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Scope and Opportunity of Intercropping of Medicinal and Aromatic Plants with Sisal Plantation

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Abstract: *A field experiment was conducted at the Sisal Research Station, Bamra, Sambalpur, Odisha, India during 2014-15 to study the most suitable medicinal and aromatic plants (MAPs) as intercrop in sisal plantation with its economic feasibility. The experiment was laid down in split plot design with three replications. In order to assess the most profitable intercrop in interspaces of sisal, eleven medicinal and aromatic (viz., aloe vera, asalio, isabgol, vetiver, lemon grass, palmorosa, citronella, kalmegh, muskdana, ashwagandha, safed musili) along with one prevailing traditional crop (horse gram) were taken in main plot and two fertiliser doses viz., recommended dose of fertiliser and other with RDF + 5t FYM in subplot. The experimental soil was sandy loam in texture with pH 4.89. Harvesting of sisal leaves for fiber starts 3 years after planting and continues up to 10 years. This crop generally does not utilize the available resources such as land, space, water, and nutrients fully as the active root zone of sisal is confined to only 30% of the available land area of plantation. The remaining area could be profitably exploited for raising some annual intercrops for initial 3 years. MAPs besides being economically beneficial are adoptable to marginal/degraded soils which can be inter-cropped with sisal plantation. The highest B:C ratio was recorded in case of intercropping with vetiver (2.9) whereas in case of traditional intercrop horsegram it was 1.26 only. Highest sisal equivalent yield of 2321.07 kg/ha was obtained in case of intercropping with safed musili followed by vetiver (1674.28. kg/ha). The interaction effect on sisal yield was significantly higher with intercrop vetiver (900 kg) in case of recommended dose of fertilizer with 5 t FYM compared to application of RDF (870 kg). Aromatic plant vetiver recorded highest B:C ratio of 2.9 and net income of Rs. 43500 ha^{-1}.*

Key words: *Intercropping, Medicinal and aromatic plants (MAPs), Sisal, Economics, Yield.*

INTRODUCTION

Sisal (*Agave sisalana*) occupies 6th place among fibre plants, representing 2% of the world's production of plant fibres [4]. Global production of sisal fibre is estimated at around 0.3 million tonnes. Sisal has a great potential in dry areas like Western Orissa, Madhya Pradesh and Jharkhand. Over the years sisal has gained economic importance as raw material for its fibre and for multifarious usages ranging from manufacture and industrial ropes, agricultural and commercial twines and other forms of rope and cables. Sisal fibre accounts for around 1.0% of the production of natural fibres in volume terms and around 0.2% in terms of value. Sisal based agro forestry models involving hybrid sisal + gambhar and hybrid sisal + teak at sisal Research station, Bamra are found highly suitable & profitable for Western Odisha and Andhra [5]. Harvesting of sisal leaves for fiber starts 3 years after planting and continues up to 10 years. This crop generally does not utilize the available resources such as land, space, water, and nutrients fully as the active root zone of sisal is confined to only 30% of the available land area of plantation. The remaining area of 3 m in double rowed sisal plantation could be profitably exploited for raising some annual intercrops for initial 3 years [10]. Establishment of smallholder sisal farms with the rows of sisal being intercropped with other cash crops such as cassava, sweet potatoes, pulses, grains, vegetables, herbs etc. are beneficial [1]. But medicinal and aromatic plants besides being more economically beneficial are adaptable to marginal / degraded soils which can be inter cropped in sisal plantation [3]. The international market for herbal products is estimated to be of US$ 62 billion and it is poised to grow to US$ 5 trillion by the year 2050 [2]. The cultivation of medicinal and aromatic plant is most productive, remunerative, environmentally sound and ecologically sustainable alternate land use system. MAP

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allows judicious use of the internal space of the sisal, allowing crop diversification, enhancing per capita land productivity and cultivation of the crops in demand. New paradigms on agriculture like inter cropping of MAP with traditional crops are avatars of alternate agriculture system. Aromatic plants besides being economically beneficial are adaptable to marginal/ degraded soils. Strategies required for deriving economic and environmental advantages of aromatic crops in existing cropping systems requires improved agronomic methods for higher essential oil production and utilization of marginal/degraded lands for essential oil production. No doubt with these crops integrating into the cropping systems and utilizing marginal & wastelands, strategic high value agriculture is in the offing. The impact of MAP as intercrop with organic farming approach improves resource use efficiency in areca nut plantation and it is revealed that lemon grass can be cultivated as intercrop with increase in productivity and net return [9]. Aromatic grasses such as citronella, lemon grass and vetiver can be incorporated into the existing agronomic system to reduce soil erosion loss. Recent study has shown that cultivation of vetiver, lemon grass & palmorosa has the ability to reduce carbon dioxide sequestration [6]. Vertiver or khus (*Veriveria zizanioides* (L.) Nash) which is used in Ayurveda and Unani medicine systems and making other product also. Cultivation of economically viable MAPs can improve the socio-economy of farmers, fast growing MAPs with high economic potential were given priority, traditional cereal crops production is uneconomic and diversification in cropping system is necessary [9]. This offers an opportunity to augment the per capita land productivity, economic returns and employment generation. Cultivation of economically viable MAPs can improve the socio-economy of farmers.

MATERIAL AND METHODS

The experimental field was conducted at Sisal Research Station (23°05'N, 84°23' E, and 256.03 m above MSL), Bamra, Sambalpur, Odisha in 2014-2015 to find suitable MAPs as intercrops for in sisal plantations in the plateau region of India. The experiment was laid down in split plot design. Eleven MAP crops viz., aloe vera (*Aloe barbadensis*), asalio (*Lepidium sativum*), isabgol (*Plantago ovata*), vetiver (*Chrysopogon zizanioides*), lemon grass (*Cymbopogon citratus)*, palmorosa (*Cymbopogon martinii*), citronella (*Cymbopogon winterianus*), kalmegh (*Andrographis paniculata*), muskdana (*Abelmoschus moschatus*), ashwagandha (*Withania somnifera*), safed musili (*Chlorophytum borivilianum*) along with one prevailing traditional crop horsegram (*Macrotyloma uniflorum*) were taken in main plots and two fertiliser doses viz., recommended dose of fertiliser (RDF) and RDF + 5t FYM were taken in sub plots and was replicated thrice. The soil of the experimental field was sandy loam in texture with pH 4.89, low in organic carbon 0.32%, medium in available nitrogen (188 kg ha^{-1}), high in available P (33 kg ha^{-1}) & potash (113 kg ha^{-1}). The sisal rows were planted 3 m apart from each other. The intercropping of MAPs was done after two years of establishment of sisal plantation as the harvesting of sisal leaves are started during third year of plantation. To compare the performance of different inter cropping systems, economic yield of all the crops were converted into sisal equivalent yield (SEY) based on prevailed market price using the formula:

$$SEY = (Ym) \times (Pm)/Ps$$

Where; Ym = yield of crop in kg/ha of economic harvest, Pm = price of crop; and Ps = price of sisal fibre.

RESULTS AND DISCUSSION

The MAPs ideal for semiarid conditions viz., vetiver, kalmegh, ashwagandha, asalio, isabgol, lemon grass, citronella, aloe-vera, palma rosa, muskdana, safed musli and with a traditional crop (horse gram) were evaluated for yield in the interspaces of sisal. All the intercrops successfully established in the sisal interspaces. The net return was highest with safed musli cultivation with B:C ratio of 2.55, but the highest B:C ratio was recorded in case of aromatic grass vetiver (2.9). In case of traditional crop i.e., horse gram the net returns and B:C ratio was Rs 12542/ha and 1.26 respectively. Similarly, Isabgol recorded highest net returns of Rs 19,600 /ha and B:C ratio of 2.58 among the MAPs. Asalio recorded highest B:C ratio of 2.49 and net income of Rs 15825/- (Table 2). Highest sisal equivalent yield of 2321.07 kg was obtained in case of safed musili followed by vetiver (1674.28 kg). In traditional crops, horsegram recorded a sisal equivalent yield of 1077.49 kg ha^{-1}. The interaction effect was significant in case of vetiver which is 900 kg ha^{-1} in case of recommended dose of fertilizer with 5 t FYM compared to application of RDF (Table 3). Similar findings were reported by [10] who reported cultivation of vetiver to be profitable for total return as Rs 229450 and B:C ratio of 3.05.

CONCLUSION

Hence, it is concluded that medicinal plant isabgol can be successfully cultivated in inter-row-spaces of sisal giving additional income during the gestation period of the base crop. Aromatic grass vetiver

Table 1
Economics of MAP and traditional crops in sisal based inter cropping system

Treatments	*Cost of cultivation (Rs/ha)*	*Net Return (Rs/ha)*	*B:C ratio*
Aloe- vera	46,700	2,146	1.05
Asalio	10,530	15,825	2.49
Isabgol	12,400	19,600	2.58
Vetiver	22,800	43,500	2.90
Lemon grass	27,200	2,557	1.09
Palmorosa	20,750	3,200	1.15
Citronella	28,400	2,290	1.08
Kalmegh	22,400	16,520	1.72
Muskdana	16,800	22,240	2.32
Horse gram	10,805	12,542	1.26
Ashwagandha	11,700	10,272	2.52
Safed musili	46,500	45,275	2.55
CD (0.05)	101.04	296.02	0.02

Table 2
Yield of inter crops and total sisal equivalent yield in sisal based inter cropping system (kg/ha)

Treatments	*Sisal fibre yield (kg)*	*MAP yield (kg)*	*Sisal equivalent yield*	*Total SEY (kg)*
Aloe- vera	850	3,000	585.47	1435.47
Asalio	895	370	432.79	1327.79
Isabgol	875	320	380.95	1255.95
Vetiver	885	840	789.28	1674.28
Lemon grass	885	18,430	354.25	1239.25
Palmorosa	870	14,000	285.11	1155.11
Citronella	850	17,800	365.35	1215.35
Kalmegh	845	2,954	463.33	1308.33
Muskdana	890	645	464.76	1354.76
Horsegram	915	680	162.49	1077.49
Ashwagandha	855	370	352.37	1207.37
Safed musili	905	1,275	1,416.07	2321.07
CD (0.05)	0.55	688	1.33	1.88

Table 3
Interaction effect of sisal based intercropping system and fertility level on sisal fibre yield (kg/ha)

Treatment	**C_1*	*C_2*	*C_3*	*C_4*	*C_5*	*C_6*	*C_7*	*C8*	*C_9*	*C_{10}*	*C_{11}*	*C_{12}*	*Mean*
$^{\$}F_1$	840	870	870	870	880	860	820	830	870	900	830	890	860.34
F_2	860	920	880	900	890	880	880	860	910	930	880	920	892.5
Mean	850	895	875	885	885	870	850	845	890	915	855	905	

LSP (*p=0.05*); C= 0.55 F= 0.13 C X F= 0.45
*C_1 = Sisal + Aloe-vera; C_2 = Sisal + Asalio; C_3 = Sisal + Isabgol; C_4 = Sisal + Vetiver;
C_5 = Sisal + Lemon Grass; C_6 = Sisal + palmorosa; C_7= Sisal + Citronella; C_8= Sisal + Kalmegh;
C_9= Sisal + Muskdana; C_{10} = Sisal + Horsegram; C_{11}= Sisal + Ashwagandha; C_{12}= Sisal + Safed musili
$^{\$}F_1$ = RDF to all crops; F_2 = RDF to all crops with 5 t FYM/ha

emerged as the most profitable intercrop in sisal plantation producing essential oil from its roots being widely used in the high grade perfume, cosmetic, chewing gum, tobacco and soft drinks etc. world wide, can be cultivated in inter-row-spaces of sisal with higher net income and B:C ratio with recommended dose of fertilizer and 5 t of farm yard manure. Thus the cultivation of MAPs as intercrop in sisal plantation is more remunerative for getting reasonable additional income compared to growing traditional crop.

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