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RESEARCH PAPER

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

VISHNU K. SOLANKI*, D.B. JADEJA AND M.B. TANDEL
College of forestry, Navsari Agricultural University, NAVSARI (GUJARAT) INDIA
(Email : vishukanwar@gmail.com)

Abstract : Field experiments were conducted to find out performance of herbal medicinal crops (basil, kalmegh and mint) 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 2011 and 2012. The experiments were laid out in Randomized Block Design with six treatments and four replications. Three medicinal plants *viz*., basil (*Ocimum sanctum* L.), kalmegh (*Andrographis paniculata* Well.) and mint (*Mentha arvensis* L) were selected for the present study. The observation on fresh weight of plant/plot (kg), dry weight of plant/plot (kg) and economic yield (q/ha) was recorded higher under sole crop of basil, kalmegh and mint as compared to intercrop with sapota-jatropha in both the years. While basil (1.67), kalmegh (1.46) and mint (1.40) when grown as intercrop gave higher economic returns as compared to sole crop in 2011 and 2012.

Key Words : Agroforestry, Intercrop, Basil, Kalmegh, Mint, 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, fibre 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

*** Author for correspondence**

potential petrocrop (Martin and Mayeux, 1985). *Ocimum* species are used as the antifungal, bactericidal and insecticidal properties and various economically important essential oil used in perfumery and cosmetic industries (Sehgal and Thakur, 2008). Kalmegh is used for cough, headache, edema, earache, pain conditions, inflammation and muscular pain, arthritis, rheumatism, multiple sclerosis, depression, diarrhoea, dysentery, cholera, candida, lupus, diabetes, piles, fevers, fatigue, hepatitis, herpes, leprosy. It can be used as a replacement for quinine in treatment of malaria (Kumar *et al.,* 2008). Mint was originally used as a medicinal herb to treat stomach ache and chest pains, and it is commonly used in the form of tea as a home remedy to help alleviate stomach pain. Menthol from mint essential oil (40–90%) is an ingredient of many cosmetics and some perfumes. 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 for the performance of herbal medicinal crops (basil, kalmegh and mint) 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 13.4^0C and 9.6^0C, respectively. Summer season commence during the middle of February and ends during middle of June. The temperature reached a maximum of 34.9^0C 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*., basil (*Ocimum sanctum* L.) at 50cm x 40cm, kalmegh (*Andrographis paniculata* Well.) at 50cm x 40cm, mint (*Mentha arvensis* L.) at 30cm x 45cm were selected for the present study. The experiment was laid out in Randomized Block Design, replicated four times. There were 6 treatments- T_1 – *Manilkara achras + Jatropha curcas + Ocimum sanctum*, T_2 – *Manilkara achras + Jatropha curcas + Andrographis paniculata*, T_3 – *Manilkara achras + Jatropha curcas + Mentha arvensis*, T_4 – *Ocimum sanctum* sole, T_5 – *Andrographis paniculata* sole, T_6 – *Mentha arvensis* 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 40:15:15 kg per hectare (for Basil), 40:20:40 kg per hectare (for Kalmegh), 120:50:60 kg per hectare (for Mint), 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 were recorded 70 q/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.

Looking to the mean data of first year trial, it was found that the sole crops of basil (T_4, 29.94 kg) noted maximum fresh weight of plant per plot as compared to basil grown under sapota-jatropha (T_1, 28.26 kg). Sole crop of kalmegh and mint (T_5, 12.04 kg and T_6, 23.70 kg) recorded significantly higher fresh weight of plant per plot which was followed by kalmegh and mint grown under sapota-jatropha (T_2, 9.88 kg and T_3, 19.72 kg). Result obtained during 2012 indicates that, sole crops of basil (T_4, 29.69 kg) noted maximum fresh weight of plant per plot as compared to basil grown under sapota-jatropha (T_1, 28.08 kg). Kalmegh showed same trend as basil. While sole mint (T_6, 24.06 kg) recorded significantly higher fresh weight of plant per plot which was followed by intercrop of mint (T_3, 20.40 kg) with sapota-jatropha. With regards to the pooled data, it showed the similar trend to those of the results of first years. However, per cent reduction in fresh weight of plant per plot in pooled data was recorded minimum in basil (5.50 %) which was followed by mint (16.00 %) and kalmegh (17.70%) (Table-1). This might be due to more light availability under open field condition and no competition for nutrients by the trees. The probable reason for minimum fresh weight beneath the tree reflects the poor resources for growth such as moisture, nutrients and radiant energy. Similar result was found by

Parekh *et al.* (2005), Thakur and Dutt (2003) and Shinde (2001).

During the first year the maximum dry weight of plant per plot (9.52 kg) was reported in treatment T_4 sole basil as compared to basil grown under sapota-jatropha (T_1, 9.23 kg). Sole crop of kalmegh (T_5, 4.66 kg) and mint (T_6, 10.03 kg) recorded significantly maximum dry weight of plant per plot which was followed by kalmegh and mint grown under sapota-jatropha (T_2, 3.73 kg and T_3, 8.05 kg), respectively. During 2012 maximum dry weight of plant per plot was observed in sole crops of basil (T_4, 9.66 kg) as compared to basil grown under sapota-jatropha (T_1, 9.54 kg). Kalmegh showed same trend as basil. While sole crop of mint (T_6, 10.18 kg) recorded significantly higher dry weight of plant per plot which was followed by intercrop of mint (T_3, 8.24 kg) with sapota-jatropha. Pooled analysis showed the same result and same trend as per the trend of first year result (Table 1). Per cent reduction in dry weight per plant per plot in pooled data was observed minimum in basil (2.19 %), it was followed by kalmegh (19.36 %) and mint (19.41 %). This account for the greater exposed photosynthetic area, ensuring greater interception of solar radiation, must have immensely helped the crop plants to maintain greater photosynthesis farther away from the trees. Similar result was found by Shinde (2001) and Singh *et al.* (1997).

The maximum economic yield was recorded in sole cropping as compared to intercropping of all herbal crops grown under sapota-jatropha (Table 1). The data corresponding to the economic yield, the sole crop of basil treatment T_4 (27.05 q/ha) noted significantly higher economic yield when compared to basil intercrop under sapota-jatropha (T_1 9.23 q/ha). Sole kalmegh and mint (T_5 13.30 q/ha and T_6 23.25 q/ha) recorded higher economic yield as compared to kalmegh and mint grown under sapota-jatropha (T_2 3.74 q/ha and T_3 8.04 q/ha), respectively. In the second year sole herbal crops of basil (27.30 q/ha), kalmegh (13.55 q/ha) and mint (23.62 q/ha) was recorded significantly higher economic yield when compared to basil (9.56 q/ha), kalmegh (3.86 q/ha) and mint (8.26 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 mint (65.23 %) which was followed by basil (65.42 %) and kalmegh (71.71 %). It might be due to reduction in light intensity as a result of shading the photosynthetic ability of the secondary canopy for reducing the total photosynthate output from the plants. These results are in line with Rathod *et al.* (2010), Kumar *et al.* (2008), Sehgal and Thakur (2008), Venugopal *et al.* (2008), Thakur and Dutt (2007), Thakur and Kumar (2006), Mohsin

Table 1 : Yield of herbal crops as influenced by Sapota-Jatropha based three-tier agroforestry system

Treatments	Fresh weight of plant/plot (kg)			Dry weight of plant/plot (kg)			Economic yield (q/ha)		
	2011	2012	Pooled	2011	2012	Pooled	2011	2012	Pooled
T_1 - Basil intercrop	28.26 (5.61)*	28.08 (5.42)*	28.17 (5.50)*	9.23 (3.05)*	9.54 (1.24)*	9.38 (2.19)*	9.23 (65.88)*	9.56 (64.98)*	9.40 (65.42)*
T_2 - Kalmegh intercrop	9.88 (17.94)*	10.03 (17.31)*	9.95 (17.70)*	3.73 (19.96)*	3.84 (19.16)*	3.79 (19.36)*	3.74 (71.88)*	3.86 (71.51)*	3.80 (71.71)*
T_3 - Mint intercrop	19.72 (16.79)*	20.40 (15.21)*	20.06 (16.00)*	8.05 (19.74)*	8.24 (19.06)*	8.14 (19.41)	8.04 (65.42)*	8.26 (65.03)*	8.15 (65.23)*
T_4 - Basil sole	29.94	29.69	29.81	9.52	9.66	9.59	27.05	27.30	27.18
T_5 - Kalmegh sole	12.04	12.13	12.09	4.66	4.75	4.70	13.30	13.55	13.43
T_6 - Mint sole	23.70	24.06	23.88	10.03	10.18	10.10	23.25	23.62	23.44
S.E. ±	0.707	1.009	0.616	0.272	0.338	0.217	0.478	0.586	0.378
C.D. (P=0.05)	2.13	3.04	1.78	0.82	1.02	0.63	1.44	1.77	1.09
CV %	6.87	9.74	8.44	7.22	8.77	8.05	6.78	8.16	7.52

*Figure in parenthesis indicates percentage reduction over respective sole cropping

Table 2 : Economics of growing herbal crops (Basil, Kalmegh and mint) 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	75473.30	80341.95	126390	137985	50916.70	57643.05	1:1.67	1:1.71
T_2	68336.80	73508.20	99935	107645	31598.20	34136.80	1:1.46	1:1.46
T_3	85482.20	91498.10	119845	130185	34362.80	38686.90	1:1.40	1:1.42
T_4	91673.30	96541.95	148775	163800	57101.70	67258.05	1:1.62	1:1.69
T_5	68536.80	73708.20	86450	94850	17913.20	21141.80	1:1.26	1:1.28
T_6	106519.20	112535.10	127875	141720	21355.80	29184.90	1:1.20	1:1.26

(2005) in mint, Parekh *et al.* (2005), 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 herbal medicinal crops and intercropping with sapota-jatropha (Table 2) in 2011 and 2012. During first year herbal medicinal crops namely basil, kalmegh and mint when grown under sapota-jatropha recorded higher benefit cost ratio (1.67, 1.46 and 1.40, respectively) as compared to their respective sole crops (1.62, 1.26 and 1.20). In the year 2012, the intercropping of herbal medicinal crops namely basil, kalmegh and mint when grown under sapota-jatropha recorded higher benefit cost ratio (1.71, 1.46 and 1.42, respectively) as compared to their respective sole crops (1.69, 1.28 and 1.26). Compared to all treatments studied, treatment T_1 basil with sapota-jatropha recorded highest B:C in 2011 and 2012 (1.67 and 1.71). Economically intercropping of basil > kalmegh > mint whereas among the sole crop also same trend was seen. The reason may attributed to the compatibility of these crops under investigation with regard to their growth habit, nutrient requirement as well as light and moisture conditions and ultimately reflected terms of better productivity and higher economic yields and returns. Similar result was observed by Kumar *et al.* (2010) in safed musli, Kumar *et al.* (2008), Ram *et al.* (1999).

Conclusion:

Significantly higher economic returns were observed under sapota-jatropha intercrop as compared to sole crops. So far as trend of economics is concerned in sole crop it was basil (1:1.62) > kalmegh (1:1.26) > mint (1:1.20); whereas the same herbal crops when grown as inter crop under sapota-jatropha, the trend was again basil (1:1.67) > kalmegh (1:1.46) > mint (1:1.40). On the basis of present investigation, it is recommended that herbal medicinal crops (basil, kalmegh and mint) can be grown as intercrops under sapota-jatropha for good financial gain.

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