T_4 = T_3 + FYM (2:1), T_5 = T_4 + FYM (2:1) + 2kg dry leaves Values in parenthesis are percentage increase over control

to assess the nutritional status of the leaves under different treatments. Data given in Table 4 showed that the differences of macro and micro nutrients in leaves were very meager among different treatments, though it was slightly better in those treatments where profile was modified either by good soil or by good soil and FYM/or dry leaves. However, they did not show definite trend as the sampling has been done at very early stage of plantation and root zone may be confined in and around earthball only but moisture holding capacity of profile showed positive trend with respect to leaf nutrient contents.

Table 4 : Leaf nutrient status under different treatments

Treatment	Macro-nutrients (%)					Micro-nutrients (ppm)			
	N	P	K	Ca	Mg	Cu	Fe	Zn	Mn
T_1	1.536	0.120	0.542	1.602	0.526	48.0	230.0	176.0	70.0
T_2	1.543	0.122	0.546	1.601	0.580	59.0	242.0	180.0	68.0
T_3	1.542	0.130	0.540	1.504	0.564	52.0	234.0	160.0	71.0
T_4	1.612	0.141	0.546	1.560	0.543	54.0	220.0	178.0	74.0
T_5	1.615	0.141	0.547	1.527	0.604	61.0	244.0	186.0	72.0
Mean	1.569	0.131	0.544	1.559	0.563	54.8	234.0	176.0	71.0

Socio-economic Considerations: In this OFR there are certain observations emerged out as i) tackling of 'gate keepers' in polite manner is very essential for such type of studies, ii) individual farm family approach is easier than community approach and iii) treatment inputs must be cost effective and locally available.

Since the experiment was carried out under gravely land conditions which are physico-chemically degraded, the initial expenditure for establishment of orchard may be high. In this study, plant materials, plant protection chemical and technical guidance were given by the Institute and rest of the works were carried out by the farmer himself. The total establishment cost was worked out per hectare basis including field preparation, cost of pitting, filling and thatching, cost of FYM, chemicals, grafted plant of Dashehari mango etc. The highest initial expenditure was incurred in T_5 (Rs. 11868/-) closely followed T_4 (Rs. 11860/-), T_2 (11240/-), T_3 (Rs. 7172/-) and minimum under T_1 (Rs. 5772/-). Though, the best result was obtained in T_5 but if we consider cost of establishment and percentage survival of the plants T_3 is the best treatment. Therefore, under resource environment such type of investigation require constant observations for further few years to reach a definite conclusion.

ACKNOWLEDGMENTS

Authors are highly grateful to Dr. J.S. Sarma, Director, CSWCRTI, Dehradun and nodal scientist of the IVLP project for their guidance and kind inspiration in various ways. Thanks are also due to Dr. Y.K. Arora, Head (Plant Science) for their suggestions. We are also thankful to Smt. Sarita Gupta and Sh. Jasmat for their laboratory and field assistance and all the farm families concerned for their cooperation during field investigation.

REFERENCES

Andersen, P.C. and Odneal, M.B. 1984. Effect of soil profile modification and drip irrigation on establishment of Vidal Blank and Chancellor grapes. *Hort Science*, **19**(4): 562-565.

Bathke, G.R., Cassel, D.K., Hargrove, W.L. and Porter, P.M. 1992. Modification of soil physical properties and root growth response. *Soil Science*, **154**(4): 316-329.

Pathak, R.K. Dixit, S.N. and Dwivedi, R. 1990. Prospects of aonla, ber and bael cultivation on salt affected wastelands in India. In: *Agroforestry - Present status and scope for future development in farming systems*. pp. 125-132.

Saroj, P.L., Dubey, K.C. and Tiwari, R.K. 1994. Utilization of degraded lands for fruit production. *Indian J. Soil Cons.*, **22**(1&2): 162-176.

Saroj. P.L. and Arora Y.K. 1994. Horticulture based agroforestry systems of Doom Valley, *Indian J. Soil Cons.*, **22**(3): 60-64.

Sharhandeh, H. 1986. Effect of profile modification on alfalfa production and peach tree growth. In: *Dissertation Abstract International, Science Engineering*, **46**(7): 2134 B.

Singh, G. Dagar, J.C. and Singh, N.T 1997. Growing fruit trees in highly alkali soils-a case study. *Land Degradation and Development*, **8**(3): 257-268.

Singh, H. 1980. Economic utilization of bouldery inactive riverbed (class VIII) lands in Doon valley under rainfed conditions. A paper presented in the National Symposium on "Soil Conservation and Watershed Management in 1980's" held at CSWCRTI, Dehradun, 12-13 March, 1980.