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Effect of Intercrops on the Relative Incidence of Insect Pests of Castor, *Ricinus communis* L.

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ABSTRACT

The effect of intercrops viz., blackgram, greengram, cowpea, redgram, sorghum and pearl millet with castor was studied at Agricultural Research Station, Darsi to identify the appropriate combination of castor (*Ricinus communis* L.) and intercropping in relation to pest incidence. The diversity created by introducing sorghum or pearl millet as intercrops in castor (1:2 ratio proportions) resulted in reduction of incidence of insect pests, namely semilooper, *Achaea janata* L. (1.42 and 1.27 larvae per plant), leaf hopper, *Empoasca flavescens* Fabricius (7.25 and 7.70 per leaf), Tobacco caterpillar, *Spodoptera litura* (0.27 and 1.35 larvae per plant), Bihar hairy caterpillar, *Spilosoma obliqua* (0.07 and 0.17 larvae per plant) and shoot and capsule borer, *Conogethes punctiferalis* Guenee (8.00 and 12.65 % damage) compared to a castor monocrop (2.57, 15.62, 1.00, 0.07 and 16.03 %, respectively). The buildup of natural enemies, *Microplitis*, coccinellids, and spiders of the major pests of castor was also observed in these intercropping systems and resulted in the reduction of insect pests. Further, these systems were more efficient in terms of castor equivalent yields (1446 and 1331 Kg/ha) and economically (36,150 and 33,275 Rs/ha), and were thus more profitable than a castor monocrop (985 Kg/ha and 24,625 Rs/ha).

Key words : Castor, intercrops, Economics,Equivalent yields, Insect pests, Natural enemies.

Castor (*Ricinus communis* L.), an important non–edible oilseed cash crop is grown as a rain–fed crop in Prakasam district, Andhra Pradesh and as a long–duration crop is subject to the vagaries of the monsoon. Fluctuations in productivity levels of castor are experienced as it attracts a large number of insect pests including the semilooper, *Achaea janata* L., tobacco caterpillar, *Spodoptera litura* Fabricius (Noctuidae: Lepidoptera) and the shoot and capsule borer, *Conogethes punctiferalis* Guenee (Crambidae: Lepidoptera). Incidence of *A. janata* is generally noticed from vegetative to early reproductive phase of the crop causes excessive defoliation affecting photosynthesis and later, the larvae eat away the tender capsules of primary and secondary spikes (Tahiliani, 1985; Basappa and Lingappa, 2001). It is estimated that castor yields are reduced by 30-50% due to *A. janata* alone (Rao *et al*., 2012). Incidence of *C. punctiferalis* is commonly noticed in the later stage of crop growth, attacks various plant parts such as the shoots, inflorescences and capsules causing considerable yield losses (Singh *et al*., 1992). Present pest management strategy in castor is use of chemical insecticides causing environmental problems and leads to the development of insecticide resistance. Utilizing the natural agro diversity and altering the microclimate is one of the cultural method and novel approach. Properly planned cropping systems involving crop rotation or intercropping of non-host crops are cost effective components of Integrated Pest Management

Several studies indicate that diversification practices such as intercropping in pigeon pea and other crops are beneficial because these practices reduce pest damage (Srinivasa Rao *et al.,* 2004; Songa *et al*., 2007). With this view, a study on impact of different intercrops in castor was conducted against insect pest incidence in castor to examine how the incidence of insect pests differs in an intercropping system compared to a castor monocrop.

MATERIAL AND METHODS

Field experiments were conducted during *Kharif* 2012-13 and 2013-14 at Agricultural Research Station, Darsi, Prakasam District, Andhra Pradesh with 7 different treatments (six castor–based intercropping systems and one castor

Table 1. Overall mean occurrence of insect pests during 2012-13 and 2013-14 in various castor based intercropping systems.

Cropping system	Semilooper larvae / plant	Leaf hopper population / leaf	Tobacco caterpillar larvae / plant	Bihar hairy caterpillar larvae / plant	Shoot and capsule borer (% Capsule damage)
Castor + Blackgram (1 : 2)	1.4 (1.6)*	9.6 (3.3)*	0.3 (1.2)*	0.0 (1.0)*	9.4 (17.9)**
Castor + Cowpea (1 : 2)	1.6 (1.6)	8.5 (3.1)	0.4 (1.2)	0.1 (1.1)	11.3 (19.6)
Castor + Greengram (1 : 2)	1.6 (1.6)	9.3 (3.2)	0.4 (1.2)	0.1 (1.0)	10.8 (19.1)
Castor + Redgram (1 : 1)	1.3 (1.5)	11.2 (3.5)	0.5 (1.2)	0.1 (1.1)	15.9 (23.3)
Castor + Sorghum (1 : 2)	1.4 (1.6)	7.3 (2.8)	0.3 (1.1)	0.03 (1.0)	8.00 (16.3)
Castor + Pearl millet (1 : 2)	1.3 (1.5)	7.7 (3.0)	1.4 (1.5)	0.2 (1.1)	12.7 (20.7)
Castor mono crop	2.6 (1.9)	15.6 (4.1)	1.0 (1.4)	0.1 (1.0)	16.0 (23.6)
SEM ±	0.1	0.2	0.1	0.0	1.4
CD (P=0.05)	0.2	0.6	0.2	NS	4.2
CV%	6.2	10.8	10.8	3.7	11.7

NS – Not Significant; S – Significant
*Values in parenthesis are SQRT (x+1) values
**Values in parenthesis are arc sine percentage values

monocrop as control) and replicated three times. Intercropping systems that have been found to be effective along with some other systems, both popular and/or suggested by the farmers were included. Six intercrops *viz*., blackgram (var. LBG 752), greengram (var. LGG 460), cowpea (var. Meghana), redgram (var. LRG 41), sorghum (Var. PSV 56) and pearl millet (local cultivar) at different ratios were intercropped with castor var. Kranthi. Blackgram, greengram, cowpea, sorghum and pearl millet were intercropped with castor at 1:2 ratio proportions whereas redgram was intercropped at 1:1 ratio. Each treatment was raised in a plot size of 7.2 X 4.8 m in a randomized block design with a spacing of 90 cm inter-row and 60 cm intra–row. Intercrops were sown in two rows 30 cm apart from each other and 30 cm away from castor rows on either side. Routine agronomic practices such as application of recommended doses of fertilizers to castor, intercrops and intercultural operations were taken up at appropriate growth stages of the crop. No pest control measures were undertaken during the entire crop growth period.

Weekly insect counts were recorded from 10 randomly labeled castor plants in each plot during the cool hours of the day with the initiation of the pests and continued till the end of the crop growth. The population of defoliator larvae of *A. janata*, *S. litura* and *Spilosoma obliqua* were counted at each observation on whole plant basis. The adult and nymphal population of leaf hoppers (*Empoasca flavescens* Fabricius) was counted from five leaves, two from top, one from middle and two from bottom canopy of plant. Crops were harvested at different intervals from first order spikes (primaries), second order spikes (secondaries), third order spikes (tertiaries) and so on. Capsules were obtained from the respective spike orders. The data recorded on damage caused by *C.punctiferalis* across intercropping systems was collected individually by

Table 2. Overall mean occurrence of natural enemies during 2012-13 and 2013-14 in various castor based intercropping systems.

Cropping system	*Microplitis* (% parasitism on *A. janata* larvae)	Coccinellids / plant	Spiders / plant
Castor + Blackgram (1 : 2)	7.5 (15.4)**	0.8 (1.4)*	0.4 (1.2)*
Castor + Cowpea (1 : 2)	7.0 (15.1)	0.9(1.4)	0.4 (1.2)
Castor + Greengram (1 : 2)	5.2 (13.1)	0.9 (1.4)	0.4 (1.2)
Castor + Redgram (1 : 1)	5.0 (12.1)	1.0 (1.4)	0.4 (1.2)
Castor + Sorghum (1 : 2)	6.1 (14.0)	0.8 (1.3)	0.3 (1.2)
Castor + Pearl millet (1 : 2)	5.3 (13.3)	0.9 (1.4)	0.5 (1.2)
Castor mono crop	4.9 (12.4)	0.2 (1.1)	0.3 (1.2)
SEM ±	2.1	0.02	0.02
CD (P=0.05)	NS	0.1	NS
CV%	26.2	3.1	2.6

NS – Not Significant; S – Significant
*Values in parenthesis are SQRT (x+1) values
**Values in parenthesis are arc sine percentage values

spike order (at the time of harvest of each primary, secondary, and tertiary); thus, percent damage was also estimated. Various species of coccinellid predators observed were considered a group and recorded as number of coccinellid adults per plant in all the intercropping systems. All the spiders, irrespective of the family to which they belonged, were recorded together as one unit. The occurrence of endo–parasitoid *Microplitis* spp. on *A. janata* was monitored at weekly intervals; neonate larvae were collected and reared in the laboratory, formation of cocoon at the posterior region of the larvae were recorded and adult emergence of braconids was represented as percent parasitism.

Overall mean insect numbers and percent damage and natural enemy counts across sampling intervals were determined to provide a single index of pest/natural enemy population for making comparisons across intercropping systems. The final pooled mean data across two cropping seasons was analyzed and presented. Plot wise seed yields of castor and intercrops were computed on hectare basis for statistical interpretations. The seed yield of intercrops was converted into castor equivalent yield on the basis of farm harvest prices of the crops. The data collected were transformed into angular or square-root values as per the standard requisites (Gomez and Gomez, 1984). Cropping systems means were compared and separated by least significant difference.

RESULTS AND DISCUSSION

Effect of intercropping on insect pests

In castor–based intercropping systems, the incidence of *A. janata*, *S. litura*, *S. obliqua*, *E. flavescens* and percent damage by *C. punctiferalis* during two year field experiments were mentioned in Table 1. The incidence of *A. janata* varied across the intercropping systems and all the intercropping systems recorded significantly lower overall mean population levels of semiloopers (1.27 to 1.60 larvae per plant) compared to castor mono crop which recorded 2.57 larvae per plant. The intercrops significantly altered two year overall mean capsule damage, and was less with sorghum (8.00%) followed by blackgram, greengram, cowpea and pearl millet (9.44 to 12.65%) and were significantly superior over the castor + redgram (15.9%) and castor monocrop (16.03%). This suggests that pest migration after initial establishment was possibly inhibited by the non–host plants as physical barriers to inter– or intra–row migration within intercrop treatment especially in the later stages of castor crop development as reflected in reduction of *C. punctiferalis* damage. The population of *E. flavescens* was also fluctuated

Table 3. Overall mean castor equivalent yields and economics of castor based intercropping systems during 2012-13 and 2013-14.

Cropping system	No. of capsules / Spike	Castor yield (Kg/ha)	Inter crop yield (Kg /ha)	Castor equivalent yields (Kg/ha)	Economics (Rs / ha)
Castor + Blackgram (1 : 2)	70.3 (8.4)	836.9 (28.5)	96.3	982	24,550
Castor + Cowpea (1 : 2)	69.3 (8.3)	637.9 (25.2)	302.8	1062	26,550
Castor + Green gram (1 : 2)	65.0 (8.1)	825.6 (28.7)	106.8	1035	25,875
Castor + Redgram (1 : 1)	87.0 (9.3)	983.7 (31.0)	166.7	1251	31, 275
Castor + Sorghum (1 : 2)	83.3 (9.1)	1122.6 (33.3)	577.2	1446	36,150
Castor + Pearl millet (1 : 2)	73.3 (8.6)	1100.8 (33.0)	410.5	1331	33,275
Castor mono crop	75.3 (8.7)	984.6 (31.3)	-	985	24,625
SEM ±	0.59	2.51			
CD (P=0.05)	NS	NS			
CV%	11.8	14.4			

Values in Parenthesis are SQRT (X+1) values
Cost of castor – Rs. 25/- per kg

significantly and varied across different intercropping systems during the two year crop period. Significantly lower population levels were recorded in castor + sorghum (7.25 per leaf) and castor + pearl millet (7.70 per leaf) systems over the other four intercropping systems which had the overall mean population range from 8.50 to 11.18 per leaf which was lower than castor monocrop (15.62 per leaf) and it clearly indicates the role of the graminaceous tall intercrops on hindering the *E. flavescens* activity. Sorghum as intercrop reduced leafhopper infestation in pigeonpea (Sekhar *et al*., 1997) and in groundnut (Nath and Singh, 1998). The leafhopper infestation was reduced by the presence of various intercrops like cluster bean, greengram, blackgram in cotton (Balasubramanian *et al*., 1998). The average *S. litura* larval population during two year period was 0.27 per plant in sorghum based castor intercropping system followed by pulse based castor intercropping systems viz., blackgram (0.32 per plant), cowpea (0.40 per plant), greengram (0.43 per plant) and redgram (0.45 per plant), whereas in pearl millet system the larval population was 1.35 per plant which was higher than castor monocrop (1.00 per plant). Significant reduction of incidence of *S. obliqua* was not observed in different castor intercropping systems over monocrop of castor. Cultural practices such as intercropping has been shown to reduce the damage caused by the insect pests in common bean (Karel, 1993), Pigeonpea (Srinivasa Rao *et al*., 2004), cowpea (Oso and Faladae, 2010), blackgram (Soundararajan and Chitra, 2012) and castor (Rao *et al*., 2012).

Effect of intercropping on natural enemies

Diversity in within crop canopy and poly crop situations often reduced the incidence of insect pests (Risch *et al*., 1983). This was mainly due to *in–situ* culturing of natural enemies well–within crop ecosystems, and the same was tested in castor crop and presented in table 2. The presence of *Microplitis* cocoons at the posterior end of larvae and adult emergence were recorded and noted as indicators of parasitism. The mean percent parasitism was more in all the intercropped systems than the castor monocrop and varied between 5-7.5%. A higher level of parasitoid attacks on *A.janata* was recorded in castor intercropped with black gram (7.54 %), cowpea (6.96 %), and sorghum (6.08 %) than the rest of the systems but the differences were not significant over two year period. The coccinellid population varied significantly across intercropping systems throughout the crop growth period during 2012-13 and 2013-14. All inter cropping systems had significantly higher populations of coccinellids that was reflected in overall mean number (0.78 to 0.93 per plant) compared to the castor monocrop (0.23 per plant). The fluctuation of the spider population was significant among intercropping systems, and the overall mean spider activity was higher in castor + pearl millet (0.47 per plant) and on par with the rest of the systems including castor monocrop. Srinivasa Rao *et al*. (2004) reported the increased activity of coccinellids and spiders in leguminous intercrops. The low incidence of insect pests in intercrop systems was often attributed to one factor i.e., higher abundance of their parasitoids and predators, which supports the "natural enemies hypothesis". Baliddawa (1985) observed that up to 30% of pest reduction in intercropping systems could be due to the "natural enemy effect". Sorghum as intercrop was found to significantly increase the natural enemies viz., *Laius malleifer*, *Coccinella septempunctata*, *Orius* sp. and *Cheilemenes sexmaculata* which effectively controlled thrips infesting groundnut (Singh *et al*., 1991). The greater effectiveness of intercrops in reducing the insect pests on castor can be attributed to the combined operation of barrier and natural enemy effects as the predators might have exercised a regulatory effect on pests of castor.

Castor equivalent yields and Economics

Overall mean equivalent yields of castor during two year period were significantly higher in castor with sorghum (1446 Kg/ha), followed by pearl millet (1331 Kg /ha) and red gram (1251 Kg/ha). Lower equivalent yields were recorded in castor + black gram (982 Kg/ha) compared to castor monocrop (985 Kg/ha). The overall mean economics of castor–based intercropping systems was found to be highest in castor + sorghum (36, 150 Rs/ha) and castor + pearl millet (33, 275 Rs/ha). The systems, castor + black gram (24, 550 Rs/ha) and castor monocrop (24, 625 Rs/ha) recorded less monetary returns (Table 3).

The present study concluded that the diversity created by introducing sorghum or pearl millet as intercrops in castor resulted in a buildup of natural enemies of the major pests of castor, also resulted in less congenial conditions for insect pests and are better protected from pest attacks. Further, these systems were more efficient agronomically in terms of equivalent yields. Economic analysis also showed that these intercropping systems were more profitable than castor alone. These components can be well fit into integrated pest management systems in castor ecosystem as environmentally safe and cost effective strategy in small farmers' holdings.

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