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Research Article

Effect of Partial Shade on the Growth and Yields of Two Commercial Types of Sisal (*Agave* sp.) Grown in India

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ABSTRACT

Field experiment was conducted on the effect of partial shade on the fibre yield of two commercial types of sisal (*Agave sisalana* and Hybrid Sisal No. 11648) at Sisal Research Station of CRIJAF, Odisha. *A. sisalana* produced more fibre in full ambient light (FAL) (13.0-53.7 g leaf^{-1}) than partial shade (50% FAL) condition (8.8-46.3 g leaf^{-1}). Similar observations were recorded in case of hybrid sisal, where full light produced more fibre (23.7-53.0 g leaf^{-1}) than partial shade (7.3-44.0 g leaf^{-1}) condition. Among two types of sisal, hybrid sisal yielded higher (36 g leaf^{-1}) than *A. sisalana* (32.8 g leaf^{-1}) in light condition. The reverse was observed in partial shade condition, where *A. sisalana* produced more fibre (24.7 g leaf^{-1}) than hybrid sisal (23.3 g leaf^{-1}). In both the types, the partial shade condition reduced the fibre yield. The yield reduction due to shade was more pronounced in case of hybrid sisal (35.5%) than *A. sisalana* (24.7%). Therefore, to incorporate sisal in any intercropping or agri-silviculture system, *Agave sisalana* may be selected over the hybrid one.

Key words: Sisal, *Agave*, Partial shade, Growth, Fibre yield

Introduction

Agave sp., commonly known as sisal of Asparagaceae family is a xerophytic perennial leaf fibre-yielding crop of commercial importance worldwide. In India, it is found and cultivated in Odisha, Chhattisgarh, Jharkhand, Maharashtra and southern states (Sarkar *et al*., 2010a). In India, mainly three types of Agave *viz*., Sisal (*Agave sisalana* Perrine ex Engelm.), Manila maguey (*Agave cantala* Roxb.) and Henequen/Yucatan sisal (*Agave fourcroydes* Lemaire) are primarily grown by the tribes and also by some unorganized or limited organized sectors. Among these types, *Agave sisalana* is the most important as far as the production of fibre on commercial scale is concerned. An inter-specific hybrid of sisal (No. 11648) is also cultivated as it produces more number of leaves, resulting higher fibre productivity compared to other traditional types (Kar, 2008). Sisal has several distinguishing characteristics such as ability to utilize wide range of light, temperature and CO_2 concentration which makes it a 'speciality crop' for conservation agriculture (Sarkar *et al*., 2010b). To be fitted as a suitable component crop in modern agri-silviculture production system in India, it needs basic understanding on the effects of partial shade on the fibre yields. Therefore, a field experiment was conducted to study the effect of partial shade on fibre yield in two commercial types of sisal (*Agave sisalana* and Hybrid sisal No. 11648).

Materials and Methods

A field experiment was conducted during 2010-11 and 2011-12 at the Sisal Research

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Station, Odisha (22.04°N, 84.30°E, and 292.8 m above mean sea level) to study the effects of partial shade on growth and yield of sisal (*Agave* sp., Family: Asparagaceae). The mean maximum and minimum temperatures are recorded in May (40.9°C) and January (8.6°C), and the mean annual rainfall is 1230.6 mm (90% occurs in the *kharif* season, followed by *rabi* (5.9%) and summer (3.7%) seasons (Sarkar *et al*., 2013). The general characteristics of the experimental soil are: Typic Haplustult, yellowish red to red, sandy loam in texture, slightly hard and very friable, *p*H (1: 2.5 w/v) in water 5.30, organic carbon 4.54 g kg^{-1}, available N 279, P 16.8, K 59.7 kg ha^{-1}, respectively. The experiment was laid with 4 treatments replicated 6 times in RBD. The treatments were, T_1: *Agave sisalana* exposed to 100% full ambient light (FAL), T_2: *A. sisalana* exposed to 50% FAL, T_3: *Agave* hybrid (No. 11648) exposed to 100% FAL, and T_4: *Agave* hybrid (No. 11648) exposed to 50% FAL. The ambient light was measured by using simple lux meter (Make: Lutron, Model: LX-101 and Sl. No. L 924738) at 100 and 50% FAL conditions. In the experimental condition, the maximum 100% FAL was about 96,000 lux in hot summer of May with direct sunlight and in July it was nearly 3400 lux (with overcast sky due to heavy monsoon cloud). The 50% FAL was ascertained in the respective treatments by using shade net at 3 m above the sisal canopy supported by temporary bamboo structures. The 50% FAL resembles the partial shady condition of agri-silviculture production system in tropical and subtropical zones. Mature leaves of sisal were harvested during mid-December coinciding with the full leaf maturity and inactive growth of sisal due to low ambient temperature. The harvested leaves were classified as (i) A: leaf length >92 cm (ii) B: leaf length 62-91 cm and (iii) C: leaf length 47-61 cm as suggested by Kirby (1963). Different biometrical observations on leaf length (cm), fresh leaf weight (g), fibre yield per leaf (g) and fibre weight per unit leaf length (g m^{-1}) were recorded and analysed using standard statistical package.

Results and Discussion

Leaf length

Leaf length of both types of sisal differed significantly with different illumination condition (100 and 50% FAL). The shortest leaf was obtained from *Agave* hybrid grown with 50% FAL in A (99.0 cm), B (74.6 cm) and C (56.1 cm) category of leaves. Whereas, in case of *Agave sisalana*, 50% FAL produced longer leaves as compared to 100% FAL (Table 1). From the mean leaf length value, it is clear that partial shade produced slightly longer leaves in *Agave sisalana*, whereas, the same condition reduced the leaf length in *Agave* hybrid, although the length variation within the sisal types was less.

Fresh leaf weight

Fresh leaf weight of the crop varied significantly due to different light conditions (Table 1). In general, it was recorded that 50% FAL drastically reduced fresh weight of leaves in both *Agave sisalana* and *Agave* hybrid types. In C category of leaf, the lowest leaf weight was recoded in *Agave* hybrid with 50% FAL (232.2 g); whereas, 100% FAL produced the maximum leaf biomass (461.9 g) from *Agave* hybrid. Similar observation was recorded for the B category leaves also. From mean values of fresh weight, it

Table 1. Effect of partial shade on growth of two types of sisal

Treatment	Leaf length (cm)				Fresh leaf weight (g)			
	C	B	A	Mean	C	B	A	Mean
T_1 AS with 100% FAL	57.0	81.1	107.8	81.97	365.8	762.3	1134.2	754.10
T_2 AS with 50% FAL	60.7	79.4	113.5	84.53	253.0	422.9	1149.2	608.37
T_3 AH with 100% FAL	59.7	81.0	98.8	79.83	461.9	756.8	1114.8	777.83
T_4 AH with 50% FAL	56.1	74.6	99.2	76.63	232.2	421.5	829.6	494.43
CD ($p = 0.05$)	3.82	4.61	7.89	5.51	20.16	38.40	78.36	44.81

Table 2. Effect of partial shade on fibre yield of two types of sisal

Treatment	Fibre yield per leaf (g)				Fibre weight per unit length (g m^{-1})			
	C	B	A	Mean	C	B	A	Mean
T_1 AS with 100% FAL	13.15	31.64	53.67	32.82	22.81	39.58	49.69	37.36
T_2 AS with 50% FAL	8.81	19.03	46.30	24.71	14.43	24.05	40.64	26.37
T_3 AH with 100% FAL	23.65	31.37	53.04	36.02	39.44	38.68	53.54	43.89
T_4 AH with 50% FAL	7.28	18.57	43.83	23.23	13.10	24.89	44.00	27.33
CD ($p = 0.05$)	1.83	4.06	7.11	4.41	2.82	4.91	7.84	5.23

may be noted that, there are significant differences among 100 and 50% FAL conditions. In both the types, fresh leaf weight was less in partially shaded condition but the effect of lower weight was much more pronounced in case of *Agave* hybrid (36.43% less weight).

Fibre yield per leaf

Fibre yield differed significantly among the treatments (Table 2). In all the categories, the fibre yield was the lowest with partial shade (50% FAL). The lowest yield was obtained with *Agave* hybrid grown under 50% FAL (23.2 g), closely followed by and at par with the fibre yield obtained from *Agave sisalana* under 50% FAL (24.7 g); whereas at 100% FAL, the highest fibre yield was obtained from *Agave* hybrid (36.0 g $leaf^{-1}$).

Fibre weight

The highest fibre weight per meter length of leaf was obtained in 100% FAL with *Agave* hybrid (43.89 g m^{-1}) and the lowest was in partial shade condition in *Agave* hybrid (27.33 g m^{-1}) and in *A. sisalana* (26.37 g m^{-1}).

Reduction in fibre yield

Partial shade condition reduced the fibre yield in both the types of sisal (Fig. 1 and 2). The yield reduction was the maximum in C category of leaf in *Agave* hybrid (69.22%) followed by B category (40.8%). In A category, the yield reduction was larger in *Agave* hybrid (17.36%) than *A. sisalana* (13.73%). Irrespective of leaf category, partial shade condition (50% FAL) further reduced the fibre yield in *Agave* hybrid (35.51%) than *A. sisalana* (24.71%).

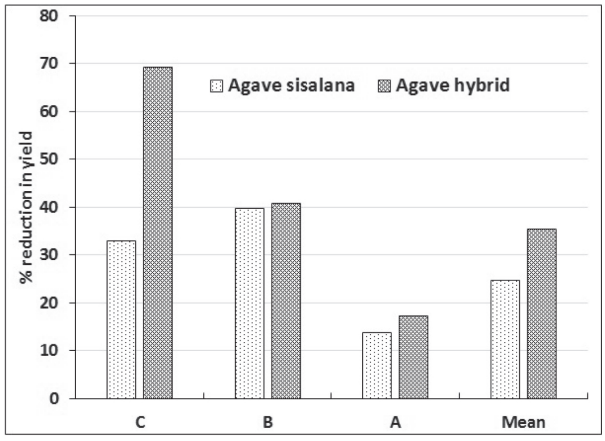

Fig. 1. Effect of partial shade on fibre yield (per leaf) in two types of sisal
[A: leaf length >92 cm, B: leaf length 62-91 cm, C: leaf length 47-61 cm]

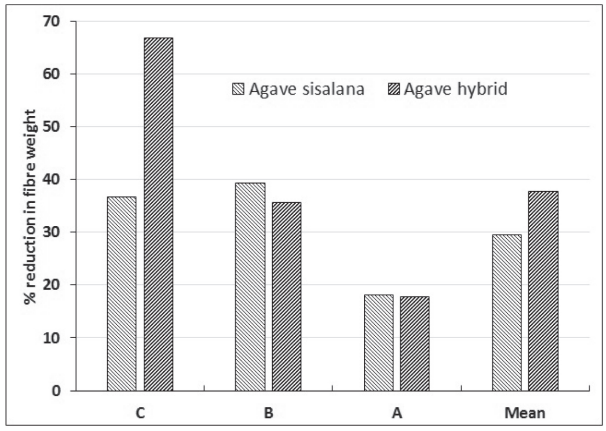

Fig. 2. Effect of partial shade on fibre weight per unit leaf length in two types of sisal
[A: leaf length >92 cm, B: leaf length 62-91 cm, C: leaf length 47-61 cm]

In both the commercially cultivated types, the partial shade condition decreased the fibre yield. The yield decline due to partial shade was more

prominent in hybrid sisal (35.5%) than *Agave sisalana* (24.7%). Therefore, to incorporate sisal in any intercropping or agri-silviculture system, out of the two important sisal types, *Agave sisalana* should be the choice to prefer over the hybrid one. Earlier it was suggested that *A. sisalana* sisal can be grown by utilizing space in between rows of gamhar planted with a density of 470 plants ha^{-1} and it was not advisable to grow hybrid sisal with teak or gamhar (Sarkar *et al*., 2010c).

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