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Yield potential and economics of mulberry – based parallel multiple cropping system under irrigated condition

A. K. MISRA, G.C. SETUA, A. GHOSH, M. SETUA , N.K. DAS AND A.K. BAJPAI

Central Sericultural Research and Training Institute
Berhampore – 742101, Murshidabad, West Bengal, India

ABSTRACT

A study was conducted on the feasibility of suitable intercropping in new mulberry garden under irrigated condition at the Central Sericultural Research and Training Institute , Berhampore, West Bengal during the period from 2005 – 08. The season specific and short duration intercrops, two in each season viz, green gram and black gram (March – May), maize and cowpea (June-August), toria and pea (Sept.- Nov.) and spinach and amaranth (Dec.- Feb.) were grown in 1:1 and 1:2 rows within mulberry (var. S-1635) planted in 60 x 60cm and 90 x 90cm spacing respectively. Maximum yield of intercrops as well as net profit per hectare were obtained in 90 x 90cm spacing with the combination of mulberry with green gram in March – May (Rs. 8344/-), mulberry with cowpea in June-August (Rs. 10,114/-), mulberry with toria in Sept-Nov (Rs. 4520/-) and mulberry with amaranth in Dec.-Feb (Rs.7880/-) seasons over Rs.7442/-, Rs.8759/-, Rs.4320/- and Rs. 6963/- in 60 x 60cm respectively. Further, it also showed better benefit : cost ratio under 90 x 90cm spacing in all the seasons.

***Key words*:** Irrigated mulberry, net monetary return and parallel multiple cropping

In West Bengal ,more than 80% of sericultural farmers are poor and marginal with an average mulberry land holding of 0.4 acres (Pandit, 2005). At the initial stage of mulberry plantation sericulture is not becoming economically viable as the new plantation of mulberry does not produce sufficient quantity of leaf. Under this context, it is thought of to make sericulture economically viable and ecologically sustainable through the development of parallel multiple cropping systems in mulberry. There are few reports on feasibility of intercropping in both irrigated and rainfed mulberry (Ahsan *et al*.,1989; Yadav and Nagendra Kumar, 1998; Shankar *et al*.,1998, 2003). Therefore, the present study was undertaken to generate information on yield potential of various mulberry - based intercropping systems in all the four mulberry crops in a year with different planting patterns, selection of best intercrop combinations and economics under irrigated condition.

MATERIALS AND METHODS

The study was carried out at the Central Sericultural Research and Training Institute, Berhampore during the period from 2004-08 . The initial soil status of the experimental plots was sandy loam , having 364 kg ha $^{-1}$ available nitrogen, 55 kg ha^{-1} and 420 kg ha^{-1} available phosphorus and potassium respectively, with pH 7.6. The experiment was laid out in randomized block design and saplings of S-1635 mulberry variety were planted in 60 x 60cm and 90 x 90cm spacings in three replications. Altogether eight treatments *i.e.* four sole crops (mulberry x 2 spacings and 2 component crops) + 2 component crops with mulberry in 2 spacings) were considered in four mulberry leaf crop schedule per year. The component crops were greengram (var.B-105) and blackgram (var. B-76) during March – May, maize (var. Opaque-2) and cowpea (var. VU-89) during June – August, toria (var. B-54) and pea (var. GF-68) during Sept. – Nov. and spinach (var. Punjab local) and amaranth (Champa note) during Dec. – Feb. crop seasons. The seed rate of greengram and blackgram @ 15 kg ha^{-1}, maize @ 40kg ha^{-1} and cowpea @15 kg ha^{-1} , toria @ 5kg ha^{-1} and pea @ 100kg ha^{-1}, spinach @ 25kg ha^{-1} and amaranth @ 2.5kg ha^{-1} and recommended dose of fertilizer for intercrops were adjusted according to population of intercrops.

After completion of six months establishment period, mulberry plants were pruned at 15cm above ground level at the end of February . Two season specific component crops in each crop seasons were cultivated within mulberry in 60 x 60cm and 90 x 90cm spacing in 1:1 and 1:2 row arrangements immediate after pruning in each crop season. Recommended improved package of practices for mulberry i.e. organic manure @ 20mt ha^{-1}yr $^{-1}$; inorganic fertilizer @ 168 kg N, 30 kg P and 112 kg K and *Azotobacter* based nitrogenous biofertilizer (20 kg ha^{-1}yr^{-1}) and AMF based phosphate biofertilizer (75 kg ha^{-1}yr $^{-4}$) were applied in equal split doses in four crop schedule per year in the experimental plots.

Season wise growth performance of mulberry *viz*. plant height, branch no., leaf no. , leaf area and leaf yield as well as intercrops yield were recorded. Three years data were pooled and analysis of variance and coefficient of variation were calculated . Land - equivalent ratio and Benefit- Cost ratio were computed as per Jain and Rao (1980). Economic returns (Rs. ha^{-1}) and cost of cultivation (Rs. ha^{-1}) for

E mail : csrtiber@rediffmail.com

individual crop in sequence were calculated on the basis of prevailing market rates of inputs and selling prices of produce.

RESULTS AND DISCUSSION

The three years pooled data revealed that during March – May crop season, plant height (147.2cm), branch no. plant $^{-1}$ (12.0) ,leaf no. plant $^{-1}$ (249.5) and leaf area (170.9 cm^2) were found significantly higher in mulberry as sole crop in 90 x 90cm spacing. Significantly highest leaf yield was recorded in mulberry as sole (8653.42 kg ha^{-1}) which was found to be at par with mulberry + blackgram combination (8008.61 kg ha^{-1}) in 60 x 60cm spacing (Table 1). During June – August, significantly highest branch no. (11.6), leaf no. plant $^{-1}$ (179.2) and leaf area (173.4 cm^2) were recorded in mulberry as sole crop in 90 x 90cm spacing except plant height (167.9 cm) in mulberry + maize combination. The leaf yield in mulberry as sole crop in 60 x 60cm was significantly highest (7843.62 kg ha^{-1}) over other treatments followed by mulberry + cowpea (7047.14 kg ha^{-1}) combination (Table 2).

During Sept. – Nov. maximum branch no. plant $^{-1}$ (11.4), leaf no. plant $^{-1}$ (177.1) and leaf area (178.2 cm^2) were found in mulberry as sole were observed in 90 x 90 cm spacing except plant height (145.7cm) in mulberry with toria in the same spacing at 1:2 row arrangement. The leaf yield was observed highest in mulberry as sole (6680.61 kg ha^{-1}) which was at par with mulberry + pea (6168.52 kg ha^{-1}) combination in 60 x 60cm spacing (Table 3). In Dec.-Feb. maximum plant height (106.7cm) and branch no. plant $^{-1}$ (13.0) in mulberry + amaranth and leaf no. plant $^{-1}$ (170.9) in mulberry as sole were observed in 90 x 90 cm spacing . Like other seasons, leaf yield was recorded highest (5888.07 kg ha^{-1}) in mulberry as sole followed by mulberry + amaranth combination (5529.15 kg ha^{-1}) in 60 x 60 cm spacing (Table 4).

The data shown in Table 5 indicated that the yield of intercrops cultivated in 90 cm x 90cm (1:2 row) spacing of mulberry was highest compared to 60 x60cm (1:1 row) spacing. The increase in yield of intercrops within mulberry in 90 x 90 cm (1:2 rows) spacing was due to more population density of intercrops in wider spacing and also for optimum utilization of land and water. Over and above, it is apparent from the result that the annual leaf yield of mulberry as a sole crop was recorded higher *i.e.* 29.06 mt ha^{-1} yr^{-1} in 60 x 60cm spacing in comparison with 23.24 mt ha^{-1} yr^{-1} in 90 x 90cm spacing, while the yield of mulberry under all the intercropping systems decreased compared with the sole crops Dayakar Yadav *et..al*. (2004) reported that the total yield of main crop as sole was highest, but marginally decreased when additional row or rows of subsidiary crop introduced between the main crops. This indicated that the inter-specific competition with intercropping was more than intra-specific competition of mulberry as sole.

Net profit

The maximum net return of Rs. 30858/- was obtained in 90 x 90cm (1: 2 rows) followed by Rs. 27484/- in 60 x 60cm (1: 1 row) spacing in crop combination I i.e. mulberry with greengram, cowpea, toria and amaranth intercrops over crop combination II per hectare per year. The result is in conformity with the findings of Dayakar Yadav *et.. al.* (2004). Among the eight component crops cultivated within mulberry in 1:1 (60 x 60 cm) and 1:2 (90 x 90cm) rows arrangements in four crop seasons, mulberry with cowpea resulted the higher monetary return during June – August season followed by mulberry with green gram in March – May (Table 6). Sinha *et al*. (1987) also observed the encouraging effect of leguminous intercrops in mulberry.

Land equivalent ratio

Land equivalent ratio (LER) was maximum in 1:2 intercropping system in all the seasons compared to sole crop and 1:1 intercropping row arrangement. The highest LER was recorded in mulberry with amaranth (1.76) and spinach (1.75) in 1:2 followed by 1: 1 row arrangement during Dec. – Feb. season. Nevertheless, mulberry with green gram , cowpea, toria and amaranth intercropping system registered the higher land equivalent ratio (Table 6).

Benefit-Cost ratio

In the study, the cropping system fetched a benefit : cost ratio which is more than 1 irrespective of intercrops and spacings. Maximum benefit : cost ratio was recorded in mulberry + cowpea (1.59:1) followed by mulberry + greengram (1.50:1), mulberry + amaranth (1.49:1) and mulberry + toria (1.27:1) under 90 x 90cm spacing . The similar trend was observed in 60 x 60 cm spacing also (Table 6).

It is inferred from the study that mulberry with greengram during March-May, cowpea during June – August, toria during Sept.- Nov. and amaranth during Dec.- Feb. seasons are proved to be an ideal intercropping combination due to higher monetary return per year in four crop schedule under irrigated condition . Further, the net profit was found to be more in 90 x 90cm (1: 2 rows) than that of 60 x 60cm (1:1 row) spacing. Hence, the above intercropping system in mulberry may be recommended for adoption at the farmers' field for additional income.

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Table 1. Growth performance and leaf yield of mulberry during March – May crop season (Pooled data of three years)

Crop	Spacing	Plant height (cm)	Branch no. plant $^{-1}$	Leaf no. plant $^{-1}$	Leaf area (cm^2)	Leaf yield (kg ha^{-1})
Mulberry (sole)	60 x 60cm	139.0	9.6	164.9	130.6	8653.42
Mulberry +Greengram	(1:1)	135.5	9.3	153.5	116.4	7556.49
Mulberry + Blackgram		134.4	9.0	156.9	128.8	8008.61
Mulberry (sole)	90 x 90cm	147.2	12.0	249.5	170.9	7035.82
Mulberry + Greengram	(1:2)	143.9	11.1	214.8	155.8	6409.55
Mulberry + Blackgram		146.5	10.6	230.6	161.6	6425.14
LSD (P=0.05)	**-**	**4.6**	**1.1**	**15.8**	**35.5**	**823.17**
CV(%)	**-**	**1.8**	**5.9**	**4.4**	**13.5**	**6.16**

Table 2. Growth performance and leaf yield of mulberry during June – August crop season (Pooled data of three years)

Crop	Spacing	Plant height (cm)	Branch no. plant $^{-1}$	Leaf no. plant $^{-1}$	Leaf area (cm^2)	Leaf yield .(kg ha^{-1})
Mulberry (sole)	60 x 60cm (1:1)	157.4	9.6	131.7	173.4	7843.62
Mulberry+Maize		162.7	8.5	104.1	155.9	6627.42
Mulberry + Cowpea		152.3	9.1	116.5	171.7	7047.14
Mulberry (sole)	90 x 90cm (1:2)	165.9	11.6	179.2	173.4	6274.29
Mulberry+ Maize		167.9	9.7	150.5	167.9	5360.01
Mulberry + Cowpea		156.6	10.0	163.7	171.9	5662.38
LSD (P=0.05)	**-**	**4.6**	**1.4**	**21.5**	**25.8**	**788.29**
CV(%)	**-**	**1.6**	**8.1**	**8.4**	**8.7**	**6.7**

Table 3. Growth performance and leaf yield of mulberry during September – November crop season (Pooled data of three years)

Crop	Spacing	Plant height (cm)	Branch no. plant $^{-1}$	Leaf no. plant $^{-1}$	Leaf area (cm^2)	Leaf yield (kgha^{-1})
Mulberry (sole)	60 x 60cm (1:1)	131.1	11.1	145.0	155.3	6680.61
Mulberry + Toria		132.4	9.3	129.7	153.7	4766.97
Mulberry + Pea		132.7	10.6	139.3	145.2	6168.52
Mulberry (sole)	90 x 90cm (1:2)	138.2	11.4	177.1	178.2	5131.07
Mulberry + Toria		145.7	10.6	161.7	168.4	4403.60
Mulberry + Pea		139.4	10.7	171.8	171.1	4969.61
LSD (P=0.05)	**-**	**9.3**	**1.1**	**9.6**	**NS**	**578.733**
CV(%)	**-**	**3.7**	**5.2**	**3.4**	**8.4**	**5.9**

Table 4. Growth performance and leaf yield of mulberry during December – February crop season (Pooled data of 3 three years)

Crop	Spacing	Plant height (cm)	Branch. no. plant $^{-1}$	Leaf no. plant $^{-1}$	Leaf area ((cm^2)	Leaf yield (kg ha^{-1})
Mulberry (sole)	60 x 60cm (1:1)	101.7	10.0	130.6	117.1	5888.07
Mulberry + Spinach		96.9	9.2	116.4	107.2	5286.03
Mulberry+ Amaranth		101.3	9.1	128.8	115.7	5529.15
Mulberry (sole)	90 x 90cm (1:2)	103.4	12.8	170.9	127.0	4711.69
Mulberry + Spinach		103.9	9.5	155.8	122.0	4179.74
Mulberry+ Amaranth		106.7	13.0	161.6	125.9	4442.55
LSD (P=0.05)	**-**	**4.6**	**1.1**	**35.5**	**NS**	**720.0**
CV(%)	**-**	**2.5**	**5.9**	**13.5**	**6.9**	**7.9**

Table 5. Yield (mt ha^{-1}) of intercrops in different seasons (Yeild /mtha^{-1})

Spacing	March - May		June-August		Sept.-Nov.		Dec.-Feb.	
	Blackgram	Greengram	Maize	Cowpea	Toria	Field Pea	Spinach	Amaranth
Sole	0.69	0.49	3.59	3.28	0.83	0.69	8.36	6.29
60 x 60cm (1:1 row)	0.29	0.23	1.66	1.44	0.38	0.18	5.62	4.33
90 x 90cm (1:1 row)	0.37	0.31	2.40	2.00	0.50	0.25	7.20	5.16

Table 6. Economics of intercrops vis a- vis mulberry (Pooled data of 3 three years) Crop combination: I

Cropping combination	Spacing	Season	Mulberry leaf yield (mt ha^{-1})	Intercrop yield (mt ha^{-1})	Net income (Rs.)	Benefit : Cost ratio	Land-equivalent ratio (LER)
Mulberry	60 x 60cm (1:1)	In 4 crop seasons	29.05	-	2156/-	1.04	1.00
Mul.+ GG		March-May	7.55	0.23	7442/-	1.44	1.34
Mul. + CP		June-August	7.04	1.44	8759/-	1.52	1.34
Mul.+ toria		Sept.-Nov.	5.76	0.38	4320/-	1.27	1.32
Mul.+ amaranth		Dec. – Feb.	5.52	4.33	6963/-	1.40	1.62
					27484		
Mulberry	90 x 90cm (1:2)	In 4 crop seasons	23.24	-	- 6064/-	0.88	1.00
Mul.+ GG		March-May	6.40	0.31	8344/-	1.50	1.54
Mul. + CP		June-August	5.66	2.00	10114/-	1.59	1.50
Mul.+ toria		Sept.-Nov.	4.40	0.50	4520/-	1.27	1.46
Mul.+ amaranth		Dec. – Feb.	4.44	5.16	7880/-	1.49	1.76
					30858		

Cropping combination : II

Cropping combination	Spacing	Season	Mulberry leaf yield (mt ha^{-1})	Intercrop yield (mt ha^{-1})	Net income (Rs.)	Benefit : Cost ratio	Land-equivalent ratio (LER)
Mulberry	60 x 60cm (1:1)	In 4 crop seasons	29.05	-	2156/-	1.04	1.00
Mul.+BG		March-May	8.00	0.29	6508/-	1.39	1.34
Mul. +Maize		June-August	6.62	1.66	4677/-	1.31	1.30
Mul.+ Pea		Sept.-Nov.	6.16	0.18	-2552/-	0.85	1.18
Mul.+ Spinach		Dec. – Feb.	5.28	5.62	3753/-	1.21	1.56
					12386/-		
Mulberry	90 x 90cm (1:2)	In 4 crop seasons	23.4	-	-6064/-	0.88	1.00
Mul.+BG		March-May	6.42	0.37	5389/-	1.32	1.45
Mul. +Maize		June-August	5.37	2.40	5042/-	1.33	1.50
Mul.+ Pea		Sept.-Nov.	4.96	0.25	-4334/-	0.76	1.33
Mul.+ Spinach		Dec. – Feb.	4.17	7.2	4350/-	1.24	1.75
					10437		

Market value (Rs./ mt) :

Mulberry leaf Rs. 2,000/-; Greengram Rs.40,000/-; Blackgram Rs.25,000/-;
Maize Rs. 4,000/-; Cowpea Rs. 8,000/- Toria Rs.25,000/-;
Pea Rs. 15,000/-; Spinach Rs. 2,000/- and Amaranth Rs. 4,000/-