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RESEARCH ARTICLE

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# Studies on tamarind (*Tamarindus indica*) + curryleaf (*Murraya koeingii*) in silvi-horti system on red gravelly degraded land conditions

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**ABSTRACT :** In an agroforestry practice of land use pattern, the study on integration of curryleaf with tamarind was conducted from 2002 to 2016 on red gravelly degraded soil conditions of Main Agricultural Research Station, University of Agricultural Sciences, Dharwad. The ten tamarind clones *viz.,* V-2, TH, H-5, P-11, S-132, U-112, PKM-2, B-1, S-201 and HR-107 were planted at 6 x 6 m spacing and curryleaf of two rows planted at 2 x 2 m apart in the inter space of tamarind alley in three replications in the Randomized Block Design. The curryleaf yield was higher when it is grown in V-2 tamarind clone. Fruit yield of tamarind was higher in V-2 and PKM-2 clones as compared to other clones. Among the agroforestry systems, higher net returns, IRR per cent and B : C ratio were recorded in the V-2 tamarind clone + Curryleaf (Rs. 9,764.5/ha/yr; 64 % and 2.16 respectively) followed by the clone PKM-2 + Curryleaf (Rs. 8,561.8/ha/yr; 51 % and 1.85, respectively) as compared to other clones. The integration of curryleaf at the initial stage of tamarind orchard is more successful practice of establishment of tamarind plantations.

**KEY WORDS :** Agroforestry system, Tamarind, Curryleaf, Inter crop, Degraded land

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## INTRODUCTION

In hill rainfall zone, soil is subjected to erosion. The sloppy nature of land and heavy rains are the main causes of erosion and soil degradation. Animals are allowed to graze throughout the year. There is very little scope for agriculture in degraded lands. As these lands are not suitable for agriculture, they can be utilized for growing of fast growing tree species in combination with fruit crops like tamarind which is a very hardy species. Tamarinds is often planted with wider spacing considering its growth habit and for few initial years till the canopy closes, lot of inter space and other resources are available. They could be used for raising arable crops or to grow short rotation tree crops like curry leaf. In the sloppy areas where arable cropping is not feasible, the inter space could be conveniently used to grow short rotation tree

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crops. This kind of mixed tree farming would help to prevent soil erosion and increase biodiversity apart from providing additional income. Mixed multipurpose trees will be more sustainable than any single orchard planting (Mariaselvam, 1994).

Silvi-horticulture system has been successful in degraded site conditions where land is limited for growing of agricultural crops. The premier horticultural plantations like mango, cashew, amla, tamarind can be grown economically and ecologically they benefit for the farming community. Tamarind is mainly grown for fruit / pulp purpose and also as condiment etc. It is one of the profitable crop in the degraded site conditions.

Agroforestry which is a need of the hour for mitigating the problems in degraded dry lands, aims at matching the land capacity in the minimum risk and maximum generation of income through efficient utilization of resources. The main aim of agroforestry in degraded site conditions is to improve the site conditions and to optimize the productivity of agricultural crops as well as forest crops (Young, 1997). Tamarind is well suited for dry lands and profitable tree spice crop for commercial cultivation. Intercropping in perennial plantation is one of the major forms of multiple cropping for increasing the production and profit in available land. In intercropping system, productivity is improved either by efficient interception of available solar energy or by having crop of greater radiation use efficiency (Anonymous, 1979).

Tamarind allows intercropping with a variety of annual crops. Different vegetables and legumes can be grown in the interspaces of tamarind plantation to augment the farm income and also to improve the soil fertility for the initial 3 to 6 years. Tamarind has got tremendous export potential due to the international interest on Indian curry (Geroge and Rao, 1997). Although tamarind has commercial potential as a species of wide adaptability and amplitude of uses, little attempt has been directed to improve it as a crop plant (Nicodemus *et al.*, 1997 and Gunasena and Hughes, 2000) and to reduce its reproductive age.

The rate and extent to which biophysical resources are captured and utilized by the component crops in a multiple cropping system are determined by the nature and intensity of interactions among crops. The net effect of these interactions is often determined by the influence of the tree components on the other components and on the overall system (Rao *et al.*, 1998 and Ranpise *et al.*, 2006). There is no back ground information available on the performance of curryleaf as intercrop in tamarind plantation suiting the agronomic conditions of Northern dry zone of Karnataka. Hence, a scientific approach to intercropping of curryleaf in tamarind plantation was undertaken to assess the comparative performance as intercrop in young tamarind plantation (eight year old) and as mono crop in an open area.

## EXPERIMENTAL METHODS

A field experiment was initiated from 2002 to 2016 at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad, Karnataka to study the integration of curryleaf with tamarind clones. The soil of the experiment site is red gravelly soil with depth of 50 cm and having the pH of 6.8. The available nitrogen, phosphorus and potassium content were 172.4, 18.6 and 210 kg/ha, respectively.

The mean annual rainfall is 782.6 mm recorded in 57.2 rainy days. The mean monthly maximum temperature ranges from 28.6$^0$C and 35.1$^0$C and mean monthly minimum temperature ranges from 13.3$^0$C and 21.9$^0$C. The experiment consisted of 10 sources of tamarind *viz*., V-1, TH, H-5, P-11, S-132, U-112, PKM-2, B-1, S-201 and HR-107 planted at 6 x 6 m spacing. Curryleaf was planted at 2 x 2 m in two rows in the inter space of tamarind rows with three replications in Randomized Block Design. During the summer season, protective irrigation or pot watering was done to curry leaf and tamarind. The soil working and basin cleaning was done at the time of onset of monsoon every year. The recommended fertilizers were applied to the curryleaf and tamarind at time of onset of the monsoon. Suitable plant protection measures were taken up to control pest and diseases. Silvicultural operations of tamarind *viz*., the pruning of side branches from bottom at 2/3$^{rd}$ height was made from second year onwards. The leaf yield of curryleaf was harvested three to four times every year and was sold in the local market and back pruning was made to currykleaf for better growth.

The income from curryleaf and fruit yield from tamarind collected every year. Observations like height, DBH, spread were collected from tamarind and curryleaf every year. The economic analysis was made based on the market rates of curryleaf yield obtained. Fruit yield and firewood yield from tamarind was also considered for economic analysis.

## EXPERIMENTAL RESULTS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under the following heads :

### Growth attributes of tamarind:

Height of tamarind was significantly higher in V-2 clone (10.17 m) followed by the clone PKM-2 (8.67 m) and lowest was observed in clone B-1 (6.77 m). Similarly DBH was significantly higher in clone V-2 (24.80 cm) followed by TH (23.20 cm) and PKM-2 (21.07 cm) as compared to HR-107 (16.63 cm). Crown spread was higher is HR-107 (22.07 $m^2$/pl) followed by S-132 (19.67 $m^2$/pl) and on TH (18.46 $m^2$/pl) as compared to other clones (Table 1).

The fruit yield of tamarind started from the year 2010; however economic yield was recorded from the year 2012-13. Mean fruit yield was higher in PKM-2 (16.72 kg/plant) followed by V-2 (16.03 kg/plant) clones as compared to the others. Similar observations were recorded in the various studies in different parts of the country. Tamarind trees were intercropped with coleus produced significantly higher plant height, spread and

**Table 1 : Growth and yield parameters of tamarind as influenced by tamarind + curryleaf based agroforestry system**

| Sr. No. | Tamarind sources | Tamarind | | | |
|---|---|---|---|---|---|
| | | Height (m) | DBH (cm) | Crown area ($m^2$/pl) | Mean fruit yield (kg/pl) |
| 1. | V-2 + CL | 10.17 | 24.80 | 17.63 | 16.03 |
| 2. | TH + CL | 8.17 | 23.20 | 18.46 | 12.54 |
| 3. | H-5 + CL | 7.83 | 16.73 | 16.25 | 10.05 |
| 4. | P-11 + CL | 7.87 | 16.25 | 17.52 | 12.49 |
| 5. | S-132 + CL | 7.02 | 17.22 | 19.67 | 11.50 |
| 6. | U-112 + CL | 8.13 | 18.17 | 16.40 | 7.57 |
| 7. | PKM-2 + CL | 8.67 | 21.07 | 18.22 | 16.72 |
| 8. | B-1 + CL | 6.77 | 18.96 | 17.68 | 11.56 |
| 9. | S-201 + CL | 6.78 | 15.60 | 19.56 | 13.28 |
| 10. | HR-107 + CL | 6.87 | 16.63 | 22.07 | 14.14 |
| | S.E. ± | 0.63 | 1.91 | 0.51 | 0.43 |
| | C.D. (P=0.05) | 1.87 | 5.67 | 1.52 | 1.29 |

CL: Curryleaf

**Table 2 : Growth parameters and leaf yield of curryleaf as influenced by tamarind + curryleaf agroforestry system**

| Sr. No. | Tamarind sources | Curryleaf | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Height (m) | Collar diameter (cm) | Leaf yield (kg/ha) | | | | | | | | | | | Mean leaf yield (kg/ha) |
| | | | | 2002-03 | 2003-04 | 2004-05 | 2005-06 | 2006-07 | 2007-08 | 2008-09 | 2009-10 | 2010-11 | 2011-12 | 2012-13 | |
| 1. | V-2 + CL | 1.34 | 4.26 | 399 | 2105 | 3213 | 3634 | 1845 | 1763 | 1745 | 1480 | 997 | 809 | 211 | 1655 |
| 2. | TH + CL | 1.50 | 4.30 | 488 | 1418 | 2903 | 3479 | 1895 | 1896 | 1811 | 1163 | 643 | 421 | 116 | 1476 |
| 3. | H-5 + CL | 1.32 | 4.65 | 443 | 1042 | 2659 | 2748 | 1812 | 1829 | 1812 | 1119 | 598 | 488 | 122 | 1334 |
| 4. | P-11 + CL | 1.10 | 5.01 | 554 | 798 | 2105 | 2814 | 1728 | 1779 | 1728 | 1042 | 543 | 399 | 100 | 1235 |
| 5. | S-132 + CL | 1.50 | 5.21 | 620 | 776 | 2282 | 2681 | 1413 | 1529 | 1591 | 1053 | 543 | 343 | 83 | 1174 |
| 6. | U-112 + CL | 1.42 | 5.16 | 709 | 731 | 2438 | 2748 | 2659 | 2530 | 2476 | 1053 | 709 | 543 | 133 | 1521 |
| 7. | PKM-2 + CL | 1.24 | 4.92 | 798 | 598 | 2327 | 3014 | 2111 | 2179 | 2177 | 1086 | 676 | 576 | 144 | 1426 |
| 8. | B-1 + CL | 1.36 | 5.12 | 709 | 798 | 2548 | 1928 | 1562 | 1563 | 1562 | 809 | 632 | 521 | 127 | 1160 |
| 9. | S-201 + CL | 1.32 | 4.15 | 288 | 687 | 2327 | 1440 | 947 | 965 | 947 | 742 | 476 | 355 | 89 | 842 |
| 10. | HR-107 +CL | 1.32 | 4.86 | 332 | 598 | 2393 | 1241 | 615 | 664 | 515 | 509 | 377 | 321 | 78 | 695 |
| | Mean | - | - | 534.0 | 955.1 | 2519.5 | 2572.7 | 1658.7 | 1669.7 | 1636.4 | 1005.6 | 619.4 | 477.6 | 120.3 | - |
| | S.E. ± | 0.19 | 0.18 | - | - | - | - | - | - | - | - | - | - | - | - |
| | C.D. (P=0.05) | 0.56 | 0.53 | - | - | - | - | - | - | - | - | - | - | - | - |

CL: Curryleaf

crown size when observed after the harvest of coleus in Chikkodi, Karnataka (Kumar *et al.*, 2013). Higher growth attributes of tamarind trees due to intercropping of coleus is attributed to beneficial effect of manuring, irrigation and other management practices on coleus in the plantation, favorable effect on the growth of young mango trees (main crop) due to intercropping was also reported by Rajput *et al*. (1999) and Kabiraj *et al.* (2008). It was observed that the plants under cropped area were relatively taller and thicker in comparison to uncropped area. This may be due to their ability to retain more soil moisture and provided better microclimate favoring growth performance (Vanlalhluna and Sahoo, 2008 and Vanlalhluna *et al.*, 2008).

**Growth attributes of curryleaf:**

As leaf yield is economic part in curryleaf and was harvested four times and height and collar diameter of the plants were recorded before pruning of the curryleaf.

At the initial stage (2002-03), green leaf yield of curryleaf was higher in PKM-2 + CL (798kg/ha) and U-112 + CL (709 kg/ha) as compared to other tamarind clones *viz*., V-2 + CL (399 kg/ha). During the year 2007-08, green leaf yield was higher when curryleaf grown with U-112 (2530 kg/ha) followed by curryleaf with PKM-2 (2179 kg/ha) as compared to curryleaf with HR-107 (664 kg/ha). After the year 2007-08, green leaf yield decreased in each treatment (Table 2). The variation in the leaf yield is due to the crown spread of tamarind clone. The mean green leaf yield was higher in curryleaf with V-2 (1655 kg/ha) followed by U-112 (1521 kg/ha) and TH (1476 kg/ha) tamarind clones as compared to HR -107 (695 kg/ha) clones. Leaf yield was negatively correlated to the spread of the tamarind clones.

**Economic evaluation of tamarind + curryleaf in silvi-horticulture system:**

Curryleaf yield was higher in the initial stages and decreased gradually from the year 2007-08 onwards as the crown area of tamarind increased. Among the treatments, green leaf yield of curryleaf was higher when grown along with V-2, TH and PKM-2 tamarind sources as compared to other sources.

The tamarind fruit yield started after the year 2009-10, however the economical yield was obtained from 2013-14 onwards. Among the different sources of tamarind, V-2, TH and P-11 and PKM-2 have recorded higher fruit yield as compared to other sources. Subsequently fruit yield increased along with the other parameters of tamarind. At the end, economic evaluation was based on prevailing market rates of curryleaf and fruit and fuel wood yield obtained from tamarind.

Among the tamarind + curryleaf intercropping system, tamarind source V-2 with curryleaf recorded higher net returns, IRR per cent and benefit cost ratio (Rs. 9764.5/ha/yr, 64 %, 2.16, respectively) followed by PKM-2 + curryleaf (Rs. 8561.8/ha/yr, 51 % and 1.85, respectively) as compared to other treatments. Total Gross Income for 14 years from tamarind + curryleaf based agroforestry system was highest in V-2 source (Rs. 15424.4/ha/yr) followed by TH (Rs. 13106.4/ha/yr) as compared to tamarind clone HR-107 (Rs. 8651.9/ha/yr) (Table 3).

The maximum and minimum returns were recorded in tamarind + custard apple + redgram (Rs. 29972/-) and tamarind + curryleaf + cowpea (Rs.12,866/-), respectively

**Table 3 : Economic evaluation of tamarind + curryleaf based agroforestry system**

| Sr. No. | Tamarind sources | Gross returns (Rs./ha/yr) | Cost of cultivation (Rs./ha/yr) | Net returns (Rs./ha/yr) | IRR (%) | B : C |
|---|---|---|---|---|---|---|
| 1. | V-2 + CL | 15424.4 | 5455.8 | 9764.5 | 64 | 2.16 |
| 2. | TH + CL | 13106.4 | 5455.8 | 7446.5 | 48 | 1.75 |
| 3. | H-5 + CL | 11474.9 | 5455.8 | 5815.1 | 42 | 1.62 |
| 4. | P-11+CL | 11772.2 | 5455.8 | 6112.3 | 37 | 1.37 |
| 5. | S-132+CL | 10902.2 | 5455.8 | 5242.3 | 39 | 1.64 |
| 6. | U-112+CL | 12133.1 | 5455.8 | 6473.1 | 45 | 1.68 |
| 7. | PKM-2+CL | 12963.2 | 5455.8 | 8561.8 | 51 | 1.85 |
| 8. | B-1 + CL | 10816.1 | 5455.8 | 5156.1 | 34 | 1.49 |
| 9. | S-201+CL | 9351.4 | 5455.8 | 3691.5 | 19 | 1.20 |
| 10. | HR-107+CL | 8651.9 | 5455.8 | 2991.9 | 17 | 1.13 |

CL: Curryleaf

in Hyderabad (Khan *et al.*, 2010). Tamarind with elephant foot yam as intercrop showed the highest benefit cost ratio (4.07:1) and intercropping with ginger also brought about appreciable benefit (3.24:1) in the young tamarind orchard (Das *et al.*, 2008). Similarly intercropping of coleus plants with tree components or horticulture crops is an attractive option as that would increase land use efficiency and simultaneously improve the economic status of the farmers (Kurian *et al.*, 2003). Hence, it can be recommended to grow the curryleaf of two rows in the initial stage of tamarind orchard in the red gravelly degraded site conditions.

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