

ERI SILK WORM REARING ON DIFFERENT CASTOR GENOTYPES AND THEIR ECONOMIC ANALYSIS

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KEYWORDS

Eri silk
Samia cynthia ricini
Castor defoliation

Received on :

17.01.2015

Accepted on :

10.05.2015

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ABSTRACT

Eight castor genotypes viz., Haritha, Kiran, Kranthi, PCS- 262, PCH-111, PCH-222, GCH-4 and DCH-177 were evaluated to identify suitable castor genotypes and the level of defoliation of castor leaves and their performance for rearing eri silk worm, *Samia cynthia ricini*. The castor genotypes PCH-111, PCS 262 and GCH-4 were found to be promising with respect to rearing performance indicators and Cocoon traits of Eri silkworm. Leaf defoliation studies indicated that the castor leaves can be removed up to 30% and can be used for Eri silk worm rearing. Significant differences were recorded with the rearing and grainage parameters of Eri silk worm fed with different castor genotypes. Castor hybrid, PCH 111 was found to be superior to other genotypes in improving the rearing performance of eri silk worm with maximum records of mature larval weight (1.85 g), cocoon weight (2.02 g), pupal weight(1.62 g), Shell weight (0.45 g), silk ratio (22.27%) and shorter larval period (19days). The Eri silk yield was also significantly highest with worms fed with PCS-262 castor leaves (12.85 kg/ha) followed by PCH-111 (12.3 kg/ha) and GCH- 4 (12.25 kg/ha). Castor genotypes viz., PCH-111, PCS 262 and GCH-4 can be grown for dual purpose which gives additional returns of about Rs.4000/- to 5000/- per ha due to ericulture for the resource poor farmers of Southern Telangana region. Higher C: B ratio was realized with castor hybrid PCH-111 (1:2.80) followed by PCS-262 (1:2.77) and GCH-4 (1:2.65). Hence, these castor hybrids / genotypes were recommended to future research and development endeavors of integrated eri silkworm rearing along with castor seed production.

INTRODUCTION

Eri silk worm, *Samia cynthia ricini* is a non-mulberry silk worm, which can be domesticated and mostly found in Assam and Meghalaya, spreading to non-traditional states like Bihar, West Bengal, Orissa, Tamil Nadu, Kerala, Karnataka and Andhra Pradesh. The Eri silk can be used to make different products like stoles, furnishings, dyed fabrics, hand bags, caps, jackets etc., Eri silk worm pupae have high nutritional value with 53.3 % proteins and the tribal people of North- Eastern states consume the pupae as a delicacy. The Eri silk worm is a polyphagous and multivoltine insect that can be reared on castor leaves throughout the year to a maximum of 6-7 times a year.

Castor (*Ricinus communis*) is an important oil seed crop widely grown in rain fed conditions of Telangana and also used for rearing of Eri silk worm (Chowdhury, 1982). It is reported that 25 to 30 per cent of castor leaves can be utilized for eri silkworm rearing without affecting the seed production and as such, ericulture can be a supportive economy for the poor, dry land cultivators and provide gainful employment to the women (Devaiah et al., 1984, Raghavaiah, 2003; Lakshamma et al., 2009).

Hazarika et al. (2003) studies proved that castor was best in terms of different growth parameters of silk worm viz, larval wt, ERR, cocoon weight, shell weight etc. Rearing technology of eri silkworm under varied seasonal and host plant conditions in Tamilnadu were reported by Subramanian et al. (2013).

Studies on performance of promising ecoraces of eri silk worm in western Odisha region was conducted by Ray et al., 2010. Impact of varietal feeding on *samia ricini* in spring and autumn seasons of Utter Pradesh was studied (Rajesh Kumar and Gangwar, 2010). The better quality cocoon production will solely depends upon the quality of leaves fed to the larvae of eri-silkworm and the identification of the factors that contribute more to how organisms respond to different foods and food components is highly essential (Ravikumar ,1988; Sannappa and Jayaramaiah, 1999). Hence, the selection of suitable castor genotypes for eri silkworms based on the silkworms growth and silk production is highly required, so these studies were taken up.

There are many local and high yielding castor hybrids are available which are suitable for oil seed production under rain fed situations of Telangana state. However, very little information is available on eri silk worm rearing on castor in Andhra Pradesh and Telangana region which is a nontraditional area for ericulture but where castor was grown extensively under rain fed conditions. Castor genotypes will respond differently to defoliation which will affect ultimately the seed yield. Leaf defoliation studies will also be required to know the tolerance limit of castor genotypes to withstand different levels of defoliation without affecting the seed yield. Therefore, attempts were made to find out promising castor genotype(s) for better eri silk productivity and which can withstand defoliation and also suitable for both the castor seed production and erisilk production. Economic analysis

was carried out to promote ericulture as an additional income source to castor growing farmers of Telangana.

MATERIAL AND METHODS

Field studies were conducted at Regional Agricultural Research Station, Palem, Mahaboobnagar district, Telangana, India during *Kharif and Rabi* seasons of 2013-14 with three defoliation levels viz., 30% defoliation, 40% defoliation, 50% defoliation and the control plot without any defoliation. Eight castor genotypes viz., Haritha, Kiran, Kranthi, PCH-111, PCH-222, PCS-262, GCH-4 and DCH-177 were used in this study. The castor genotypes were evaluated under rain fed conditions for seed yield and also for eri silk worm rearing. The experiment was laid out in a randomized complete block design with four replications in each genotype. Regular agronomic practices were followed for raising the castor crop. The defoliation of leaves was taken up at 45 days after sowing of crop before the initiation of primary spike. The defoliated leaves were used for rearing of Eri silk worm under laboratory conditions. Three layings of Eri silk worm were reared from the defoliated leaves of Castor genotypes under laboratory conditions.

Rearing of Eri silk worm, *Samia cynthia ricini*

Studies were carried out at RARS, Palem in a well established Eri culture laboratory during *Kharif and Rabi* seasons of 2013-14. Eri silk worm breed, Wakagrey was used for the experiment. The silkworm rearing room and equipment were cleaned and disinfected with 2% formaldehyde solution before the commencement of experiment (Dayashankar, 1982). Rearing and grainage, procedures were practiced as recommended by Sarkar (1980). The disease free layings (DFL's) of *S. cynthia ricini* were collected from Regional Eri Research station, Central Silk Board, Shadnagar. The eggs were disinfected with 2% formaldehyde for five minutes and washed in tap water and dried under shade. 10 days after incubation, black boxing was done with the appearance of black spots on eggs to ensure uniform hatchability as per the rearing recommendations of Dayashankar (1982). The leaves obtained from different castor genotypes were separately fed to Eri silk worms from brushing till Cocoon spinning. Tender leaves of castor were fed four times a day until the larvae ends 2nd instar stage and semi tender leaves to 3rd instar while more matured leaves to 4th and 5th instars. One hundred silk worms were maintained for each castor genotype and replicated thrice. Larval weight was recorded on 10th day larvae and mature 5th instar larvae from each castor genotype separately. Matured worms were transferred to separate mountages for spinning. On the sixth day of spinning, the Cocoons were harvested, counted and weighed (Singh and Benchamin, 2002). The cocoon weight, pupal weight and shell weight were recorded and the shell ratio were calculated following Krishna swami *et al.* (1972).

$$\text{Shell ratio} = \frac{\text{Weight of cocoon shell}}{\text{Weight of Green cocoon}} \times 100$$

The cost of production of castor genotypes was worked out by taking observations on seed yield, cocoon and shell yield and the returns were computed based on the prevailing market rates. The economic analysis was carried out and the Cost:

Benefit ratio was worked out based on the cost of production and gross returns. The data were subjected to suitable transformations and analyzed statically (Snedecor and Cochran, 1979).

RESULTS AND DISCUSSION

Effect of defoliation on Castor Seed yield

Seed yield of different Castor genotypes at different defoliation levels is presented in the Table 1. The total seed yield was reduced with increased defoliation levels and there was significant reduction in yield beyond 30% defoliation level.

30% defoliation

Highest seed yield was recorded with PCH-111 (1454 kg/ha) followed by PCS 262 (1399 kg/ha) and the lowest yield of 749 kg/ha was recorded with Castor variety Kiran. There are about 3.75 to 7.07 % yield losses were recorded with different castor genotypes which comes to an amount of Rs. /- 1530 to Rs.2730 /- per hectare. Lowest percent yield loss was recorded with PCS-262, GCH-4 and PCH-111 where as highest yield loss % was recorded with Castor Varieties viz., PCH-222, Haritha, Kiran and Kranthi (6.34 to 7.07% loss).

40% defoliation

At this defoliation level the yield losses were high and in the range of 18.58 to 62.31 % and recorded very poor yields of about 441 kg/ha (Haritha) to 1099 kg/ha (PCS-262). This may lead to very high monetary loss of Rs. 10,890 to Rs.23, 040/ ha. Hence the 40 % removal of leaves is not advisable to safeguard the crop and seed yield.

50% defoliation

Same trend was also recorded at 50% defoliation where the seed yields were further reduced to 402 kg/ha to 958 kg/ha with different castor genotypes. Up to 65% yield loss was recorded with this level; hence the castor crop can't be defoliated above 30% which may lead to higher yield losses and monetary loss. In general, defoliation at any stage beyond 30% significantly reduced seed yield in castor. Present findings are comparable with the studies of Lakshamma *et al.* (2009) who reported that the castor crop could compensate 20- 25% defoliation at any stage but there was significant yield reduction with defoliation beyond 25%. Dinesh Hans and Sundaramoorthy (2002) also reported decrease in plant height, number of branches and spikes and seed yield of castor with the increase in defoliation rate and frequency. Hence, the castor leaves can be defoliated up to 30% level which can be used for eri silk worm rearing through which the farmer can get additional returns without much loss in seed yield. Similarly, Isa *et al.* (1994) and Sanappa *et al.* (2002) also opined that castor plant can be defoliated up to 25% in turn these leaves can be utilized for eri silk worm rearing.

Effect of different castor genotypes on Eri silk worm rearing

Performance of eri silkworms in relation to larval and Cocoon traits as influenced by different Castor genotypes was presented in Table 2.

Larval weight

The larval weight was very much influenced by the castor genotypes with significant variations in 10th day larval weight

Table 1: Effect of defoliation on seed yield of Castor in different Castor genotypes (Kharif and Rabi, 2013-14)

Castor Genotype	Seed Yield (Kg/ha)				Percent Yield loss Due to Defoliation (%)			Monitory loss (Rs/-) Defoliation (%)		
	No Defoliation	30 %	40 %	50%	30 %	40 %	50%	30 %	40 %	50%
Haritha	1170	1090 b	441a	402a	6.84	62.31	65.68	2400	21870	23040
Kiran	800	748.8 a	536a	437a	6.34	32.91	45.34	1536	7920	10890
Kranthi	1028	958 a	770b	565a	6.81	25.06	45.04	2100	7740	13890
PCS-262	1454	1399c	1099c	902a	3.75	24.39	37.94	1650	10650	16560
PCH 111	1529	1454c	1039 c	958b	4.87	32.05	37.32	2250	14700	17130
PCH 222	1288	1197b	1012b	846a	7.07	21.43	34.32	2730	8280	13260
GCH-4	1349	1298b	1008b	899a	3.75	18.58	33.33	1530	7530	13500
DCH-177	1316	1243b	1012b	855a	5.51	23.10	35.01	2190	9120	13830
CD @ 5%		252.2	264.8	529.5						

recorded with PCS-262, GCH-4 and PCH-111 where as highest yield loss % was recorded with Castor Varieties viz., PCH-222, Haritha, Kiran and Kranthi (6.34 to 7.07% loss).

Table 2: Effect of Selected Castor Genotypes on rearing performance and silk yield of Eri silkworm, *Samia cynthia ricini* (Kharif and Rabi, 2013-14)

Genotype	Larval weight (10th day (g))	Mature larval weight (g)	Larval duration(days)	Pupal duration (days)	Cocoon weight (g)	Pupal weight (g)	Shell weight (g)	Silk (or)Shell ratio (%)
Haritha	0.31c(0.90)	1.74b(1.49)	20.83b	18.20	1.74a	1.49b	0.25b	14.50a
Kiran	0.29b(0.89)	1.69a(1.48)	20.60b	18.30	1.71a	1.47a	0.24b	13.81a
Kranthi	0.28b(0.89)	1.62a(1.46)	21.00b	18.37	1.73a	1.38a	0.35c	18.44b
PCS-262	0.34d(0.92)	1.93c(1.56)	19.33a	18.20	1.98b	1.58c	0.40c	20.20 c
PCH 111	0.33d(0.91)	1.85 c(1.53)	19.00a	18.33	2.02b	1.62c	0.45c	22.27c
PCH-222	0.32c(0.90)	1.77b(1.51)	20.80b	18.33	1.76a	1.60c	0.16a	13.94a
GCH-4	0.30a(0.89)	1.69 a(1.48)	19.66a	18.33	1.80a	1.44a	0.36c	21.56b
DCH-177	0.25b(0.87)	1.66a(1.47)	20.96b	18.16	1.80a	1.54b	0.26b	13.48a
CD @ 5%	0.01	0.08	1.46	NS	0.14	0.08	0.06	4.07

*Figures in parentheses are square root Transformed Values.

Table 3: Economic returns from castor seed and Eri silkworm cocoons with different castor genotypes

Castor Genotype	Seed Yield (Kg/ha)#	Eri silk shell yield (Kg/ha)	Returns through Castor seed(Rs/-) * (A)	Additional returns Through Eri silk cocoons (Rs/-) ** (B)	Gross returns(Rs/ha) D= (A + B)	Total Cost (Rs/-)(C)	NetProfit (Rs/-)(D- C)	C:B Ratio
Haritha	1090 b	11.7 a	32700 b	4680	37380	16745	20635	1: 2.23
Kiran	749 a	11.4 a	22570 a	4560	27130	16726	10404	1: 1.62
Kranthi	958 a	11.6 a	27460 a	4640	32100	16764	15336	1: 1.91
PCS-262	1399 c	12.85 c	38930 b	5140	47110	17002	30108	1: 2.77
PCH 111	1454 c	12.3 b	43650 c	4920	48570	17375	31195	1: 2.80
PCH 222	1197 b	12.1 b	41130 c	4840	45970	17347	28623	1: 2.65
GCH-4	1243 b	12.25 b	40700 c	4900	45600	17328	28272	1: 2.63
DCH-177	1298 b	11.9 a	39520 b	4760	44280	17090	27190	1: 2.59
CD @ 5%	252.2	0.53	7570					

* Price of Castor seed – Rs. 30/- per Kg. ** -Price of Eri cocoon shell – Rs.400/kg; # Seed Yield/ ha at 30 % defoliation.

and mature larval weight. Highest mature larval weight was recorded with PCS 262 and PCH 111 with 1.93 g and 1.85 g respectively where as lowest larval weight was recorded with kranthi (1.62g) and kiran (1.69g) castor genotypes. The variation in larval weight of silkworm fed with different castor genotypes may be due to the differences in foliar composition and nutrients availability in different genotypes which contribute to the growth and development of silk worms. Present findings are in agreement with that of Sannappa *et al.*, 2007 who reported variation in larval, cocoon and grainage parameters of eri silk worm when fed with different castor genotypes. Similar findings were reported by Patil *et al.*, 2000, Sarmah *et al.* (2002) and Kedir shifa *et al.*, 2014 who observed the variations in mature larval weight when silk worms were

reared on different castor genotypes.

Larval duration

Significant differences in larval duration were observed when the Eri silk worm was fed with different castor genotypes (Table 2). The worms nourished with castor genotype PCH 111 recorded least larval duration (19 days) closely followed by PCS-262 (19.33 days) and GCH 4 (19.66 days). Basaiah (1988) reported the larval duration of 20.2, 22.3 and 22.3 days in local, Aruna and RC-8 Castor varieties respectively. In similar studies with different ecoraces of eri silk worm, Ray *et al.*, 2010 had reported that the larval duration may vary from 21-22 days with different races.

Cocoon traits

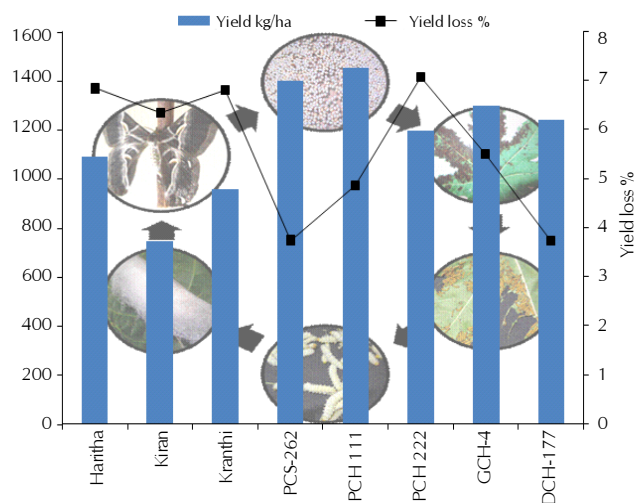


Figure 1: Effect of defoliation of on Castor seed yield and percent yield loss at 30 % defoliation in different castor genotypes during 2013-14

Significant differences were observed in single Cocoon weight of those larvae which were fed with the leaves of different castor genotypes. Maximum and significantly higher Cocoon weight was recorded with those larvae which were fed with leaves of PCH 111 (2.02gm) followed by PCS -262 (1.98 gm). Minimum single Cocoon weight (1.71 gm) was recorded with Kiran but was statistically on par with other castor genotypes viz., Haritha, Kranthi, PCH 222, GCH 4 and DCH- 177 which recorded the Cocoon weight in the range of 1.73 to 1.80 g. These results are in agreement with the findings of Devaiah and Dayashankar (1982) who reported that the cocoon weight depends on the type of hosts provided for feeding the worms. Similarly the highest and significant pupal weight was obtained from worms fed on PCH 111 (1.63 g) and PCH 222 (1.60g) closely followed by PCS 262 (1.58) and the lowest was obtained from those fed on Kranthi (1.38g) (Table 2).

Significant variation in shell weight was recorded when worms were fed with the different castor genotypes. PCH-111 yielded maximum and significantly higher shell weight (0.41g) and closely followed by PCS -262 (0.40), GCH-4 (0.36) and Kranthi (0.35). The silk ratio was found to be significantly higher in PCH-111(22.27%) and followed by GCH-4 (21.56 %) and PCS 262 (20.20%) while the lowest shell ratio was recorded with Kiran (13.81%). These findings are comparable with the reports of Sannappa and Jayaramaiah (1999) who opined that the shell weight varied with the type of hosts provided at the larval stage and he obtained 2.13 g of single cocoon weight and 0.339 g of shell weight respectively with selected Aruna Castor. The present study revealed that the castor genotypes have strong influence on eri silk worm rearing performance. Selection of castor genotype is very much important to get better larval development, Cocoon yield and silk yield. The castor genotype PCH-111 was found to be the promising with respect to rearing performance indicators and Cocoon traits of Eri silkworm. Kedir Shifa *et al.*, 2014, reported that silk worm fed with Abaro castor yielded high cocoon weight, pupal weight, shell weight and silk ratio respectively in Ethiopia. The

differences in the rearing performances of eri silk worm regarding larval, cocoon and post cocoon traits when fed with different castor genotypes was comparable with research findings of many workers. (Jayaramaiah and Sannappa, 2000, Sengupta *et al.*, 2008; Patil *et al.*, 2009, Kedir Shifa *et al.*, 2014).

Cost Economics of Eri silk worm production using different Castor genotypes

Economic analysis revealed that the hybrid Castor PCH-111 cultivated under rain fed conditions at 30 % defoliation recorded higher gross returns (Rs. 48570/-), net returns (Rs. 31195/-) and C: B Ratio (1: 2.80) both for seed production and eri silk worm rearing followed by PCS-262 and DCH-4. The results of the experiment on cost of seed production of Castor and economics of eri silk worm production were discussed (Table 3).

Economic returns and C: B ratio

The seed yield of castor was significantly higher in castor hybrid PCH-111 (1454 kg/ha) and on par with PCS 262 (1399 kg/ha) at 30% defoliation of castor levels. The Eri silk yield was also significantly highest with worms fed with PCS-262 castor leaves (12.85 kg/ha) followed by PCH-111 (12.3 kg/ha) and GCH- 4 (12.25 kg/ha). Highest additional returns due to ericulture was realized with PCS-262 castor genotype (Rs. 5140/ha) followed by PCH-111 (Rs 4920/-). The gross returns and net profit released with PCH-111 (Rs.48, 570/- and Rs.31, 195/-/ha) followed by PCS-262 (Rs.47, 110/- and 30,108/-) and GCH-4. (Rs. 45,600/- and 28,272/-). Higher C: B ratio was realized with castor hybrid PCH-111 (1:2.80) followed by PCS-262 (1:2.77) and GCH-4 (1:2.65). However, the lowest C: B ratio (1:1.62) was obtained with castor variety Kiran raised under rain fed conditions. (Table 3 and Figure 1).Misra (2001) reported 16% net profit when castor was grown for seed production where as 34% profit was obtained when it was used for both seed and eri silk production.

Pandey (2003) realized the net returns of Rs.3000 per acre during first year from Ericulture and it was Rs.13, 256 from second year onwards. Chandrappa *et al.* (2012) reported highest B: C ratio of 2.32:1 with castor genotype JI-226 when used for both castor seed and eri cocoon production. The differences in net returns may be attributed to the seasonal price fluctuations of castor seed and eri silk cocoons. Singh *et al.* (2014) realized high cost benefit ratio of 1:1.80, which revealed that Ericulture is a profitable venture for the poor and marginal farmers of North East India. The success story of tribal women who adopted rearing Tasar silk worm under the project of empowerment of tribals of Chhattisgarh which has improved the livelihood of tribals was documented by Bhatia *et al.* (2010).

The results of this experiment clearly indicated the differential response of castor genotypes in terms of leaf yield, seed yield and Eri cocoon / silk production. The castor genotypes viz., PCH-111, PCS 262 and GCH-4 are better suited for both castor seed as well as eri silk worms rearing under rain fed conditions. These castor genotypes can be grown for dual purpose which gives additional returns due to ericulture for the resource poor farmers of Southern Telangana region with less fertile lands under rain fed cropping situation.

However, there is an enormous scope for eri culture in castor growing areas without hampering castor seed production and it also provides a supportive economy for the small and marginal farmers. It is remarkable for its low investment, high returns which makes it as a profitable venture and an ideal agro based industry for castor growers of Telangana region.

ACKNOWLEDGEMENT

The authors are grateful to the National Bank for Agriculture and Rural development (NABARD) for their financial assistance and the Associate Director of Research, RARS, palem, Mahaboobnagar dt. for providing facilities to conduct the experiments.

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