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Evaluation of Integrated pest management modules for the management of whitefly *Trileurodes ricini* (Misra) on castor *Ricinus communis*.

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Abstract

Castor is an important oilseed crop. The castor bean contains about 50-55% oil. Among vegetable oils, castor oil is distinguished by its high content (over 85%) of ricinoleic acid. No other vegetable oil contains so high proportion of fatty hydroxy acids. Castor oil's unsaturated bond, high molecular weight (298), low melting point (5°C), and very low solidification point (-12°C to -18°C) make it industrially useful, most of all for the highest and most stable viscosity of any vegetable oil. The castor plant has a substantial taproot with many lateral branches which can reach a great depth enabling them to withstand drought and harsh weather conditions. Leaves of castor plants are large, glossy, and green with pointed lobes and prominent veins; However, the castor leaf for many years has often been attacked by the whitefly and in most cases leads to the destruction of the plant. The whitefly causes stunted growth of the plant and yellowing of leaves which renders the shedding of fruiting bodies. Among the eight treatments, the lowest whitefly/plant recorded by The T4 quinolphos and T6 Neem oil 2% recorded as the best treatments over the rest of the treatments. Significantly highest grain yield @3730.00 kg and 3627.63 kg was recorded by T6 Neem oil 2% and T7 Pongamia oil 2% followed by T5 Mahuva oil recorded yield @ 3283.30kg. However, the chemical treatments viz., T3 Profenophos 50 EC @0.03% and T4 quinolphos 25 EC @ 0.05% recorded yield @ 2956.66 and 2936.00 kg/ha both at par with each other. Whereas untreated control recorded the lowest yield @2426.03 kg/ha.

Keywords
Castor (Ricinus communis); whitefly *Trileurodes ricini* Misra ;Wax bloom, Quinolphos, Profenophos, Neem, Pongamia and Mahua

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Introduction: 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 (Anonymous, 2019). 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 is 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 (Mohan Kumar and Yamanura, 2019)

As many as 20 species of insect pests were associated with castor, but many of them were highly irregular in nature of incidence and their occurrence over the years, distributed in patches with less infestation causing no remarkable damage to the crop. Only 10 species belonging to Lepidoptera, Hemiptera, Orthoptera, and Thysanoptera showed variable economic importance and of these, five species were regular with a high degree of severity as major pests. Most of the insect pests were either defoliators or sucking pests. The magnitude of insect pest damage and problems that arise from them is quite high in the southern part of India where castor is grown mainly as a rainfed crop, resulting in lower seed yield. The pest problem in castor includes defoliators namely semilooper, *A. janata*, tobacco caterpillar, *S.litura*, capsule borer, *C. punctiferalis* (Sarma *et al*., 2005). The sucking pests namely leafhopper, *E. flavescens* Fab., thrips, *Retithrips syniacus* Mayet, and white fly, *T. ricini* also cause considerable damage to castor crops(Lakshminarayana and Raoof, 2005).

Apart from defoliators, sap feeders and borers have assumed regional importance and quite sporadic pests *viz*., castor gallfly, *Aspondylia ricini* M., spiny caterpillar, *Ergollis merione* C. and red spider mite, *Tetranychus telarius* L. In Gujarat, castor inflorescence thrips (*Scirtothrips dorsalis* Hood) also attained a pest status by infesting the crop at the flowering stage, causing considerable loss to the crop. A highly resistant and polyphagous pest, *Helicoverpa armigera* Hubner also causes considerable damage to castor crops by feeding foliage at the vegetative stage and boring into the castor capsules at a later stage (Basappa, 1995).

In the castor ecosystem, insect pests also have a good number of natural enemies and attack at different growth stages, among them; the egg parasitoid, *Trichogramma chilonis* Ishii; larval parasitoid, *Microplitis maculipennis* Szepligate, insect predators, insectivorous birds and some of the microbial agents exert greater biological resistance in the succession of the pest complex of castor (Basappa, 2003).

Remarkable yield losses occur in cultivated castor due to severe pest outbreaks including leafhoppers, whiteflies, semi-loopers, cutworms, hairy/slug caterpillars, capsule borers, etc.(Jayaraj and Diraviam, 2004). Basic inputs like fertilizers and pesticides greatly help in enhancing the production and productivity of crops. Indiscriminate use of chemical pesticides and fertilizers has a drastic impact on the 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 introduction of measures that can harness challenges that arise due to chemical pesticides. Thus, the use of bio-pesticides and bio-fertilizers can play a major role in dealing with these challenges sustainably (Gupta, 2010).

In recent years, the use of synthetic insecticides in crop protection programs resulted in adverse effects on the environment, noticing pesticide residues in the crop produce, pest resurgence, pest resistance in the existing pest population, etc. This led to the increased importance of naturally occurring plants associated with a rich traditional knowledge base available to the highly diverse indigenous communities in India, as it is an environmentally friendly agricultural technology for ensuring food safety and food security (Raghavendra *et al*., 2016). India has vast potential use of bio-pesticides. Some bio-pesticides currently developed may be excellent alternatives to chemical pesticides. Bio-pesticides being target pest specific presumed to be relatively safe to non-target organisms including humans, livestock, and water bodies. However, in India, some of the bio-pesticides like Bt, NPV plant-based neem, Pongamia, and mahua bio-pesticides; *Trichoderma*, etc. have already been registered and are also being practiced. There are many locally available plants like beshram, neem, garlic, *etc*. which can be easily processed and used for the management of many of the hard-core insect pests of crops (Dutta, 2015). Keeping the above information and literature about the current investigation in view, it is evident that, castor is being majorly affected by the lepidopteran defoliators and sucking pests. Hence, the management of defoliators as well as sucking pests through an integrated/eco-friendly approach is of prime importance to keep the pest population below the level of economic injury. In this context, the current investigation has been undertaken by adopting integrated approaches for the management of the sucking pest whitefly *Trileurodes ricini* Misra on castor.

Materials and methods: The DCH-177 variety of castor seeds were sown at 90 x 60 cm spacing in plots of 5.0 x 5.0 m adopting Randomized Complete Block Design (RCBD) with three replications at Zonal Agricultural Research Station, University of Agricultural Sciences (UAS), Gandhi Krishi Vigyan Kendra (GKVK), Bengaluru during 2019-20 and 2020-21. Before sowing, the seeds were soaked in cold water to smoothen the seed coat which makes it easy for germination. Two seeds were dibbled at each spot. Sprouting of seeds was observed after one week. The newly germinated seedlings were allowed to grow for a few days, later thinning was done. Among the two seedlings in each spot, a healthy seedling was allowed to grow and weak and slow-growing seedlings were removed. This technique was followed to maintain the optimum population in the field. The crop was raised by following the recommended package of practices (except for plant protection measures) developed for rainfed conditions with protective irrigation as and when required for better crop stand and to maintain the required population in the field (Anonymous, 2016). Treatments were imposed immediately after the Whitefly population reached above the threshold level. The second spray was undertaken at 25th days after the first spray.

The observations of Whitefly *Trileurodes ricini* Misra were recorded from 6 randomly selected plants from each treatment one day before the imposition of treatment and 3,7,11 and 15 days after the imposition of treatments. Simultaneously natural enemies like green lacewings, damselfly, and other natural enemies populations were also recorded along with the whitefly population. Data collected from the experimental plot before and after the treatment imposition was subjected to statistical analysis.

Test pesticides used in the study:

Sl No.	Common name	Trade name	Formulation	Dosage [ml/litre]	Source of supply
1	Fenvalerate	Rocket	20 EC	1.00	TATA (Rallys) Mumbai
2	Profenophos	Prahar	50 EC	0.75	Biostadt (India) Ltd., Mumbai
3	Quinalphos	Ekalux	25 EC	1.50	Bayer (India) Ltd., Mumbai
4	Mahuva oil	-	-	-	M/S Venkateshwara Oil Manufacturers, Hoskote Taluk, Bengaluru Rural District
5	Neem oil	-	-	-	
6	Pongamia oil	-	-	-	

Results and Discussion:

The effectiveness of various insecticides was tested under field conditions based on the population of Whitefly *Trileurodes ricini* Misra per plant. The Whitefly population did not vary significantly among the treatments before the application of insecticides. However, three days after spraying, the population of Whitefly per plant decreased significantly among the chemical and plant-based insecticidal treatments. The Whitefly population remained under normal limit up to 15 days after spraying. The treatment T6 Neem oil 2% recorded the lowest Whitefly population per plant with a 68.29% reduction over control. It was followed by T4 Quinolphos 25 EC @ 0.05%, which recorded a 63.62% reduction over control during the first spray. The highest Whitefly population per plant was recorded by treatment T1 because it did not receive any insecticidal spray either chemical or plant-based insecticides throughout the experimental period. The same trend was noticed after the second spray as well. During the second spray, treatment T6 Neem oil 2% recorded the highest percentage of reduction over control with a 92.03% reduction, followed by T4 Quinolphos 25 EC @ 0.05% with an 89.84% reduction over control. In both sprayings, the population of Whitefly reduced considerably after three days and continued even after 15 days. The lowest population of Whitefly per plant was recorded by T6 Neem oil 2% and T4 Quinolphos 25 EC @0.05%, which were statistically at par throughout the observation. T6 Neem oil 2% and T4 Quinolphos 25 EC @ 0.05% were recorded as the best treatments among all the treatments.

The grain yield was significantly highest in T6 Neem oil 2% and T7 Pongamia oil 2%, which recorded yields of 3627.63 kg and 3283.30 kg, respectively. T5 Mahuva oil recorded yield at 3283.30kg. However, the chemical treatments T3 Profenophos 50% and T4 Quinolphos 25 EC @ 0.05% recorded yield at 2956.66 and 2936.00 kg/ha, respectively. The untreated control recorded the lowest yield of 2426.03 kg/ha.

Efficacy IPM Modules on natural enemis populations at different days after imposition of treatments:

Green lacewings :

There was a study conducted on the use of selective integrated management practices against whiteflies on castor, which showed no significant variation in the population of green lacewings on the day before the treatments were imposed. However, their numbers varied significantly on the 3rd, 7th, 11th, and 15th days after the treatments were imposed. The use of chemical and plant-based insecticides for the management of whiteflies on castor resulted in a considerable reduction in the population of green lacewings.

On the 3rd day, the control (T0) and the treatment with cucumber and *T. chelonis* @ 2 lakh eggs/ha (T1) recorded the highest population of green lacewings (1.247/plant and 1.143/plant, respectively) as these two treatments did not receive insecticidal spray. A similar trend was noticed on the 7th (1.100 and 1.023/plant), 11th (1.000 and 0.830/plant), and 15th days (1.143 and 0.867/plant) after the treatments were imposed, respectively.

Among the chemical and plant-based treatments, on the 3rd day, T3 (Profenophos 50 EC @ 0.03%) recorded the highest population of green lacewings (0.843/plant) with a reduction of -35.35% population over the control, while on the 7th day, T7 (Pongamia oil @2%) recorded a green lacewing population of 1.023/plant with a meager reduction of -7.527% population as compared to the control. However, at 11th and 15th days, T3 (Profenophos 50EC @ 0.03%) and T7 (Pongamia oil @2%) registered the highest green lacewing population of 0.800 and 0.857/plant with a decrease in population over the control of -26.08% and -32.99%, respectively.

Damselfly

The population of damselflies varied before the implementation of selective integrated management practices, which were adopted to manage whiteflies on the castor crop. A significant increase in the population of damselflies was observed in T1 (Cucumber+ T. chelonis @ 2 lakh eggs/ha at 30 DAS) (0.923, 0.990, 0.933 and 0.943/plant) and T0 (Control) (0.900, 0.930, 0.890 and 0.833/plant) on different days (3rd, 7th, 11th, and 15th) after the implementation of integrated management practices on castor. These two treatments did not receive either chemical or plant-based insecticides. Among the chemical and plant-based treatments, T6(Neem oil @ 2%) on the 3rd day (0.867/plant) and T7 (Pongamia oil @2%) on the 7th (0.800/plant), 11th(0.833/plant), and 15th day (0.780/plant) recorded a significant increase in population, but their number decreased by -3.667, -16.95, -5.181, and -7.001 when compared to the control, respectively.

Other natural enemies

The population of other natural enemies did not show significant variation on the day before and on the 3rd day after the implementation of integrated management practices against whitefly on castor. However, on the 7th day, the highest population of other natural enemies (0.680/plant) was recorded in T7 (Pongamia oil @ 2%), with an increase of 12.21% over the control. On the 11th day, T1 (Cucumber+ T.chelonis @ 2 lakh eggs/ha at 30 DAS) recorded the highest population of other natural enemies (0.633/plant), with an increase of 11.64% compared to the control. On the 15th day, a significantly higher population of other natural enemies (0.530/plant) was recorded in T0 (Control), together with T6 (Neem oil @ 2%)and T7(Pongamia oil @ 2%), where both recorded an other natural enemies population of 0.500/plant, with a meager reduction of -7.143% over control.

TABLE 1: Effect of chemical and plant based pesticides on **Whitefly** *Trileurodes ricini* Misra on castor 2019-20.

Sl.no	Integrated management pracrices	Pre treatment	Whitefly /plant 2018-19										Yield kg/ha
			3 DAS	7DAS	11 DAS	15 DAS	% ROC	3 DAS	7DAS	11 DAS	15 DAS	% ROC	
			(1st spray)					(2nd spray)					
1	T0 control	30.66 (33.62)	31.05 (33.86)	33.15 (35.13)	34.28 (35.82)	36.20 (36.97)	------	38.44 (38.30)	39.76 (39.07)	40.88 (39.72)	41.14 (39.88)	------	2426.03
	T1 cucumber +release of *T.chelonis* 2 lakhs eggs/ha @30 DAS	31.38 (34.07)	29.36 (32.81)	28.85 (32.47)	28..43 (32.20)	26.59 (31.02)	26.55	25.01 (29.99)	22.71 (28.45)	18.11 (25.17)	16.23 (23.75)	60.55	2730.03
2	T2 release of *T.chelonis* 2 lakhs eggs/ha @30 DAS +Fenvalerate20EC@0.02%	31.22 (33.96)	26.89 (31.23)	20.50 (26.91)	19.24 (26.00)	16.10 (23.64)	55.53	14.21 (22.13)	11.14 (19.49)	09.08 (17.53)	07.81 (16.22)	82.75	2793.36
3	T3 release of *T.chelonis* 2 lakhs eggs/ha @30 DAS + Profenophos 0EC@0.03%	31.05 (33.86)	20.50 (26.91)	18.19 (25.24)	17.17 (24.47)	16.67 (24.09)	53.96	15.26 (22.98)	14.18 (22.11)	10.20 (18.62)	7.10 (15.45)	81.02	2956.66
4	T4 release of *T.chelonis* 2 lakhs eggs/ha @30 DAS + Qinolphos 25EC@0.05%	29.36 (32.81)	20.08 (26.62)	17.26 (24.54)	17.06 (24.39)	13.17 (21.27)	63.62	16.04 (23.60)	12.37 (20.58)	08.07 (16.49)	4.18 (11.79)	89.84	2936.00
5	T5 release of *T.chelonis* 2 lakhs eggs/ha @30 DAS +Mahuva oil 2%	30.83 (33.72)	22.77 (28.49)	16.28 (23.78)	14.06 (22.01)	15.89 (23.48)	56.11	13.38 (21.44)	14.21 (22.13)	12.71 (20.87)	6.53 (14.78)	84.13	3283.30
6	T6 release of *T.chelonis* 2 lakhs eggs/ha @30 DAS + Neem oil 2%	31.94 (34.41)	21.53 (27.64)	17.13 (24.43)	15.06 (22.83)	11.48 (21.27)	68.29	11.76 (20.05)	09.48 (17.92)	07.54 (15.93)	3.28 (10.42)	92.03	3730.00
7	T7 release of *T.chelonis* 2 lakhs eggs/ha @30 DAS + Pongamia oil 2%	31.05 (33.86)	21.76 (27.80)	17.21 (24.50)	16.19 (23.71)	13.77 (21.76)	61.97	14.10 (22.04)	14.71 (22.54)	10.24 (18.65)	6.24 (14.44)	84.84	3627.63
	Sem± CD CV	0.16 NS -----	0.58 1.71 4.79	0.24 0.75 2.02	0.34 1.05 2.97	0.35 1.07 3.22	________	0.27 0.84 3.89	0.16 0.49 4.12	0.22 0.69 3.67	0.28 0.85 4.19	---------	91.66 275.00 13.10

Values in parentheses are Arc sign transformed values

Table2 : Efficacy of selective Integrated management practices on natural enemie green lacewing at different days after imposition of treatment on castor 2019-20

Integrated management practice	Day before imposition	Third day	Seventh day	Eleventh day	Fifteenth day
T_0 =Control	1.023 ± 0.053	1.247 ± 0.153	1.100 ± 0.085	1.000 ± 0.017	1.143 ± 0.030
T_1 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS	0.933 ± 0.071 [-8.798]	1.143 ± 0.057 [-8.340]	1.023 ± 0.039 [-7.000]	0.830 ± 0.100 [-22.16]	0.867 ± 0.082 [-24.15]
T_2 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Fenvalerate 20 EC @ 0.02%	1.023 ± 0.079 [0.000]	0.800 ± 0.040 [-39.11]	0.843 ± 0.030 [-25.12]	0.767±0.020 [-23.30]	0.810 ± 0.092 [-38.41]
T_3 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Profenophos 50 EC 0.03%	0.820 ± 0.146 [-21.76]	0.843 ± 0.070 [-35.35]	0.857 ± 0.059 [23.75]	0.800 ± 0.051 [-26.08]	0.770 ± 0.000 [-43.02]
T_4 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Quinalphos 25 EC @ 0.05%	0.957 ± 0.047 [-7.074]	0.643 ± 0.047 [-52.84]	0.697 ± 0.033 [-39.39]	0.623 ± 0.079 [-49.15]	0.757 ± 0.030 [-44.52]
T_5 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Mahua oil @ 2%	1.037 ± 0.033 [1.501]	0.577 ± 0.062 [-58.62]	0.833 ± 0.082 [-26.10]	0.723 ± 0.096 [-36.12]	0.810 ± 0.042 [-38.41]
T_6 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Neem oil @ 2%	0.937 ± 0.033 [-9.218]	0.723 ± 0.062 [-45.84]	1.000 ± 0.058 [-9.775]	0.797 ± 0.033 [-26.47]	0.823 ± 0.101 [-36.91]
T_7 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Pongamia oil @ 2%	1.080 ± 0.010 [6.109]	0.823 ± 0.039 [-37.10]	1.023 ± 0.029 [-7.527]	0.753 ± 0.039 [-32.20]	0.857 ± 0.057 [-32.99]
Mean	0.976 ± 0.026	0.850 ± 0.051	0.922 ± 0.031	0.787 ± 0.028	0.855 ± 0.030
F - value	1.342^{NS}	9.716^{**}	5.762^{**}	2.905^{*}	3.755^{*}

DAS : Days after sowing *: $p \leq 0.05$ **: $p \leq 0.01$ NS: Non-significant [ ] : Per cent change over control

Table3 : Efficacy of selective Integrated management practices on natural enemie damselfly at different days after imposition of treatment on castor 2019-20

Integrated management practice	Day before imposition	Third day	Seventh day	Eleventh day	Fifteenth day
T_0 =Control	0.813 ± 0.030	0.900 ± 0.040	0.930 ± 0.000	0.890 ± 0.010	0.833 ± 0.067
T_1 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS	0.867 ± 0.117 [6.642]	0.923 ± 0.053 [2.653]	0.990 ± 0.061 [7.823]	0.933 ± 0.020 [17.23]	0.943 ± 0.043 [14.53]
T_2 =Sowing of cucumber along with castor + release of *Trichogramma chil onis* @ 2 lakh eggs/ha at 30 DAS + Fenvalerate 20 EC @ 0.02%	0.603 ± 0.033 [-24.22]	0.380 ± 0.049 [-59.98]	0.367 ± 0.038 [-73.40]	0.423 ± 0.039 [-44.22]	0.233 ± 0.049 [-79.26]
T_3 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Profenophos 50 EC 0.03%	0.433 ± 0.020 [-43.83]	0.477 ± 0.091 [-48.79]	0.443 ± 0.127 [-63.49]	0.357 ± 0.013 [-52.17]	0.500 ± 0.101 [-43.99]
T_4 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Quinalphos 25 EC @ 0.05%	0.523 ± 0.039 [-33.45]	0.397 ± 0.033 [-58.02]	0.437 ± .0330 [-64.28]	0.447 ± 0.039 [-41.33]	0.487 ± 0.030 [-45.71]
T_5 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Mahua oil @ 2%	0.777 ± 0.023 [-4.152]	0.737 ± 0.067 [-18.80]	0.653 ± 0.062 [-36.12]	0.787 ± 0.030 [-0.361]	0.657 ± 0.098 [-23.25]
T_6 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Neem oil @ 2%	0.967 ± 0.049 [17.76]	0.867±0.052 [-3.667]	0.767±0.033 [-17.53]	0.830 ± 0.100 [5.063]	0.757 ± 0.072 [-9.124]
T_7 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Pongamia oil @ 2%	0.877 ± 0.029 [7.382]	0.853 ± 0.039 [-5.421]	0.800 ± 0.051 [-16.95]	0.833 ± 0.020 [-5.181]	0.780 ± 0.049 [-7.001]
Mean	0.733 ± 0.040	0.692 ± 0.049	0.673 ± 0.050	0.675 ± 0.046	0.649 ± 0.049
F - value	13.40**	17.68**	14.99**	27.18**	11.42**

DAS : Days after sowing **: $p \leq 0.01$ NS: Non-significant [ ] : Per cent change over control

Table4 : Population of other natural enemies at different days after imposition of selective integrated management practices on castor 2019-20

Integrated management practice	Day before imposition	Third day	Seventh day	Eleventh day	Fifteenth day
T_0 =Control	0.690 ± 0.061	0.553 ± 0.077	0.623 ± 0.079	0.567 ± 0.033	0.530 ± 0.058
T_1 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS	0.603 ± 0.033 [-12.61]	0.490 ± 0.076 [-11.39]	0.467 ± 0.084 [-25.04]	0.633 ± 0.082 [11.64]	0.420 ± 0.067 [-20.76]
T_2 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Fenvalerate 20 EC @ 0.02%	0.500 ± 0.051 [-31.51]	0.547 ± 0.062 [-1.224]	0.320 ± 0.049 [-64.88]	0.357 ± 0.030 [-33.18]	0.210 ± 0.076 [-76.19]
T_3 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Profenophos 50 EC 0.03%	0.557 ± 0.030 [-22.06]	0.543 ± 0.047 [-2.041]	0.400 ± 0.017 [-47.75]	0.477 ± 0.062 [-14.22]	0.220 ± 0.049 [-73.81]
T_4 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Quinalphos 25 EC @ 0.05%	0.543 ± 0.047 [-24.38]	0.433 ± 0.052 [-24.49]	0.433 ± 0.078 [-40.69]	0.323 ± 0.023 [-38.55]	0.367 ± 0.038 [-38.81]
T_5 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Mahua oil @ 2%	0.500 ± 0.051 [-31.51]	0.413 ± 0.030 [-28.57]	0.443 ± 0.047 [-38.54]	0.447 ± 0.077 [-18.96]	0.387 ± 0.043 [-34.05]
T_6 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Neem oil @ 2%	0.567 ± 0.020 [-20.40]	0.513 ± 0.072 [-8.163]	0.490 ± 0.059 [-28.48]	0.453 ± 0.023 [-18.01]	0.500 ± 0.017 [-7.143]
T_7 = Sowing of cucumber along with castor + release of *Trichogramma chilonis* @ 2 lakh eggs/ha at 30 DAS + Pongamia oil @ 2%	0.590 ± 0.010 [-16.584]	0.377 ± 0.053 [-35.92]	0.680 ± 0.095 [12.21]	0.487 ± 0.057 [-12.64]	0.500 ± 0.051 [-7.143]
Mean	0.569 ± 0.017	0.484 ± 0.022	0.482 ± 0.030	0.468 ± 0.025	0.392 ± 0.029
F - value	2.222^{NS}	1.255^{NS}	2.993^{*}	3.585^{*}	5.495^{**}

DAS : Days after sowing *: $p \leq 0.05$ **: $p \leq 0.01$ NS: Non-significant [ ] :Per cent change over control

Conclusion : It was observed that the population of whitefly Trileurodes ricini Misra reduced significantly three days after spraying and continued to decrease even after fifteen days. Among all the treatments, the best results were obtained from T6 Neem oil 2%, which recorded the lowest white fly population/plant with a 68.29% reduction over control during the first spray. This treatment was followed by T4 Quinolphos 25 EC @0.05%, which recorded a 63.62% reduction over control during the first spray. The same trend continued during the second spray. T6 Neem oil 2% recorded the highest percent reduction over control with a 92.03% reduction over control, followed by T4 Quinolphos 25 EC @0.05% with an 89.84% reduction over control. Therefore, the treatments T6 Neem oil 2% and T4 Quinolphos 25 EC @0.05% were considered the best treatments among all the treatments.

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