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Research Paper

Impact of Selective Integrated Management Practices on the Lepidopteran Defoliators of Castor, *Ricinus communis* L.

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ABSTRACT

An investigation was undertaken to evaluate the selective integrated management practices on the incidence of lepidopteran defoliators of castor, *Ricinus communis* L., a primary host plant of the eri silkworm, *Samia cynthia ricini* Boisduval. The investigation comprises of altogether eight treatments as integrated management practices adopted against defoliators of castor including control. Except for the control, each treatment consists of sowing cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS and three chemical insecticides [Fenvalerate 20 EC @ 0.02%, Profenophos 50 EC 0.03%, Quinalphos 25 EC @ 0.05%] and three plant-based insecticides [Mahua oil @ 2%, Neem oil @ 2% and Pongamia oil @ 2%] were included in the study. The population of castor defoliators namely castor semilooper, tobacco caterpillar, castor butterfly and red headed caterpillar were recorded at different days [3rd, 7th, 11th and 15th] after imposition of integrated management practices. The study revealed that, the population of these defoliators were lowest in an integrated management practices composed of plant-based insecticides [Neem oil @ 2%, Mahuva oil @ 2% and Pongamia oil @2%] when compared to chemical based insecticides [Fenvalerate 20 EC @ 0.03%, Profenophos 50 EC @0.03% and Quinalphos 25 EC @ 0.05%] and control. Thus, the study inferred that, plant-based chemicals can be conveniently used to manage the castor defoliators as they are safe to natural enemies besides castor leaf can be used for rearing of eri silkworm.

***Key words*:** Castor, Defoliators, Eri silkworm, Insecticides, Integrated management practices

Castor is one of the industrially important non-edible oil seed crops of the world. India ranks first among the major castor producing countries (Brazil and China) in the world occupying 68% of area and 85% of castor seed production [1]. In India, castor is grown in an area of 9.92 lakh ha with a production of 10.82 lakh MT during 2019-20 and mainly cultivated in Gujarat, Rajasthan, Andhra Pradesh and Karnataka. Gujarat occupies about 65% of the total share in area and contributes 75% share in production, while Karnataka occupies 9,527 ha in area with a production of 4,722 MT [2]. Among the biological constraints in castor production, undoubtedly insect pests and diseases cause considerable damage to the crop. In India, more than 107 species of insects and six species of mites recorded on castor (*Ricinus communis* L.) at different phenological stages of the crop. The defoliating pests of both major and minor infestation in castor crop include red headed hairy caterpillar, *Amsacta albistriga*; castor semilooper, *Achaea janata*; castor slug caterpillar, *Parasa lepida*; castor hairy caterpillar, *Euproctis fraterna*; tobacco caterpillar, *Spodoptera litura*; Bihar hairy caterpillar, *S. oblique*; hairy caterpillar, *Dasychira mendosa*; castor butterfly (Spiny caterpillar), *Ergolis merione*; castor wooly bear, *P. ricini* [3].

The magnitude of insect pest damage and problem arises from them is quite high in southern part of India where castor is grown mainly as rainfed crop, resulting in lower seed yield. Remarkable yield losses occur in cultivated castor due to severe pest outbreak including leafhoppers, whiteflies, semiloopers, cutworms, hairy/slug caterpillars, capsule borers, etc. [4]. Many of the pests of castor are of seasonal importance and their management should be undertaken with effective eco-friendly (non-chemical) strategies for the management of pests in castor. Basic inputs like fertilizers and pesticides helped greatly in improving and increasing the production and productivity of crops. Indiscriminate use of chemical pesticides and fertilizers have drastically caused and impart negative impact on environment by affecting soil fertility, water hardness, development of insect resistance, genetic variation in plants, increasing toxic residue through food chain and animal feed thus increasing health problems and many more. This necessitates to introduce measures that can harness challenges arise due to chemical pesticides. Use of bio-pesticides and bio-fertilizers can play a major role in dealing with these challenges in a sustainable way [5].

Keeping the above information in view, it is evident that, castor is being majorly affected by the Lepidopteran defoliators. Hence, management of lepidopteran defoliators of castor through integrated approach is of prime importance to keep the pest population below the level of economic injury.

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MATERIALS AND METHODS

The castor [variety: DCS-9] crop was raised at a spacing of 90 × 60 cm in plots of 5.0 × 5.0 m adopting randomized complete block design (RCBD) to know the impact of selective integrated management practices on lepidopteran defoliators. The investigation was undertaken at Zonal Agricultural Research Station, University of Agricultural Sciences, Gandhi Krishi Vigyan Kendra, Bengaluru during 2017-18 and 2018-19. The crop was raised as per the package of practices under rainfed condition with protective irrigation as and when required for better crop stand and to maintain required population in the field [6]. The selective integrated management practices adopted in the investigation are detailed below:

Treatments details

- T_0 : Control
- T_1 : Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS
- T_2 : Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Fenvalerate 20 EC @ 0.02%
- T_3 : Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Profenophos 50 EC 0.03%
- T_4 : Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Quinalphos 25 EC @ 0.05%
- T_5 : Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Mahua oil @ 2%
- T_6 : Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Neem oil @ 2%
- T_7 : Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Pongamia oil @ 2%

The insecticides were applied immediately after the pest appearance on the crop. Each treatment was replicated thrice. The observations were taken a day before application of insecticides and 3rd, 7th, 11th and 15th days after insecticidal application. Ten plants were randomly selected in each treatment plot for recording the observations on the incidence of lepidopteran defoliators and mean population of defoliators were computed.

The data pertaining to field studies for two years was pooled and analyzed adopting one-way Analysis of Variance [ANOVA] using SPSS statistical package [Ver. 21.0] [7]. The treatments under study were compared with control and per cent change in values were computed.

RESULTS AND DISCUSSION

The results of the current investigations are presented in (Fig 1-4) and are discussed in the light of earlier works in the following paragraphs:

Castor semilooper

The population of castor semilooper could vary considerably at different days (3rd, 7th, 11th and 15th) after imposition of selective integrated management practices on castor when compared to their number on a day before their imposition. Notably the semilooper population was less when integrated management practices that includes chemical/plant-based insecticides as one of the component. It was clear from the results that at 3rd day after imposition of treatments, T_6 [Neem oil @ 2%] recorded significantly lowest population of 3.743/plant [-35.94%] when compared to control. However, at 7th and 11th day after imposition of integrated management practices, the population of castor semilooper was least [3.503 and 2.443/plant] with T3 [Profenophos 50 EC @ 0.03%] and the per cent population decreased by -34.84 and -54.74 as compared to control, respectively. On the other hand, at 15th day after imposition of treatments, T_5 [Mahuva oil @ 2%] recorded lowest castor semilooper population of 1.397/plant and was closesly followed by T_4 [Quinalphos 25 EC @ 0.05%] [1.543/plant] and the per cent population decreased by -86.95 and -83.45 when compared with control treatment. Overall, the population recorded by the respective treatments were arranged in decreasing order [$T_5 < T_4 < T_3 < T_6 < T_7 < T_2 < T_1 < T_0$]. 11 insecticides against grey semilooper were tested, *Trichoplusia orichalcea* Rivula, out of these Fenvalerate [0.1%] and Quinalphos [0.025%] kept the castor crop free from pest infestation upto 15 days [8]. Fenvalerate at 0.02% was most effective against castor semilooper [82.94%] followed by Endosulfan at 0.07%, Carbaryl at 0.1% and Phosalone at 0.07% with 60.92, 56.69 and 50.48% mean reduction of the larvae, respectively [9]. NSKE at 2% and neem leaf extract at 10% kept the defoliating insects away after 24 hours of treatment and the reduction in population of pests was mainly due to repellent action by the neem insecticides [10]. Application of Endosulfan 35 EC @ 3 l/ha, Fenvalerate 20 EC @ 20 kg [0.4%] dust/ha, Fenvalerate @ 0.75 litre 20 EC/ha were effective in controlling castor semilooper [11]. Anti-feedent activity of six commercially available formulations of neem-based insecticides viz. nimbicidin [2%], multineem [2%], neemgold [2%], econeem [0.5%], neemzol [0.3%] and fortuneza on third instar larvae of castor semilooper and among them, nimbicidin at 2% was significantly superior over rest of the neem-based insecticides [12]. Four IPM modules on defoliating pests of castor, among them Module-I proved superior over others by using Fenvalerate @ 0.01% application at 35 days after sowing (DAS) followed by Azadirachtin 0.3% at 60 DAS [13]. Further, the Module-I found better in suppression of the pest with moderate conservation of natural enemies, with a yield of 15.03 qt/ha and C:B ratio of 1:4.2.

The plot treated with NSKE at 1500 PPM [0.0015%] reduced larval population up to 58.32 and 46.45% after 24 and 72 hours of application [14]. Toxicity caused by Profenophos to early instar was almost same as methyl parathion, but proved eight times more toxic to late instar larvae [15]. Also reported that intrinsic toxicity of insecticides to early 2nd and late 4th instar larvae of castor semilooper. Among nine insecticides tested Fenvalerate exerted highest toxicity both at 24 and 72 hours intervals of observation followed by Profenophos. Profenophos 50 EC [0.03%] was one of the best chemical in controlling the castor semilooper [16]. Neem oil @ 2% was found most effective and significantly superior in checking the population of leaf miner, semilooper and leafhopper as compared to Neem oil [1%] > Mahua oil [2%] > Pongamia oil [2%] > Pongamia oil [1%] and Mahua oil (1%) [17]. Quinalphos @ 250g and Quinalphos @ 200g reduced the castor semilooper population by 64.18 and 61.97% [18]. Spinosad at 45 SC 0.018% [0.4 ml/l] was found most effective in suppressing castor semilooper infestation resulting in higher seed yield [1168.67 kg/ha] followed by Triazophos 40 EC 0.05% (1.25 ml/l) (1062.17 kg/ha) [19].

Tobacco caterpillar

Selective integrated management practices adopted against tobacco caterpillar had significant influence on their number at different days [3rd, 7th, 11th and 15th] after their imposition as compared to their number on a day before their imposition. Considerably the number of tobacco caterpillars was relatively less when integrated management practices that comprise of chemical/plant-based insecticides. The results revealed that at 3rd day after imposition of treatments, T_6 [Neem oil @ 2%] registered significantly lowest population of 0.690/plant with a decrease of -53.28% when compared to control. However, at 7th day after imposition of integrated management practices, the population of tobacco caterpillar was least with T_5 [Mahua oil @ 2%] [0.553/plant] with a reduction of -57.46% over control. At 11th day, T_6 [Neem oil @ 2%] found best by recording lowest population of 0.433/plant with a reduction of -63.41% as compared to control. In contrast, at 15th day after imposition of treatments, T_5 [Mahuva oil @ 2%] recorded lowest tobacco caterpillar population of 0.400/plant and was closely followed by T_4 [Quinalphos 25 EC @ 0.05%] and T_2 [Fenvalerate 20 EC @ 0.03%] as both recorded 0.443/plant and the per cent population decreased by -72.35 and -69.68 when compared with T_0 (Control) [20]. NSKE at 2% resulted in ovipositional deterrence to tobacco caterpillar. Significant reduction in larval mortality and fecundity, anti-feedancy, ovipositional repellency and prolonged larval and pupal duration was noticed after application of acetone extract of neem leaf exudates on fifth instar larvae of *S. litura* [21]. Application of Azadirachtin and neem oil on oil seed crops can control and disrupt the growth of insects [22]. Both Quinalphos and Chlorpyriphos at 0.05% found highly toxic to tobacco caterpillar, on castor [23]. Application of NSKE @ 23.5% + Neem leaf extract [NLE] @ 10% considerably reduced the larval population [51.59%], while application of NSKE at 5% proved economically most viable among the neem-based pesticides followed by NLE 5% [24]. Spraying of NSKE at 4 to 5% acts as ovipositional deterrent and when defoliation exceeds 25%, often recommended to go for spraying with Chlorpyriphos at 0.004% or Monocrotophos at 0.05% or Quinalphos at 0.05% [25]. PONNEEM [combination of neem and pungam [karanj] recorded the maximum antifeedant activity [88.6%] at 0.6%, while neem and karanj as individual treatments along with PONNEEM extended larval and pupal duration with a reduction in fecundity and pupal weight [26]. In addition, PONNEEM showed growth disruption activity against fourth instar larvae. Flubendiamide @ 48 g.a.i/ha and Chlorantriniliprole @ 30 g a.i./ha were as effective as two conventional insecticides viz. Lambda–Cyhalothrin and Profenophos in suppression of semilooper larvae, tobacco caterpillar and capsule borer [27].

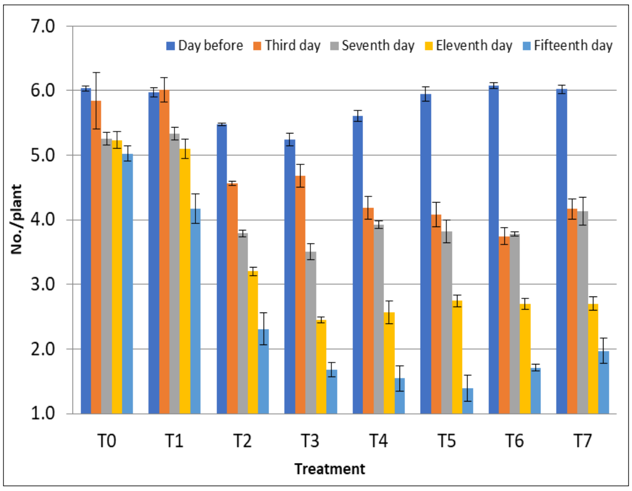

Fig 1 Population of castor semilooper at different days after imposition of selective integrated management practices on castor

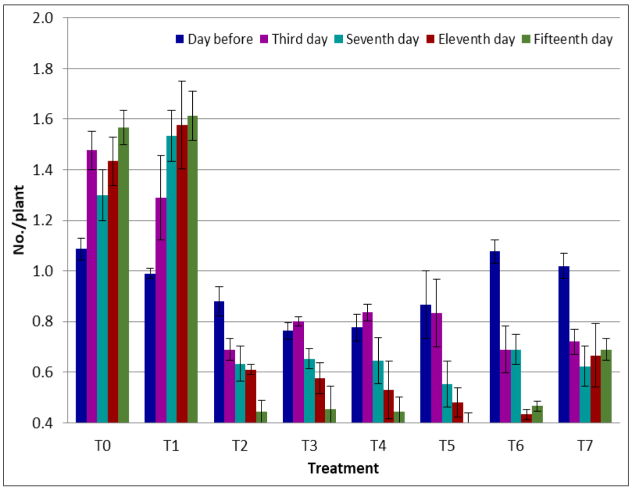

Fig 2 Population of tobacco caterpillar at different days after imposition of selective integrated management practices on castor

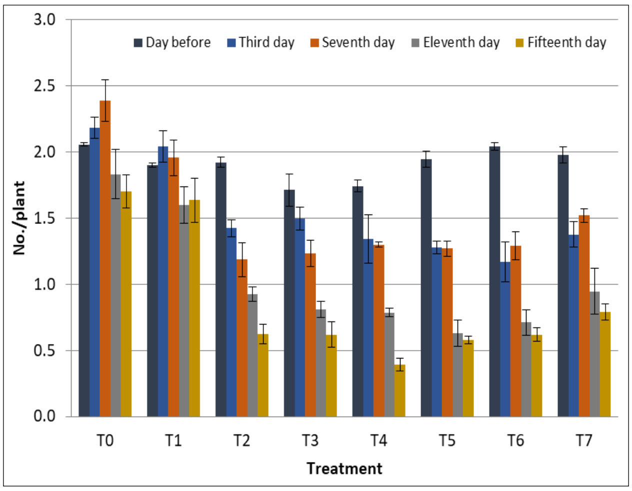

Fig 3 Population of castor butterfly at different days after imposition of selective integrated management practices on castor

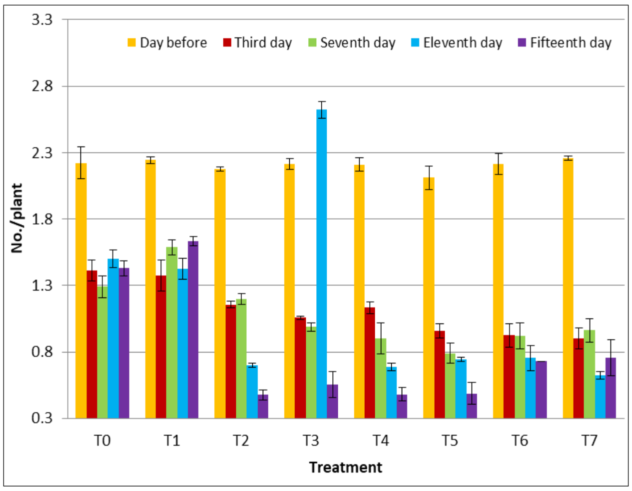

Fig 4 Population of red headed hairy caterpillar at different days after imposition of selective integrated management practices on castor

Castor butterfly

Statistical variations were observed with respect to the population of castor butterfly at 3rd, 7th, 11th and 15th days after the imposition of selective integrated management practices adopted on castor, while their number did not vary considerably on a day before their imposition. Lowest population of castor butterfly [1.170/plant] was found in T_6 [Neem oil @ 2%] at 3rd day with a reduction of -46.50% when compared to control. At 7th day, the population was least with T_2 [Fenvalerate 20 EC @ 0.02%] [1.187/plant] together with T_3 [Profenophos 50 EC @ 0.03%] [1.233/plant] with a reduction of -50.34 and -48.41% over control. On the other hand, T_5 [Mahuva oil @ 2%] and T_6 [Neem oil @ 2%] at 11th day found best by recording a castor butterfly population of 0.630 and 0.710/plant with a reduction of -75.19 and -70.19% as compared to control, respectively. Considerably, the population of castor butterfly was relatively less in T_4 [Quinalphos 25 EC @ 0.05%] and T_5 [Mahuva oil @ 2%] that recorded 0.390 and 0.577/plant at 15th day after imposition of integrated management practices and the per cent population decreased by -80.02 and -68.60, respectively when compared to control. The use of plant-based bio-pesticides like *Erythrina indica* seeds or flower of *Delonix regia* with ether extract at 0.5% resulted higher larval and pupal mortality of *Ergolis merione* and larval mortality ranged from at 20 to 91% and damage decreased by 65% [28]. Chlorfenapyr 10 SC @ 1.5 ml/l followed by Monocrotophos 36 WSC @1.6 ml/l were found effective against defoliators viz., castor semilooper, tobacco caterpillar and castor butterfly [29]. Spray of NSKE at 5% or *Azadirachtin* at 5% @ 0.5ml/l was found most effective in controlling gregarious caterpillar [30]. Cartaphydrochloride was found more toxic than nimbicidin on the larvae of castor butterfly [31].

Red headed hairy caterpillar

Selective integrated management practices adopted against red headed hairy caterpillar population showed significant influence on their number at 3rd, 7th, 11th and 15th days after their imposition when compared to a day before their imposition where it showed non-significant variation in the population. The results revealed that at 3rd day after imposition of treatments, T_7 [Pongamia oil @ 2%] recorded lowest population of 0.900/plant with the reduction of -36.17% over control. In respect of 7th day after their imposition, T_5 [Mahuva oil @ 2%] recorded 0.790/plant with a reduction of -50.22 when compared to control treatment. However, at 11th day, T_7 [Pongamia oil @ 2%] registered least population of red headed caterpillar [0.623/plant] with a significant reduction in the population [-140.55%] over control. Notably, T_2 [Fenvalerate 20 EC @ 0.02%] noticed less number of red headed caterpillar [0.477/plant] and was found parity with T_4 [Quinalphos 25 EC @ 0.05%] [0.480/plant] at 15th day with a reduction of -80.84 and -80.63% population over control, respectively. Overall, it can be inferred that, the population of red headed caterpillar was found least when integrated management practices comprise of either chemical or plant-based insecticides. Leaf extract of *Pongamia* in water showed toxicity to larvae of red headed hairy caterpillar, *Amsacta moorei* [32]. Red headed hairy caterpillar can be effectively controlled by spray of 5% Neem seed kernel extract (NSKE) [33]. Further, intercropping with pigeon pea, mungbean and soybean enhances the population of spiders. Red headed hairy caterpillar on castor can be effectively managed by intercrop with cowpea, sesamum, greengram, castor and redgram [34]. Sowing of cucumber/cowpea and planting twigs of *Ipomea*, *Jatropha* and *Calatrophis* along the borders of the castor field helps to attract the migrating larvae of red headed hairy caterpillar [35]. Red headed hairy caterpillar can be effectively managed by spray of Monocrotophos (1.6ml) or Fenvalerate (0.02%), Quinalphos (2ml) or Methyl parathion (0.02%) or Dimethoate (2 ml) [36].

CONCLUSIONS

Among the chemical and plant-based insecticides tested in the current investigation against defoliating pests of castor, plant-based insecticides [Mahua and Neem] registered lowest population of lepidopteran defoliators due to antifeedent, repellent, ovicidal and ovipositional deterrent action towards pests. Further, neem and mahua oil acts as antagonistic effects to the plants against pest infestation on castor. On the other hand, out of three chemical based pesticides (Fenvalerate, Profenophos and Quinalphos) Profenophos and Quinalphos recorded lowest population of semilooper. Further, Profenophos is responsible for disruption of respiration and Quinalphos induce acute toxicity through contact stomach poison on insects' pests.

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