HortFlora Research Spectrum www.hortflorajournal.com
Vol. 5, Issue 4; 301-305 (December 2016) ISSN: 2250-2823

EVALUATION OF PRODUCTION POTENTIAL OF SUBTROPICAL MANGO UNDER DEGRADED LANDS IN FOOTHILLS OF UTTARAKHAND

A. C. Rathore[1*], D. M. Kadam[1], V. K. Doharey[2] and V. K. Umrao[3]

[1]*ICAR-Indian Institute of Soil and Water Conservation, 218 Kaulagarh Road, Dehradun-248195, Uttarakhand, India,*

[2]*Krishi Vigyan Kendra, Jeolikot, GBPUAT, Pantnagar, Udham Singh Nagar, Uttarakhand*

[3]*Deptt. of Horticulture, CSSS (P.G.) College, Machhra, Meerut (U.P.) India,*

**Corresponding Author's E-mail : rathoreac@gmail.com*

ABSTRACT : A trial was conducted on 5 years old subtropical mango cultivars (T_1 = Amrapali, T_2 = Mallika, T_3 = Dashehari, T_4 = Langra, T_5 = Bombay green (BG) and T_6 = Ramkela) during 2000-2014 at Research Farm, Selakui, ICAR-Indian Institute of Soil and Water Conservation (ICAR-IISWC), Dehradun. Mango cultivars were planted in the randomized block design (RBD) with three replications to assess performance on non-arable lands in the subtropical zone of Uttarakhand, India. Data revealed that Mallika cultivar of mango recorded maximum canopy spread (5.85 m), produced highest fruit yield (9.85 tha^{-1}) followed by Amrapali and Dashehari, Langra, Bombay Green and lowest fruit yield in Ramkela. Similarly, Mallika also produced maximum carbon stock in the plant body (25.45 Mg ha^{-1}) and sequestered maximum atmospheric carbon dioxide (93.15 Mg ha^{-1}) followed by Dashehari, Langra and minimum with Amrapali. Economic returns were also recorded maximum with Mallika followed by Amrapali, Dashehari, Langra and minimum with Ramkela. Hence, Mallika followed by Amrapali / Dashehari is recommended for economic returns, productivity, carbon sequestration and rehabilitation of degraded lands in the foothills of Uttrakahnd.

Keywords : *Degraded land, fruit yield, growth performance, mango cultivars.*

Mango (*Mangifera indica* L) is an important, indigenous, popular fruit of tropical and sub-tropical regions of India. It is a national fruit of our country because of its wider adaptability, rich biodiversity, high nutritive value, excellent flavours, attractive appearance and popularity among masses of India. It is gaining momentum slowly in foothills of Uttarakhand, where it has been cultivated on 38,994 ha area produces 13,5320 tonnes fruit with a very low productivity (3.47 tha^{-1}) which is much lower than national mango productivity (7.3 tha^{-1}) (Anon., 1). This is because of mango orchards in Uttarakhand is purely rainfed, local seedlings and produces fruits of sub-standard quality and fruit productivity, which offers opportunity for evaluation of high yielding mango hybrids along with popular chance seedlings for nutritional, environmental and economic returns. But sometimes mango productivity suffers under low temperature (< 10°C) once in 4-5 years in Uttarakhand (Rathore *et al.,* 12). So far, most of research on mango have been done on arable lands with assured input supply, but little information is available on rehabilitation and utilization of degraded lands and wastelands through fruit plants (Rathore *et al.,* 13 and Saroj *et al.,* 17), which covers about 146.82 mha in India and about 0.21 mha in foothills of Uttarakhand (Rathore *et al.,* 14). These waste lands are characterized as gravely riverbed land and are either lying vacant or underutilized due to undulating topography, shallow soil depth, poor soil organic carbon and water holding capacity (Rathore *et al.,* 10, 11 and 15). Fruit based models can mined moisture and nutrients from deeper layers, conserve soil moisture, reduce soil erosion, nutritional security, maintains sustainable production, besides biomass production, carbon sequestration, mitigating climate change and global warming (Rathore *et al.,* 15). Sequestering carbon through tree based systems is considered as an attractive economic opportunity for carbon trading. Despite the recognized importance of fruit trees for nutritional security, carbon sequestration and climate change mitigation, the assessment of the fruit production with carbon sequestration potential of fruit tree-based systems is still lacking. Fruit tree orchards have received attention in recent years by virtue of their potential to act as carbon pools (Phani

Article's History:
Received : 13-11-2016 ***Accepted : 06-12-2016***

Kumar *et al.,* 8; and Verma *et al.,* 20) besides production and nutritional security. Most promising fruit species like mango, peach, litchi, sweet orange, mandarin, lemon, grapefruit, citrus, guava, jackfruit, pomegranate, etc are being cultivated in the subtropical region of Uttarakhand.

Alternative only seems to utilize the non-arable lands or degraded lands for enhancing food production and nutritional as well as environmental security by means of carbon sequestration. Therefore, the present study was undertaken to generate information on growth, fruit production and carbon sequestration, which vary with the variations in environment and agro-climate. In view of the changes in environmental conditions and topographic features, efforts were made to assess the production potential of mango on degraded lands of foothills of Uttarakhand, Indian Himalayan region.

MATERIALS AND METHODS

Experiment was conducted during 2000 to 2014 at the Research Farm of ICAR-Indian Institute of Soil and Water Conservation (ICAR-IISWC), Selakui, Dehradun on uniformly grown Geographic position of experimental site lies between Latitude 30° 20' 40" N and Longitude 72° 52' 12" E with altitude of about 516.5 m amsl. Climate was humid subtropical with average rainfall of 1636 mm per annum. Average maximum and minimum temperature during experimentation ranged from 19.0-37.6 °C and 3.6-24.0 °C respectively. In the foothills of Uttarakhand (Doon Valley), May-June months are hottest and December-January months are coldest in the years. One year old grafts of mango cultivars were planted in square system at spacing of 8 m $\times$ 8 m in a pit size (1m^3) filled with recommended dose of NPK and farm-yard manure. The experiment was laid out in randomized block design with three replications. Six mango cultivars (T_1 = Amrapali, T_2 = Mallika, T_3 = Dashehari, T_4 = Langra, T_5 = Bombay green (BG) and T_6 = Ramkela) were evaluated under randomized block design (RBD) for 14 years. Four plants were kept as an experimental unit for recording of data in each cultivar of mango.

The experimental site was bouldery riverbed (class VI based on land capability classification) and situated at either side of Asan River, a tributary of River Yamuna. Average workable topsoil depth mixed with some gravels was lesser than even one fit. Surface soil of the experimental field was sandy-loam in texture, slightly acidic in reaction (pH 6.5) with medium organic carbon (0.52%), poor total N (0.060%), medium available P_2O_5 (11.13 ppm), Ca (0.19%), Mg (0.14%) and rich in available K_2O (52.92 ppm). N, P, K and soil organic carbon were analyzed as per procedure laid down by Black (2) and Walkley (22). Overall fertility status was very poor. Size and amount of gravels/boulder increased with increasing depth of soil profile. Mechanical analysis of soil particle (< 2.0 mm) indicates that the fraction of coarse sand (45.13 %), fine sand (29.73%), silt (13.74%) and clay (11.40%) were observed. Soil moisture content at field capacity and permanent wilting point ranged between 24.7-22.2 and 7.4 – 6.6 per cent, respectively in different soil horizons within 0-100 cm depth, whereas, bulk density of soil varied between 1.10-1.14 Mg m^{-3}.

Observations on canopy spread and fruit yield was recorded. Carbon stock in different part of mango tree (roots, stems, twigs, leaves, fruits) in mango cultivars was obtained by multiplying the dry weights of plant by their average carbon concentration present in them. Carbon was assumed to constitute 50% of the ash-free dry mass. Ash content was determined by igniting 1.0 g of powdered sample at 550°C for 6 h in muffle furnace and is expressed in Mg ha^{-1}. Statistical analysis was done for pooled data over the years for different parameters. The mean effect of treatments were compared at P< 0.05 level of significance (Gomez and Gomez, 3). The uniform training, cultural and plant protection practices were followed. Fruits of mango cultivars were counted to record the number and weight of fruits per tree.

RESULTS AND DISCUSSION

Canopy spread of mango is important factor which harvest solar energy for manufacturing food material, which was positively correlated with fruit yield (r2= 0.55) because of regular (cv. Mallika and Amrapali) and irregular (cv. Dashehari, Langra, Chausa and Ramkela) fruit bearing characteristics of mango (Fig. 1). Canopy spread was significantly varied among mango cultivars. Maximum mean canopy spread was recorded in Mallika (5.85 m) followed by Dashehari, Langra, Bombay green, Ramkela with lowest spread with Amrapali (4.5 m) grown on degraded lands during 2000 to 2014. Similarly, Mallika produced maximum fruit yield (9.85 t/ha) followed by Amrapali (8.00 t/ha), Dashehari (7.00 t/ha), whereas Ramkela produced lowest fruit yield (6.54 t/ha) with significant differences. Mallika and Amrapali cultivars of mango were regular fruit bearers, whereas Langra, Bombay green, Ramkela bear fruit in alternate years however, Dashehari cultivar was a partial fruit bearer. Canopy spread in mango cultivars increased continuously and growth pattern was sigmoid (Ram, 9; Singh and

Chadha, 18) in mango. Mallika attained maximum canopy spread and produced highest fruit yield due to varietal characters like regular bearing habit, biggest fruit size, maximum moisture conservation by plant canopy, mined more essential plant nutrients from soil, better acclimatization to climate of Doon Valley and sparse foliage favoured better light infiltration and photosynthesis, which were usually known to have pronounced relation with productivity since vigorous trees produced more fruit yield. Rao *et al.* (16) reported in aonla that more canopy spread was responsible for more photosynthesis and production of biomass including fruit yield. Rathore *et al.* (11) reported that more canopy spread conserved more moisture in soil profile by reducing evaporation losses in Indian goose berry. Kumar *et al.* (7) and Kanpure *et al.* (5) stated that regular bearing cultivars (Amrapali and Mallika) produced significantly higher fruit yield over irregular cultivars of mango.

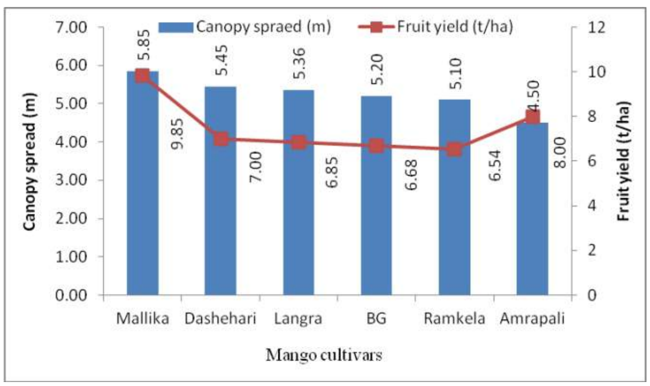

Fig. 1 : Canopy spread and fruit yields in various mango cultivars grown on degraded lands.

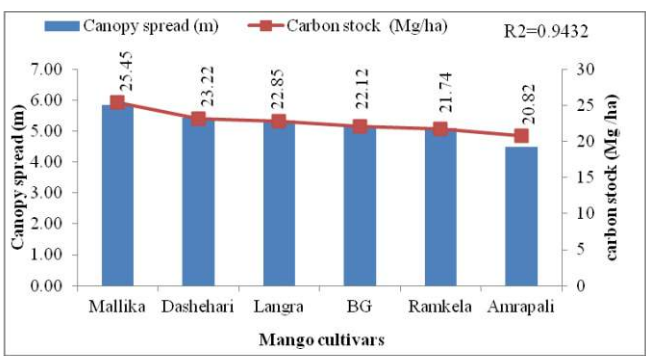

Fig. 2 : Canopy spread and carbon stock in various mango cultivars grown on degraded lands.

Canopy spread was also positively correlated with production of carbon stock among mango cultivars (r^2= 0.94), which means more canopy spread captured more carbon dioxide for CO_2 fixation in the plant body (Fig. 2). Total carbon stock (above ground including fruit yield and below ground) was highest in Mallika (28.45 Mg ha^{-1}) followed by Dashehari (26.22), Langra (25.85), Bombay green (25.12), Ramkela (24.74) with minimum in case of Amrapali (23.82 Mg ha^{-1}) cultivar in different mango tree components. Carbon stock refers to the absolute quantity of C held at the time of inventory (Takimoto *et al.,* 19). Large C stock does not necessarily mean a large C sequestration potential. The results are further in agreement with the findings of Kanime *et al.* (6) who reported that mango in tarai region (India) yielded 1.43 Mg C ha^{-1} yr^{-1}. Carbon absorption by plants is directly related to biomass production in different components (Verma, *et al.* 21). Soil C is currently not considered to be tradable. However, data revealed that plant biomass contained less amount of carbon stock as compared to soils. IPCC (4) also reported that globally carbon stocks in soil exceed carbon stocks in vegetation by a factor of five. Therefore, soil C is important when the potential for absorption for long-term storage is considered (Takimoto *et al.,* 19).

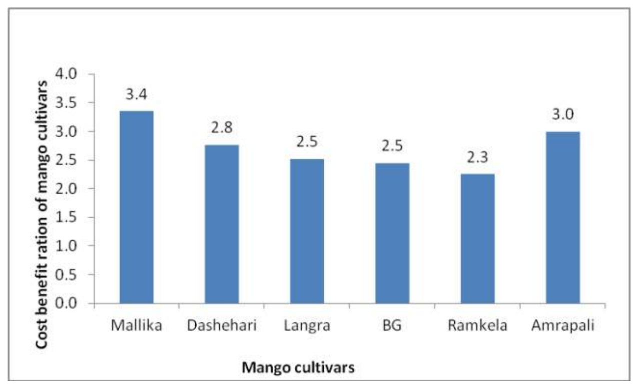

Fig. 3 : Cost benefit ratio of various mango cultivars grown on degraded lands.

The economic evaluation of mango cultivars indicated that all the cultivars were economically viable and profitable on degraded lands as they were having BCR > 1.0 (Fig. 3) which was recorded as 3.4, 3.0, 2.8, 2.5, 2.5, 2.3 in Mallika, Amrapali, Dahsehari, Langra, Bombay Green and Ramkela, respectively. Maximum fruit yield was harvested from Mallika which is most profitable because it bears fruit regularly every year and fruits are suitable for processing as it contains 73.73% hence industry prefers this cultivar for making various products and fetches good price in the market followed by Amrapali and Dashehari scored second and third position among mango cultivars based on BCR. Besides Mallika added more nutrients to the soil as it produces more litter ultimately going into soil and adding nutrients which improved soil fertility, soil moisture, moisture retention capacity and maintained soil microbial population on degraded lands. This indicated that the Mallika cultivar of mango is beneficial for restoration of degraded lands. Rathore *et al.* (13) and Verma *et al.* (21) had reported higher returns from mango and apple on degraded lands of Indian Sub-Himalaya.

Conclusion

Mango (cv. Mallika) was recorded maximum fruit productivity, carbon sequestration and economic returns among all mango cultivars grown on non-arable lands of Uttarakhand. However, Amrapali in fruit productivity and BCR and Dashehari in BCR and carbon sequestration got second position among mango cultivars grown on degraded lands in foothills of Uttarakhand in North Western Himalaya. Hence, Mallika cultivar of mango is recommended for cultivation on degraded lands for productivity, economic returns and carbon sequestration in the Uttarakahnd.

REFERENCES

1. Anonymous. (2001). *Horticulture Production Year Book*-2001. National Horticulture Board, Ministry of Agriculture, Govt. of India.
2. Black, C.A. (1965). *Methods of Soil Analysis,* Vol. 1, Madison (WI): American Society of Agronomy.
3. Gomez, K.A. and Gomez, A.A. (1984). *Statistical Procedures for Agricultural Research*. John Wiley & Sons, New York.
4. IPCC (2000). "*Land use, land use change and forestry: a special report of the Intergovernmental Panel on Climate Change"*. Edited by: Watson, RT and Dokken, DJ. 25–51. UK: WMO/UNEP, CUP. Cambridge, England: Cambridge University press.
5. Kanpure, R.N., Singh, H.P and Reja, R.K. (2009). Evaluation of mango hybrids for Kymore Plateau of Madhya Pradesh. *J. Comm. Mobil. and Sustain Dev.,* **4**(2): 70-73.
6. Kanime, N., Kaushal, R., Tewari, S.K., Raverkar, K.P., Chaturvedi, S. and Chaturvedi, O.P. (2013). Biomass production and carbon sequestration in different tree based systems of central Himalayan Tarai region. *Forests, Trees and Livelihoods,* **22** (1) : 38-50, DOI:10.1080/14728028. 2013. 764 073.
7. Kumar, R., Rajan, S. and Negi, S.S. (2002). Evaluation of important mango cultivars of diverse origin for their fruit set behaviour under Lucknow conditions. *Indian J. Plant Resour.,* **15** (3): 267-268.
8. Phani Kumar, G. Murugan, M.P., Ashutosh, A. Murkute and Singh, S. (2010). A carbon sequestration strategy involving temperate fruit crops in the trans-Himalayan region. *J. Hortic. Sci. & Biotech***,** **85** (5): 405-409.
9. Ram, S. (1993). Factors affecting mango tree architecture. *Acta Hort.,* **341** : 117-91.
10. Rathore, A.C., Raizada, A. and Jayaprakash, J. (2008). Performance of phalsa (*Grewia subinequalis* Lin.) under integrated nutrient and canopy management on saline soils of the Indo-gangetic plains. *Ind. J. Soil Cons.,* **36** (1) : 42-47.
11. Rathore, A.C., Lal, H., Jayaprakash, J. and Chaturvedi, O.P. (2011). Productivity evaluation of Indian gooseberry cultivars on degraded lands under rainfed condition of North West Himalaya. *Ind. J. Soil Cons.,* **39** (1) : 63-66.
12. Rathore, A. C., Raizada, A., Jayaprakash, J. and Sharda, V. N. (2012). Impact of chilling injury on common fruit plants in the Doon Valley. *Curr. Sci,* **102** (8) : 1107-1111.
13. Rathore, A.C., Saroj, P.L., Lal, H., Sharma, N.K., Jayaprakash, J., Chaturvedi, O.P., Raizada, A., Tomar, J.M.S. and Dogra, P. (2013). Performance of mango based models under rainfed situation in North – Western Himalaya. *Agrofor Syst.* **87** : 1389-1404.
14. Rathore, A.C., Lal, H., Sharma, N.K., Jayaprakash, J., Mehta, H. and Chaturvedi, O.P. (2014). Livelihood security through Litchi (*Litchi chinensis* L.)-based agri-horticultural models for resource-poor communities of Indian Sub-Himalaya. *Curr. Sci.,* **106** (11) : 1081-1484.
15. Rathore, A.C., Kumar, A., Tomar, J.M.S. Jayaprakash, J., Mehta, H., Kaushal, R., Alam, N.M., Gupta, A.K. and Chaturvedi, O.P. (2016). Predictive models for biomass and carbon stock estimation in *Psidium guajava* on bouldery riverbed lands in North-Western Himalayas. India. *Agrofor Syst.,* DOI:10.1007/s10457-016-0023-z
16. Rao, V.K., Rathore, A.C. and Singh, H.K. (2009). Screening of Aonla (*Emblica officinalis* Gaertn.) cultivars for leaf chlorophyll and amino acid under different sodicity and salinity levels. *Ind. J. Soil Cons.,* **37** (3) : 193-196.
17. Saroj, P.L., Dubey, K.C. and Tiwari, R.K. (1994). Utilization of degraded lands for fruit production. *Ind. J. Soil Cons.,* **22** (1&2) : 162-176.

18. Singh, H. and Chadha, K.L. (1981). Evaluation of some mango cultivars on the basis of their biochemical composition. *Indian J. Hort.,* **38** : 70-3.

19. Takimoto, A., Nair, P.K. and Nair, V.D. (2008). Carbon stock and sequestration potential of traditional and improved agroforestry systems in the West African Sahel. *Agri. Ecosyst. Environ.,* **125** : 159–166.

20. Verma, A., Kaushal, R., Alam, N.M., Mehta, H., Chaturvedi, O.P., Mandal, D., Tomar, J.M.S., Rathore, A.C. and Singh, C. (2014). Predictive models for biomass and carbon stocks estimation in Grewia optiva on degraded lands in Western Himalaya. *Agrofor Syst.,* DOI 10.1007/s 10457-014-9734-1.

21. Verma, M. L., Sharma, Rakesh, Singh, Charan and Rathore, A. C (2010). Influence of organic manuring on apple performance and soil properties in temperate zone of Himachal Pradesh. *Indian J. Soil Conser.,* **37** (3) : 193-196.

22. Walkley, A.J. and Black, I.A. (1934). Estimation of soil organic carbon by chronic acid titration method. *Soil Sci.,* **37** : 29–38.

❑

Citation : Rathore A.C., Kadam D.M., Doharey V.K. and Umrao V.K. (2016). Evaluation of production potential of subtropical mango under degraded lands in foothills of Uttarakhand. *HortFlora Res. Spectrum,* **5**(4) : 301-305.