

INTERCROPPING OF PULSES AND OILSEEDS WITH SISAL (*Agave sisalana*) IN NORTH COASTAL ZONE OF ANDHRA PRADESH

ABSTRACT

Sisal (*Agave sisalana*) is a semi perennial, xerophytic, leaf fibre crop mainly grown in degraded soils for conservation and as live fence, renewed interests in recent times primarily for its quality fibre having great demand in the country. A field experiment was conducted during *rabi 2020 and 2021* under AINP on Jute and Allied Fibres at Agricultural Research Station, Amadalavalasa – ANGRAU. The experiment was conducted to study the suitability and economic feasibility of short duration pulses and oilseeds as intercrops in between paired row spaces of sisal plantation. Results revealed that, short duration pulses are more feasible than oilseeds as intercrops with increased productivity per unit area. The sisal fibre yield and intercrops yield was higher with pulse intercropping than oilseeds. The sisal fibre equivalent yield of intercrops varied between 1.87 q ha⁻¹ in the case of sisal + mustard to 5.28 q ha⁻¹ in sisal + cowpea. The net returns per rupee invested was the highest in sisal + cowpea (3.42) followed by sisal + greengram (3.34), sisal + rajma (3.05) and the lowest among pulses was sisal + blackgram (2.83). while, among oilseeds, the highest return was in sisal + niger (2.90) followed by sisal + mustard (2.80) and sisal + sesame (2.65) compared to the lowest in sole sisal (2.49). However, the total system productivity in terms of sisal fibre equivalent yield of the cropping system varied between 14.05 q ha⁻¹ in case of sole sisal to 21.64 q ha⁻¹ in sisal + cowpea. The results inferred that, growing of short duration pulses in between paired row spaces of sisal could be efficiently used by growing short duration pulses like cowpea, greengram, rajma and blackgram for increased cropping system under sisal plantation.

Keywords: Sisal, Intercropping, Short duration pulses, Oilseeds, Economics. Yield

INTRODUCTION

Sisal (*Agave sisalana*), is a leaf fibre producing plant belongs to Asparagaceae family, commonly known as Agave in India. It is semi perennial, xerophytic and mainly grown in arid and semi-arid regions of Andhra Pradesh, Orissa, Bihar, Karnataka, Maharashtra, and West Bengal (Nayak et al. 2011). In the context of climate change and land degradation neutrality, sisal is an excellent CDM (clean development mechanism) crop for biochemical as well as for afforestation in degraded lands besides improvement in soil carbon sequestration (Sarkar and Jha.

2017). Generally, sisal plants resistant to many pests and diseases consequently reduces pesticide load in the environment, reducing soil erosion through its extensive root system, contributes positively to watershed management. Therefore, designated as “specialty crop” for conservation agriculture (Sarkar et al. 2010; Sarkar et al. 2015; Sarkar and Jha. 2017).

Several species of sisal are indigenous to India largely and as live fences as well as in wild conditions. Different species are *Agave sisalana*, *A. cantala*, *A. veracruz*, *A. amanuensis*, *A. angustifolia*, and *A. fourcroyodes*. Among these, *A. sisalana* contributes nearly 85% of total sisal fibre production in the world. A healthy sisal plant produces 500 -750 leaves in about 10-12 years of its life span. Thus a normal sisal leaf with 600-gram weight produces about 1000 fibres for each leaf (Nayak et al. 2011 and Sarkar et al. 2015). Globally, sisal fibre can be used for multiple purposes and is commonly used in the industry and several other domestic to industrial uses including high strength requiring long lasting geo-textile and speciality composites.

In this scenario, renewed interest in recent times has been noticed to grow sisal primarily for its quality fibre having great demand in the country (Sarkar et al. 2015). Further, some pockets of the north coastal region of Andhra Pradesh are having undulated terrain, poor soil fertility, low water retention capacity, where no other arable crop could be grown by the resource poor farmers. Sisal appears to be a promising alternative in this regions if the profitability of this crop could be sustained by introducing of suitable inter crops in sisal for increasing the system productivity.

However, improved production technology of paired row systems is usually practiced in north coastal zone for sisal production. But in this system a large amount of land area is unutilized in between rows. Therefore, the inter-row space may be utilized with suitable intercrops to improve the profitability of the system. But, sufficient and detailed research work on suitable inter crops for sisal plantation in north coastal zone of A.P is truly lacking. Therefore, a field experiment was conducted to identify suitable intercrops for increasing the system productivity as well as profitability of sisal-based cropping system.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* and *Rabi*, 2020-21 and 2021-22 in sandy clay loam soil at Agricultural Research Station farm, Amadalavalasa, ANGRAU, Andhra Pradesh under All India Network Project on Jute and Allied Fibres (AINPJAF). Geographically, the experimental field is situated at latitude / longitude of 18.4°N, 83.89°E with an altitude of 35 m above mean sea level.

The experiment was laid out in a randomized block design with 9 treatments and three replications. The treatment details are T₁: Sisal + Black gram (GBG-1); T₂: Sisal + Greengram (IPM 2-14); T₃: Sisal + Cowpea (Local variety); T₄: Sisal + Horsegram (Local Black); T₅: Sisal + Sesame (YLM-66); T₆: Sisal + Niger (KGN-2); T₇: Sisal + Mustard (Local variety); T₈: Sisal + Rajma (Amber) and T₉: Sole Sisal. The agro-techniques adopted for the short duration pulses and oilseeds as intercrops in sisal plantation are given in Table 1.

Table 1: Agro-techniques adopted for pulses and oilseeds as intercrops in between paired rows of sisal

Crop	Variety	Duration (Days)	Spacing (cm)	RDF N:P:K:S (kg ha ⁻¹)
Pulses				
<i>Vigna mungo</i> (L.) (Blackgram)	GBG-1	70-75	30 × 10	20:50:0
<i>Vigna radiata</i> (L.) (Greengram)	IPM 2-14	60-65	30 × 10	20:50:0
<i>Vigna unguiculata</i> (L.) (Cowpea)	DC-15	75-80	30 × 15	15:50:50
<i>Macrotyloma uniflorum</i> (L.) (Horsegram)	CRHG -22	85-90	30 × 10	10:25:4
<i>Phaseolus vulgaris</i> (Rajmash)	Amber	70-75	30 × 10	90:60:0
Oilseeds				
<i>Sesamum indicum</i> (L.) (Sesame)	YLM-66	80-90	30 × 15	50:20:20
<i>Guizotia abyssinica</i> (L.) (Niger)	KGN-2	95-100	30 × 10	10:0:0
<i>Brassica nigra</i> (Mustard)	Varuna	135-140	30 × 15	60:30:15:20

The sole sisal crop was sown during *kharif* season and in the *rabi* season sisal along with short duration pulses and oilseeds crops were grown. Sisal crop was sown in 4.0 m × 4.0 m paired row and inter crops were sown in line with 4.0 m × 2.4 m spacing

in between the lines of sisal. The main crop sisal and inter crops were grown completely under rainfed conditions. agronomic management for growing of inter crops were followed as per the package of practices as prescribed by ANGRAU. Weeding and thinning operations in inter crops was done after 30 days after sowing and harvested at maturity. Biometrical observations of all the component crops were recorded at regular intervals. The yield and yield attributes were recorded at harvest. The recorded observations for different parameters were statistically analysed using analysis of variance (ANOVA) technique and results are presented at 5 % level of significance ($P=0.05$).

Note: the methods of calculation of the sisal fiber equivalent value should be stated

RESULTS AND DISCUSSION

Effect of intercrops on growth parameters of sisal

Effect of pulses and oilseeds as intercrops on growth parameters of sisal did not vary significantly during the two years of study (Table 2). The pooled data of the two-year study revealed that, the highest number of leaves per sisal plant was recorded in pulses as intercrops than oilseeds. The highest number of leaves (31.9 cm) is recorded in sisal + horsegram followed by sisal + cowpea (31.8 cm), sisal + rajma (31.7 cm), sisal + greengram (31.3 cm) and the lowest was in sisal + blackgram (30.1 cm). while oilseeds as intercrops, the highest number of sisal leaves was recorded in sisal + sesame and sisal + niger (29.7 cm) and the lowest was in (29.4 cm) as compared to sole sisal (29.2 cm). Whereas, the highest leaf length was recorded in Sisal+ Greengram (101.0 cm) followed by (sisal + horsegram) (97.9 cm), which was on par with sole sisal. Among oilseeds as intercrops, the highest leaf length was recorded in sisal + niger (99.5 cm) followed by sisal + sesame (98.7 cm) and the lowest was recorded in sisal + mustard (98.4 cm) as compared to sole sisal. similar findings were also reported by Sarkar et al. (2015) in intercropping system with pulses followed in double rowed sisal plantation.

However, a similar trend was recorded with respect to leaf width of sisal wherein, the highest leaf width was in sisal + cowpea (9.6 cm) among pulses, sisal + sesame and sisal + niger (9.6 cm) among oilseeds than sole sisal (9.5 cm). while the green biomass of sisal was obtained with sisal + cowpea (47.25 t/ha) followed by sisal + greengram (47.18 t/ha) in both pulses and oilseeds as intercrops compared to sole sisal (45.97 t/ha). The results are in conformity with Sarkar et al. (2015). All intercrops in the present study were successfully established in sisal interspaces as pulses and oilseeds fit well in intercropping system. However, pulses influenced

yield attributes of sisal more than oilseeds might be due to the plant stature of the pulses and provided enough space for the sisal to expand. Besides, intercrops positively influenced the soil fertility.

Table 2: Effect of pulses and oilseeds grown as intercrops on growth parameters of Sisal

Table 2: Effect of intercropping of pulses and oilseeds on growth parameters of Sisal

Treatments	No. of Leaves / Plant			Leaf length (cm)			Leaf width (cm)			Green biomass (t/ha)		
	2020	2021	pooled	2020	2021	pooled	2020	2021	pooled	2020	2021	pooled
Sisal + Blackgram	25.4	34.9	30.1	103.5	90.7	97.1	10.6	8.3	9.4	43.34	41.39	42.37
Sisal+ Greengram	26.5	36.2	31.3	102.5	101.0	101.7	10.5	8.5	9.5	45.12	49.24	47.18
Sisal + Cowpea	27.2	36.5	31.8	100.7	95.0	97.8	10.6	8.5	9.6	46.38	48.13	47.25
Sisal + Horsegram	26.9	36.9	31.9	103.4	92.4	97.9	10.7	8.2	9.5	45.89	45.29	45.59
Sisal + Sesame	26.5	32.9	29.7	102.6	94.8	98.7	10.8	8.3	9.6	45.22	38.39	41.80
Sisal + Niger	27.2	32.1	29.7	101.2	97.8	99.5	10.7	8.4	9.6	46.46	43.26	44.86
Sisal + Mustard	26.6	32.3	29.4	102.3	94.5	98.4	10.6	8.3	9.4	45.40	37.33	41.36
Sisal + Rajma	26.4	37.0	31.7	102.5	90.6	96.5	10.7	7.8	9.3	45.10	46.75	45.93
Sole Sisal	25.5	33.0	29.2	102.9	92.8	97.9	10.8	8.1	9.5	43.49	48.46	45.97
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
SEm ±	0.97	2.71	1.44	0.88	3.98	2.04	0.21	0.29	0.24	1.66	3.53	1.95
CV (%)	6.4	13.5	11.5	1.5	7.3	5.1	3.3	5.9	4.5	6.4	13.8	10.7

EFFECT OF INTERCROPS ON YIELD PARAMETERS OF SISAL

The fibre yield of sisal during two years of study did not vary significantly (Table 3). However, pooled data of fibre yield revealed that, the effect of intercrops on yield of sisal was higher with pulses than oilseeds. Among pulses, except sisal + black gram which recorded a lower yield (14.69 q/ha) and the remaining treatments were on par with the highest yield in sisal + cowpea (16.35 q/ha). Among oilseeds, the highest yield was recorded in sisal + niger (15.57 q/ha) followed by sisal + sesame (14.54 q/ha) and sisal + mustard (14.40 q/ha). However, sole sisal was comparatively higher than oilseeds and recorded 15.88 q/ha of sisal fibre yield. The similar findings were also reported by Rajesh kumar et al. (2017) in maize intercropped with pulses.

Pooled data of intercrops yield was revealed that, yields among intercrops was on par and the highest yield was recorded in sisal + cowpea (11.47 q/ha) and the lowest was in sisal + rajma (3.73 q/ha). However, among oilseeds as intercrops the highest yield was recorded in sisal + mustard (3.07 q/ha) followed by sisal + sesame (2.47 q/ha) and sisal + niger (2.43 q/ha). Similar trend of results was obtained when intercrops yield was converted to sisal

Sisal + Blackgram	15.79	13.60	14.69	4.55	4.74	4.64	3.41	3.73	3.57	19.20	17.33	18.27
Sisal+ Greengram	16.43	16.18	16.31	5.07	5.61	5.34	4.56	5.10	4.83	20.99	21.28	21.14
Sisal + Cowpea	16.89	15.82	16.35	14.50	8.45	11.47	6.34	4.22	5.28	23.24	20.04	21.64
Sisal + Horsegram	16.71	14.88	15.80	3.98	3.96	3.97	1.49	1.48	1.49	18.21	16.36	17.29
Sisal + Sesame	16.47	12.62	14.54	2.64	2.30	2.47	2.27	2.10	2.18	18.73	14.72	16.72
Sisal + Niger	16.92	14.21	15.57	2.34	2.53	2.43	1.96	2.19	2.07	18.88	16.41	17.64
Sisal + Mustard	16.53	15.36	14.40	2.95	3.19	3.07	1.71	2.02	1.87	18.25	17.38	17.81
Sisal + Rajma	16.43	15.92	15.89	4.58	2.88	3.73	4.58	2.70	3.64	21.00	18.63	19.81
Sole Sisal	15.84	12.27	15.88	0.00	0.00	0.00	0.00	0.00	0.00	15.84	12.27	14.05
CD (P=0.05)	NS	NS	NS	-	-	-	-	-	-	1.69	3.41	1.83
SEm±	0.61	1.16	0.65	-	-	-	-	-	-	0.56	1.14	0.64
CV (%)	6.4	13.8	10.3	-	-	-	-	-	-	5.1	11.5	8.5

ECONOMICS OF SISAL BASED INTERCROPPING SYSTEM

The economics of sole sisal crop and intercropping with short duration pulses and oilseeds was worked out by considering the variable cost of fertilizers, labours, seeds and price of each crop yield. Calculated the gross returns, net returns and benefit cost ratio of the sole sisal, intercropping with pulses and oilseeds and sisal based cropping system were shown in (Table 4). The results revealed that, inter cropping with short duration pulses positively contributed to economic feasibility and sustainability of the system by ensuring higher economic income to farmers in sisal based intercropping system.

Sisal intercropped with cowpea treatment among different treatments ensures the highest profit to resource poor farmers as it was reflected in gross, net profit and the highest B:C ratio (3.42) compared to other treatments and the lowest B:C ratio was recorded in sole sisal (2.49). Intercropping with sisal + cowpea ensured the highest B:C ratio followed by sisal + greengram (3.34), sisal + rajma (3.05), sisal + niger (2.90), sisal + horsegram (2.90), sisal + blackgram (2.83), sisal + mustard (2.80) and sisal + sesame (2.65). In the present study, intercropping with short duration pulses contributed higher than oilseeds for cropping system productivity. The results are in conformity with the findings of Padhi et al. 2010 and Sarkar et al. 2015.

Even though the sole crop of sisal was grown as live fence and also as an erosion control measure in degraded soils. However, in the present study, the inclusion of short duration pulses as intercrops in the system enhanced the productivity of the cropping system. This is due to positive impact of pulses and oilseeds on sisal fibre yield and in improving the system productivity. Similar findings were reported by Sarkar et al. 2015 wherein, they reported that, sisal equivalent yield from the system was the highest with pigeonpea followed by cowpea and

blackgram as intercrops along with sisal. In addition, the cropping system including pulses ensures food and nutritional security of farm family (FAO, 2016).

Table 4: Economics of Sisalbased inter cropping system (pooled data of 2020 and 2021)

Treatment	Gross Returns of cropping system (Rs./ha)	Cost of Cultivation of cropping system (Rs./ha)	Net Returns of cropping system (Rs./ha)	BC Ratio
Sisal + Blackgram	146160	51600	94560	2.83
Sisal+ Greengram	169120	50640	118480	3.34
Sisal + Cowpea	173120	50580	122540	3.42
Sisal + Horsegram	138320	47634	90686	2.90
Sisal + Sesame	133760	50436	83324	2.65
Sisal + Niger	141120	48740	92380	2.90
Sisal + Mustard	139760	49980	89780	2.80
Sisal + Rajma	156160	51130	105030	3.05
Sole Sisal	112400	45184	67216	2.49

CONCLUSION

Sole sisal is generally grown in poor fertile soils, sloppy lands or in degraded soils as live fence, as erosion control measures and for its fibre in various diversified uses. The vacant space in between the paired rows of sisal plantation may be effectively utilized by growing short duration pulses, as they are relatively hardy, being adopted and fitted into various cropping systems compared to oilseeds. Thus, cultivation of short duration pulses in paired row sisal plantation effectively utilizes space available, protects soil and makes cropping system more remunerative by ensuring nutritional support and higher farm income to resource poor farm family than traditional sole sisal.

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