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RESEARCH PAPER

Performance of tuber medicinal crops under sapota-jatropha based three-tier agroforestry system

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Abstract : Field experiments were conducted to find out performance of tuber medicinal crops (kalihari, kali musli and safed musli) under sapota-jatropha based three-tier agroforestry system at the Agronomy Farm (Block-E), ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari (Gujarat) during rainy season of year 2011 and 2012. The experiments were laid out in Randomized Block Design with six treatments and four replications. Three medicinal plants *viz*., kalihari (*Gloriosa superba* L.), kali musli (*Curculigo orchioides* Gaertn) and safed musli (*Chlorophytum borivilianum* Ker.) were selected for the present study. The observation on economic yield (q/ha) was recorded higher under sole crop of kalihari, kali musli and safed musli as compared to intercrop with sapota-jatropha in both the years. While, kalihari (1.79), kali musli (1.38) and safed musli (1.81) when grown as intercrop gave higher economic returns as compared to sole crop in 2011 and 2012.

Key Words : Agroforestry, Intercrop, Kalihari, Kali musli, Safed musli, Economics

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INTRODUCTION

Newly established forest plantations can be intercropped with medicinal plants similar to food crops until the trees cover the ground. The participation of the local people with the right to share benefits of the plantations, especially ownership to crops, has helped government to establish plantations without conflict with the local people in many Asian countries. The same approach can be employed for the cultivation of medicinal plants in the new plantations. In the rehabilitation of degraded forest lands, participating, planning and implementation with local communities and economic benefits from an early stage onwards will ensure commitment of the people. The intensity of shade experienced by the under storey medicinal plants growing in forests and tree plantation affects their growth and chemical composition. In recent year's attention has focused on the diversified medicinal plant production system for maximizing utilization of resources as compared to the monoculture cropping systems. The improved use of resources results in greater total intercrop yields as compared to sole crops of the same species grown on the same area (Oraon *et al.,* 2005). This allows judicious use of the internal spaces of the trees and crops promoting diversification, enhancing per capita land productivity and cultivation of the crops in demand (Willey, 1979). Medicinal plants in the nature are now under great pressure due to their excessive collection and exploitation (Laloo *et al.,* 2000). Continuous exploitation of several medicinal plant species and substantial loss of their habitats have resulted in the population decline of many high value medicinal plant species over the years (Kala and Sajwan, 2003). The global importance of medicinal plant materials is evident at national and international markets.

The Sapota fruit is a good source of digestible sugar (12-18%), protein, fat, fiber and minerals *viz.*, Ca, P and Fe. The fruit skin can also be eaten and is richer than the pulp in nutritive value (Gopalan *et al*., 1977). In the recent past Jatropha has evoked much interest all over the world as

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potential petrocrop (Martin and Mayeux, 1985). *Gloriosa superba* is an imperative medicinal plant, all parts are used in the medicine, which contains two important alkaloid, colchicine and colchicoside, and leaves are used to treat cancer related diseases, also in ulcer, piles, and scrofula (Evans *et al.,* 1981). Kali musli used as medicine, root is carminative, tonic, aphrodisiac, antipyretic and useful in bronchitis, ophthalmia, indigestion, vomiting, diarrhoea, lumbago, gonorrhoea, gleet, hydrophobia, joint pains etc. (Irshad *et al.,* 2006). Safed musli is a medicinal crop and generally grows in the forest (Prajapati *et al*., 2003). It grows under semi shade condition (Patel *et al.,* 2009). To increase the production per unit area and net income of the farmer with the developed suitable three-tier agroforestry system and to analyze the cost and benefits of the silvicultural, horticultural and medicinal crops association.

MATERIAL AND METHODS

Field experiments were conducted under rainfed conditions during *Kharif* season 2011 at Navsari Agricultural University, Navsari, Gujarat to "the performance of tuber medicinal crops (kalihari, kali musli and safed musli) under Sapota-Jatropha based three-tier agroforestry system". Geographically, Navsari is situated at 20° 95'N latitude, 75° 90'E longitude and at altitude of 10 metres above the mean sea level. The college farm is located 3 kilometres away in west from Navsari city and 12 kilometres away in the East from the historical place Dandi on Arabian Sea shore. The climate of the area is characterized by three well defined seasons *viz*., monsoon, winter and summer. The monsoon commences from the middle of June and ends by the second fortnight of September. Pre monsoon rains in the last week of May or in the first week of June are not uncommon. Most of the precipitation is received from South West monsoon, concentrated during the month of June, July and August. The winter season starts from November with mild cold and lasts up to February. December and January are the coldest months of the season and the minimum temperature registered during these months of the experimental period were 13.4^{0}C and 9.6^{0}C, respectively. Summer season commence during the middle of February and ends during middle of June. The temperature reached a maximum of 34.9^{0}C in the month of May. April and May are the hottest months of summer season. The climate of this area is humid and the mean relative humidity remained above 68.27 per cent throughout the year. The weather condition was favorable for growing rainy, winter and summer crops during this study.

The seven year old plantation of sapota (*Manilkara acharas* (Mill) Fosberg.) at 10.0m x 10.0m spacing, inter cropped with five year old plantation of jatropha (*Jatropha curcus* L.) at 2.5m x 2.5m spacing were used for intercropping study. Three medicinal plants *viz.*, kalihari (*Gloriosa superba* L.) at 30cm x 60cm, kali musli (*Curculigo orchioides* Gaertn) at 30cm x 30cm and safed musli (*Chlorophytum borivilianum* Ker.) at 30cm x 30cm were selected for the present study. The experiment was laid out in Randomized Block Design with replicated four times. There were 6 treatments- T_1 – *Manilkara achras* + *Jatropha curcas* + *Gloriosa superba*, T_2 – *Manilkara achras* + *Jatropha curcas* + *Curculigo orchioides*, T_3 – *Manilkara achras* + *Jatropha curcas* + *Chlorophytum borivilianum*, T_4 – *Gloriosa superba* sole, T_5 – *Curculigo orchioides* sole, T_6 – *Chlorophytum borivilianum* sole. Farm Yard manure was applied @ 20t/ha to all the plots uniformly and was incorporated into the soil at the time of land preparation. Nitrogen, phosphorus and potash were applied at the rate of 50:50:70 Kg per hectare (for Kalihari), 25:15:10 kg per hectare (for kali musli), 60:65:20 kg per hectare (for safed musli), respectively. Weeding and hoeing were done five times at 30, 60, 90 120 and 150 days after planting. Irrigations were applied at an interval of 15 days after the post-monsoon.

RESULTS AND DISCUSSION

The data regarding yield of Sapota was recorded 70q/ha in Sapota tree in 2011 and 75 q/ha in 2012 while yield of Jatropha tree was recorded 2.25 q/ha in 2011 and 2012. Result obtained from study indicates that significantly different the economic yield in q ha^{-1} of sole crops and grown under sapota-jatropha are obtained and are presented in Table 1. The maximum economic yield was recorded in sole cropping as compared to intercropping of all tuber crops grown under sapota-jatropha. The data corresponding to the economic yield (2011), the sole crop of kalihari, kali musli and safed musli (T_4 8.33 q/ha, T_5, 5.52 q/ha and T_6, 10.99 q/ha) noted significantly higher economic yield when compared to kalihari, kali musli and safed musli under sapota-jatropha (T_1, 3.48 q/ha, T_2, 1.98 q/ha and T_3, 4.41 q/ha), respectively. In the second year sole tuber crops of kalihari (8.61 q/ha), kali musli (5.56 q/ha) and safed musli (11.12 q/ha) was recorded significantly higher economic yield when compared to kalihari (3.60 q/ha), kali musli (2.05 q/ha) and safed musli (4.45 q/ha) intercrop under sapota-jatropha. Further perusal of data reveals that pooled data showed the similar trends as of the first year and second year results. In case of per cent reduction of economic yield in pooled data it was minimum in kalihari (58.21 %) which was followed by safed musli (59.95 %) and kali musli (63.54 %). Similar trends of results were obtained in case of first year and second year data. It may be due to greater availability of solar energy for photosynthesis coupled with lack of competition by tree component. Similar results were recorded by Rathod *et al.* (2010), Kumar *et al.* (2008), Sehgal and Thakur (2008), Venugopal *et al.* (2008), Thakur and Dutt (2007), Thakur and

Table 1 : Economic yield of tuber crops as influenced by sapota-jatropha based three-tier agroforestry system

Treatments	Economic yield (q/ha)		
	2011	2012	Pooled
T_1 - *Gloriosa superb* Intercrop	3.48 (58.22)*	3.60 (58.19)*	3.54(58.21)*
T_2 – *Curculigo orchioides* Intercrop	1.98 (64.13)*	2.05 (63.13)*	2.02 (63.54)*
T_3 – *Chlorophytum borivilianum* Intercrop	4.41 (59.87)*	4.45 (59.98)*	4.43 (59.95)*
T_4 - *Gloriosa superba* Sole	8.33	8.61	8.47
T_5 – *Curculigo orchioides* Sole	5.52	5.56	5.54
T_6 – *Chlorophytum borivilianum* Sole	10.99	11.12	11.06
S. E. ±	0.234	0.341	0.207
C.D. (P=0.05)	0.71	1.03	0.60
CV %	8.10	11.57	10.02

*Figure in parenthesis indicates percentage reduction over respective sole cropping

Table 2 : Economics of growing tuber crops (Kalihari, Kali musli and Safed musli) under Sapota- Jatropha based three-tier agroforestry system

Treatments	Total cost of production (Rs./ha)		Gross income (Rs./ha)		Net income (Rs./ha)		BCR	
	2011	2012	2011	2012	2011	2012	2011	2012
T_1	81000.90	86904.50	145225	156225	64224.10	69320.50	1:1.79	1:1.79
T_2	90426.45	95204.75	125125	133925	34698.55	38720.25	1:1.38	1:1.40
T_3	308573.90	314255.05	560725	614625	252151.10	300369.95	1:1.81	1:1.95
T_4	96777.90	102681.50	166600	180810	69822.1	78128.50	1:1.72	1:1.76
T_5	121981.45	126759.75	138000	144560	16018.55	17800.25	1:1.13	1:1.14
T_6	624128.90	629810.05	1208900	1334400	584771.10	704589.95	1:1.93	1:2.11

Kumar (2006), Mohsin (2005) in mint, Saroj *et al.* (2003), Shinde (2001), Singh (2000), Singh *et al.* (1997) and George and Nair (1987).

The data on cost of cultivation, gross returns, net returns and benefit cost ratio (B:C) as influenced by sole tuber medicinal crops and intercrop under sapota-jatropha are presented in Table 2 in both the year 2011 and 2012. During 2011, tuber medicinal crops under sapota-jatropha kalihari and kali musli recorded higher benefit cost ratio (1.79 and 1.38) as compared to sole kalihari and kali musli (1.72 and 1.13) while treatment T_6 sole safed musli higher benefit cost ratio (1.93) as compared to treatment T_3 safed musli under sapota-jatropha (1.81). In the second year trial, the intercropping of tuber medicinal crops under sapota-jatropha kalihari and kali musli recorded higher benefit cost ratio (1.79 and 1.40) as compared to sole kalihari and kali musli (1.76 and 1.14) while treatment T_6 sole safed musli had higher benefit cost ratio (2.11) as compared to treatment T_3 safed musli under sapota-jatropha (1.95). Compared to all treatments studied, treatment T_6 safed musli in sole recorded higher B:C (2.11) compared to all other treatments *viz.*, T_3, T_1, T_4, T_2 and T_5.

Economically following trend was evident in intercrops safed musli > kalihari > kali musli whereas among the sole crop same trend was seen. This may be due to prevailing light condition and absence of competition for available moisture and nutrient coupled with higher cost of safed musli may be the reasons for higher yield and return in open field condition. Similar result was observed by Patel *et al.* (2009) in safed musli and Dutt and Thakur (2004) in ocimum.

Conclusion:

Significantly higher economic returns were observed under sapota-jatropha intercrop as compared to sole crops while, safed musli showed opposite trend. So far as trend of economics is concerned in sole crop it was safed musli (1:1.93) > kalihari (1:1.72) > kali musli (1:1.13); whereas the same tuber crops when grown as inter crop under sapota-jatropha, the trend was again safed musli (1:1.81) > kalihari (1:1.79) > kali musli (1:1.38). On the basis of present investigation we recommended that tuber medicinal crops (kalihari, kali musli and safed musli) can be grown as intercrops under Sapota-Jatropha for good financial gain.

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