Evaluation of Under-utilized Fruit Tree Species in Hortipastoral System

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ABSTRACT

A study was conducted during 1995 to 2001 at National Research Centre for Agroforestry, Jhansi, to evaluate the performance of twelve fruit tree species, viz. *Emblica officinalis* (Aonla), *Buchanania lanzan* (Chironji), *Annona squamosa* (Custard apple), *Aegle marmelos* (Bael), *Cordia myxa* (Lasora), *Morus rubra* (Red mulberry), *Tamarindus indica* (Tamarind), *Punica granatum* (Pomegranate), *Achras zapota* (Sapota), *Manilkara hexandra* (Khirni), *Limonia acidissima* (Kainth) and *Ziziphus mauritiana* (Deshi Ber) in hortipastoral system. The study revealed that the fruit trees namely, *Emblica officinalis*, *Cordia myxa*, *Morus rubra* and *Ziziphus mauritiana* proved hardy and precocious and could be grown successfully with satisfactory plant establishment, survival and growth in rangelands of semi-arid regions in association with natural vegetation, while the fruit species, viz. *Buchanania lanzan*, *Annona squamosa* and *Achras zapota* were not suitable for growing in hortipastoral system in rangelands because of their poor establishment and survival.

Key words : *Under utilized fruit trees, hortipasture*

India having attained self-sufficiency in food grains, is yet to attain nutritional security by producing fruits and vegetables in sufficient quantities for its populace. One of the ways to enhance fruit production is by horizontal expansion in so far untapped areas. The land use data indicates that about one half of the geographical area, i.e. 158.06 m ha, of the country is wasteland or degraded land yielding less than 20 per cent of its biological productivity (NWDB, 1986). Because of rising pressure of human population, per capita land availability is declining day by day leading to the use of all possible cultivable land for raising food crops such as cereals, pulses and oilseeds being the top priority. Moreover, farmers are often reluctant in diverting their good fertile land for fruit cultivation. There are several under-utilized less known, highly nutritious and hardy fruit tree species which have bright prospects for commercial exploitation, are yet to be utilized to their full potential (Pareek and Sharma, 1993). These under utilized tree species have tremendous scope for expanding fruit cultivation through horti-pastoral system of agroforestry, which ensures not only fruit production but also gives forage for the huge livestock population. Keeping this in view, efforts were made to evaluate twelve under-utilized fruit trees in hortipastoral system in the present investigation.

The experiment was laid out in Randomised Block Design (RBD) with twelve treatments and three replications at the experimental farm of National Research Centre for Agroforestry, Jhansi, in red gravelly soils. The under utilized fruit tree species included in the experiment were viz. *E. officinalis* (Aonla), *B. lanzan* (Chironji), *A. squamosa* (Custard apple), *A. marmelos* (Bael), *C. myxa* (Lasora), *M. rubra* (Red mulberry), *T. indica* (Tamarind), *P. granatum* (Pomegranate), *A. zapota* (Cheeku), *M. hexandra* (Khirni), *L. acidissima syn. F. limonia* (Kainth) and *Z. mauritiana* (Deshi Ber). Five trees of each fruit tree species planted in a row, were maintained in each replicate. Seedlings of these fruit tree species were raised/procured and planted in prepared pits of 0.75cm X 0.75cm X 0.75cm spaced at 6 m in a row in July 1995. Rows were also spaced 6.0 m apart. Though the experiment was under rainfed condition, fruit plants were watered from time to time in the first year of experimentation to avoid mortality during hot summer. Data were recorded on plant establishment in first year, survival in subsequent year. Growth parameters, viz. plant height, canopy diameter and stem girth were recorded using measuring tape. Mean of the canopy diameters noted for East-West and North-South directions was used for analysis of data. Stem girth was recorded in the collar region of the tree stem at a marked point. The observations on fruit yield were also recorded after start of flowering and fruiting in different tree species. Harvesting of pasture component was carried out every year in the month of October and data were recorded on forage production from the pasture component maintained in the fruit tree interspaces. Observations on precocity of fruit trees and fruit yield (kg/plant) were also recorded. Data on growth parameters and forage yield were analyzed

statistically as per methods given by Panse *et al.* (1985).

Data on plant establishment of fruit trees were recorded in the month of June 1996 during first year. The data presented in table 1 reveals maximum plant establishment in *C. myxa* (93.3 %) followed by 86.7 percent in case of *E. officinalis, M. rubra* and *A. marmelos*, 80.0 per cent in case of *Z. mauritiana* and *P. granatum*, 73.3 per cent in *T. indica* and *L. acidissima*. Poor establishment was recorded in *M. hexandra* (46.7%). *A. zapota* and *A. squamosa* showed 26.7% and 6.7% establishment, while *B. lanzan* exhibited cent per cent mortality. The treatments showed significant differences. Data recorded on plant survival in June 1997 (Table 1) after gap filling in July 1996, depict cent per cent survival in *C. myxa* and it reduced to 93.3 per cent in *E. officinalis*, 86.7 per cent in *M. rubra*, *T. indica* and *Z. mauritiana*, 80 per cent in *P. granatum* and *M. hexandra*, 73.3 per cent in *A. marmelos* and *L. acidissima*. The plant survival in *E. officinalis* and *C. myxa* was significantly higher than *M. rubra, Z. mauritiana, T. indica* and *M. hexandra*. Three species, namely *B. lanzan, A. squamosa* and *A. zapota* were deleted form the experiment due to the poor establishment and survival of plants. Poor establishment and survival of fruit trees, namely *A. zapota*, *A. squamosa* and *B. lanzan* planted under hortipastoral system may be due to varying ability of fruit plants to compete with pasture component maintained in the tree interspaces. Rai *et al.* (1998) also recorded adverse effects of pasture (*Chrysopogon fulvus* + *Stylosanthes hamata* + *S. scabra*) on the establishment of tree component (*Acacia nilotica* var. *cupressiformis*, *Dalbergia sissoo* and *Hardwickia binata*) in silvipasoral system.

Table 1 : Establishment, survival and growth parameters of fruit trees and forage yield in hortipastoral system.

Fruit tree species	Establishment (%)	Survival (%)	Growth parameters in 1999			Dry forage yield (t ha^{-1})			
			Plant height (m)	Canopy diameter (m)	Stem girth (cm)	1997	1998	1999	2000
Emblica officinalis	86.7	93.3	3.40	3.44	30.40	3.51	4.89	4.30	3.97
Cordia myxa	93.3	100	3.07	3.08	35.97	3.91	4.20	3.46	3.99
Morus rubra	86.7	86.7	3.47	3.86	27.60	4.51	4.30	3.86	5.53
Tamarindus indica	73.3	86.7	2.38	2.08	21.80	4.31	4.87	4.52	4.47
Manilkara hexandra	46.7	80.0	1.19	0.65	8.94	4.79	5.04	4.42	5.52
Aegle marmelos	86.7	73.3	2.06	1.71	16.75	4.47	6.02	4.71	4.21
Punica granatum	80.0	80	1.82	1.41	15.14	5.49	5.12	4.06	5.59
Limonia acidissima	73.3	73.3	0.97	0.91	17.75	4.62	4.28	4.71	5.49
Ziziphus mauritiana	80.0	86.7	2.58	2.80	17.25	4.68	4.06	3.33	3.91
CD (5%)	15.6	11.5	0.62	0.86	7.26	NS	NS	NS	1.42

Data on plant height, stem girth and canopy diameter recorded in December 1999, have been presented in the Table 1. Plant height of different fruit tree species varied from 0.97 m to 3.47 m. Maximum height was attained by trees of *Morus rubra* (3.47 m) followed by *E. officinalis*, *C. myxa*, *Z. mauritiana*, *T. indica*, *A. marmelos* and *P. granatum*. The plant height attained by *M. rubra* and *E. officinalis* was significantly higher than other fruit trees. The tree height of *C. myxa* was statistically at par with *Z. mauritiana*. *L. acidissima* attained minimum plant height (0.97 m) which was statistically akin with *M. hexandra*, but significantly lower than all other fruit species. Both *L. acidissima* and *M. hexandra* exhibited slow growth habit in hortipastoral system. Canopy diameter of fruit trees exhibited a trend almost similar to that of plant height. Maximum canopy diameter was recorded in *M. rubra* (red mulberry) followed by *E. officinalis*, *C. myxa*, *Z. mauritiana*, *T. indica*, *A. marmelos* and *P. granatum*. Minimum canopy diameter was noticed in *M. hexandra* (0.65 m) which was statistically at par with *L. acidissima, P. granatum and A. marmelos*. *M. rubra*, *E. officinalis* and *C. myxa* were statistically alike in respect of canopy diameter but they had significantly higher canopy diameter than all other fruit species under the study. The stem girth in fruit trees varied from 8.94 cm to 35.97 cm. *C. myxa* attained maximum stem girth (35.97 cm) which was significantly higher than all the fruit tree species under the study except *E. officinalis*, which exhibited non-significant

differences. The fruit species, namely *T. indica*, *L. acidissima*, *Z. mauritiana* and *A. marmelos* were statistically alike with regard to stem girth. Minimum stem girth recorded in *M. hexandra* was statistically at par with that of *P. granatum*.

The variation in the growth behaviour of fruit trees under hortipastoral system may be due to differences in species characteristics genotypic variation, inherent ability to compete with pasture component or differential root growth pattern to avoid competition with shallow rooted pasture grasses. The fruit species such as *Morus rubra*, *E. officinalis*, *C. myxa* and *Z. mauritiana* were not much affected by pasture. Similar results were obtained by Muthana *et al.* (1977) in case of *H. integrifolia* when intercropped with *C. ciliaris*. Debroy *et al.* (1980) also recorded that growth of *A. tortilis* trees was not affected adversely, when grown with grasses such as *C. ciliaris* or *C. setigerus*. On the other hand, the growth of *A. nilotica* var. *cupressiformis*, *D. sissoo* and *H. binata* was adversely affected when grown with pasture during initial seven years (Rai *et al.*, 1998).Variations in the growth parameters of various Multipurpose Trees in terms of tree height, canopy diameter and diameter at breast height (dbh) were also recorded by Rai *et al.* (2000).

Data on forage production (Table 1) revealed that dry forage production varied from 2.53 to 4.78 t/ha during 1997, 3.51 to 5.68 tonnes/ha during 1998, 3.33 to 4.71 tonnes/ha during 1999 and 3.91 to 5.59 tonnes/ha during 2000 after five years of plantation in association with various fruit trees. The data during initial four years exhibited non-significant differences, with respect to forage production, amongst different treatments. It clearly indicates that fruit tree species during initial four years did not offer any competition with the pasture component. This might be due to smaller crown area and low interception of light by trees in the initial years. Earlier, Evans *et al.* (1976) have opined that although growth of plant species is governed by various environmental factors, but among these, light is most important. These results are in conformity with Kaushik *et al.* (2002), Gill (1998) and Subhramanyam (1996). In the year 2000, dry forage production exhibited significant differences in association with different fruit species. Highest forage production was recorded in association with *P. granatum* (5.59 t/ha) which was statistically at par with *M. rubra*, *M. hexandra*, *L. acidissima*, *T. indica* and *A. marmelos*. Forage production in association with *P. granatum*, *M. rubra*, *M. hexandra* and *L. acidissima* was significantly higher than *C. myxa*, *E. officinalis* and *Z. mauritiana*. The forage production was minimum in association with *Z. mauritiana*, which exhibited non-significant differences when compared with *C. myxa* and *E. officinalis*. The reduction of forage yield in association with fruit trees during 2000 may be due to competition for light, moisture and nutrients between tree and pasture component. Similar results were recorded by Ramshie *et al.* (1995) in case of pearl millet and red gram, wherein, crop yield was reduced in association with *D. sissoo* and *A. indica* with the increase in age of trees.

The observations were also recorded on the start of flowering and fruiting (precocity) of tree species. *M. rubra* and *Z. mauritiana* started flowering and fruiting five years after planting, giving a fruit yield of 1.15 kg/plant and 2.4 kg/plant, respectively. After six years of planting in the year 2000-2001, *E. officinalis and C. myxa* also started flowering and fruiting, besides *M. rubra* and *Z. mauritiana*. An average yield of 1.75, 3.55, 19.45 and 3.3 kg/tree was obtained from *Mo. rubra*, *Z. mauritiana*, *E. officinalis* and *C. myxa* during 2000-01. The fruit yield obtained from the tree component will go long way in ensuring the economic viability of the hortipastoral system. The higher economic gain from hortipastoral system (Sharma and Diwakar,1989) and the enhanced productivity of marginal and degraded lands through horti-silvipastoral system (Raturi and Hiwale,1993) have been reported.

On the basis of the study, it can be concluded that the fruit trees namely, *E. officinalis*, *C. myxa*, *M. rubra* and *Z. mauritiana* are hardy and precocious and can be grown successfully with satisfactory plant establishment, survival and growth in rangelands of semi-arid regions in association with natural vegetation. The yield reduction in dry forage production from the fruit tree interspaces will be compensated by the fruit yield from the tree component. The findings also indicated that fruit species, viz. *B. lanzan*, *A. squamosa* and *A. zapota* are not suitable for growing in hortipastoral system in rangelands because of their poor establishment and survival.

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