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**Impact of different cultivation systems on
incidence of natural enemies in rice field**

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Abstract

The field experiment was conducted at College farm, College of Agriculture, Rajendranagar, Hyderabad during *Rabi* 2017-18 to evaluate the effect of different cultivation systems on incidence of spiders, coccinellids and per cent parasitisation in paddy with four treatments and three replications, taking TN1 as test cultivar and following the recommended package of practices under each cultivation systems. In general, there was no significant difference in the natural enemies incidence between the systems but it was observed that comparatively higher population of spiders, coccinellids and per cent parasitisation were observed in biodynamic cultivation system followed by organic and conventional cultivation systems.

Keywords: Rice natural enemies, incidence, organic, biodynamic, conventional cultivation

Introduction

Rice (*Oryza sativa* L.) is one of the important cereal crops of the world and forms the staple food for more than 65 per cent of the world population and known as king of cereals. Approximately 52 per cent of the global production of rice is lost annually owing to the damage caused by biotic stress factors, of which 21 per cent is attributed to the attack of insect pests (Yarasi *et al.* 2008)^[15]. About 300 species of insects have been reported to attack rice crop in India, among the insect pests, yellow stem borer (*Scirphophaga incertulas* Wlk.), brown planthopper (*Nilaparvata lugens* Stal.), green leafhopper (*Nephrotettix spp.*), ear head bug (*Leptocoris oratorius* Fabricius), leaf folder (*Cnaphalocrocis medinalis* Gn.) and case worm (*Nymphula depunctalis* Guenée) are predominant. These pests infest the crop at all stages of plant growth and cause a variety of damage such as tissue boring, sap sucking, defoliation and leaf scrapping.

Though various management strategies are being adopted to check insect pests of rice, use of synthetic insecticides is a common method of pest control, which has increased rapidly and has over shadowed the traditional methods used to protect crop damage due to insects. Indiscriminate use of insecticides has resulted in undesirable side effects such as the development of resistance among insect pests, causing environmental pollution and health hazards to farmers (Hassal, 1990)^[3].

The effect of pesticides on non-target organisms has been a source of worldwide attention and concern for decades. Adverse effects of applied pesticides on non-target arthropods have been widely reported (Ware, 1980)^[14]. Unfortunately, natural enemies e.g., parasitoids and predators are most susceptible to insecticides and are severely affected (Aveling, 1997)^[1], Vickerman, (1988)^[13].

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The destruction of natural enemies can exacerbate pest problems as they play an important role in regulating pest population levels.

Therefore, it has now become necessary to search for alternative means of pest control, which can minimize the use of synthetic pesticides. Maintenance of soil health without affecting the properties of soil (physical, chemical, biological etc.), sustainable crop production without harmful effects on environment. Information available on natural enemies of paddy insect pests from this area is meagre. An attempt has been made to study the natural enemy fauna associated with rice crop during Rabi 2017-2018.

Materials and Methods

The field experiments were laid out during summer 2017-18, in randomized block design (RBD) with four treatments and three replications at College farm, College of Agriculture, Rajendra Nagar to assess the incidence of spiders, coccinellids and per cent parasitisation under different rice cultivation systems such as organic cultivation, biodynamic cultivation, conventional cultivation systems. The soil of the experimental plot was light textured red sandy loam. TN1, a known insect pest susceptible cultivar was taken as the test cultivar. Planting was done in plots of size 20m x 5m at spacing of 20cm x 10cm.

Seed treatment

The seeds were treated with *Pseudomonas fluorescens* 10gm per kg and soaked in 1 litre of water overnight under organic cultivation system.

In conventional cultivation system the seeds were treated with Bavistin (50 WP) @ 2g per litre of water for 1 kg seed, and dried for 30 minutes.

The seeds were treated with *bheejamrutha* and shade dried for 30 minutes under biodynamic cultivation system.

Methods and time of application of manures and fertilizers

During land preparation and puddling, 10 tonnes of FYM per ha and 5 tonnes of paddy straw per ha was incorporated in the soil. In the last puddle, 2 tonnes of vermicompost per ha was added under organic cultivation system.

NPK at 120:60:40 per ha respectively was applied under conventional cultivation system. Nitrogen was applied in the form of urea, phosphorus and potassium were applied in the form of single super phosphate and murate of potash respectively. Half of the nitrogen and total quantities of phosphorus and potassium were applied as basal dose prior to transplantation. The remaining half of the nitrogen was applied at panicle initiation stage.

In the last puddle *ghanajeevamrutha* at 10 kg per acre mixed with FYM was added to the field evenly and incorporated into the soil in biodynamic cultivation system.

Plant protection

Azadirachtin 1500 ppm @ 5ml per litre of water was sprayed at 25, 45 and 65 DAT.

Field release of *Trichogramma chilonis* @ 1,00,000 per ha starting at 30, 45 and 60 DAT was undertaken in organic cultivation system.

Carbofuran 3G @ 1.0 kg a.i. per ha was applied at 25 DAT, Cartap hydrochloride 50 SP @ 300 g a.i. per ha was sprayed at 45 and 60 DAT under conventional cultivation system.

Spray application of *jeevamrutha* @ 200 litres per acre at 25 DAT, *bhramasthra* at 45 DAT, *neemastra* at 60 DAT and sour buttermilk at 80 DAT was undertaken under biodynamic cultivation system.

Sampling techniques for record of spiders and coccinellids population

Numbers of spiders per unit area were counted by searching the plants thoroughly. Spiders observed on the crop canopy, base and mid of the plants, from the webs in between the plants, from the webs in individual leaf folds, from water, border weeds and field bunds were carefully collected in specimen tubes and brought to the laboratory and sorted and grouped. For coccinellids the numbers of adult populations per unit area were counted in all the rice cultivation systems. The species identification of spiders and coccinellids was done at AICRP on Biological control of Crop Pests and Weeds, College of Agriculture, Rajendranagar, Hyderabad.

Sampling technique for record of Parasites

The per cent parasitisation by *Trichogramma*, *Tetrastichus* and *Telenomus* sp was estimated through sentinel cards in all the test rice cultivation systems.

Field release of sentinel cards

Sentinel cards (3x4 cm) with at least 100 inactivated and unparasitized eggs of *C. cephalonica* were positioned on underside of the paddy leaves in all the four directions in all the test rice cultivation systems. The stapled cards were removed after 24 hrs of release and kept in glass vials. The recovered cards were maintained at ambient temperature of 27-30°C in AICRP on Biological control of insect pests and weeds laboratory, to record the percentage of parasitised eggs.

$$\text{Per cent parasitisation (egg)} = \frac{\text{Number of parasitoids emerged}}{\text{No. of parasitoids emerged} + \text{No. of larvae hatched}} \times 100$$

The data thus obtained on incidence of spiders, coccinellids and parasite were computed. Data were subjected to ANOVA after suitable transformation and means were separated by Duncan's Multiple Range Test.

Results and Discussion

Effect of different rice cultivation systems on incidence of spiders

The spider populations were recorded from 40 DAT to maturity at ten days interval in different rice cultivation systems during rabi 2017-2018 is presented in Table 1. Spider population consisted of *Pardosa pseudoannulata*, *Tetragnatha* sp, *Agelena* sp, *Oxyopes* sp, *Thomisus* sp, and *Araneus* sp.

It was observed that spider population was found to increase gradually from 60 to 70 DAT and then decreased, with the advancement of crop growth. However, higher population was recorded in biodynamic cultivation (11.0 and 14.4 per m²) followed by organic cultivation (9.4 and 12.8 per m²) during 60 and 70 DAT respectively. In subsequent sampling dates i.e., 80, 90, 100, and 110 DAT spider population in different cultivation systems showed similar trends.

The present findings on the abundance of spiders are in agreement with Muthukrishnan *et al.* (1994)^[8] who reported that maximum number of spiders (5.7 per hill) were recorded in untreated control than in neem oil treated plots (4.0 per hill)

and their number was still less in insecticide treated plots (1.7 per hill). Reddy, (2007) [10] reported that the population of spiders was highest in organic plots with no plant protection. Karthikeyan *et al.* (2008) [4] and Zhong *et al.* (2010) [16] also reported that the spiders were higher in organic rice fields than conventional rice fields.

Effect of different rice cultivation systems on incidence of coccinellids

Coccinellid fauna in the experimental field consisted of *Harmonia octomaculata* Fabricius, *Coccinella transversalis* Fabricius, and *Micraspis discolor*. The data on coccinellid incidence in different rice cultivation systems during *rabi* 2017-2018 is presented in Table 2. Coccinellid population was found to increase gradually from 60 to 90 DAT and then decreased with the advancement of crop growth. However, the coccinellid population under different cultivation systems were found to follow almost similar trends to that of data registered at 50 DAT. The highest population was recorded in biodynamic cultivation (11.4 per m²) followed by organic cultivation (9.4 per m²) at 90 DAT.

Pfinner and Niggli, 1996 reported that the activity as well density of carabids and spiders was high in the bio-dynamic and organic plots than in the conventional plots. Lawanprasert *et al.* (2006) [5] reported that the highest population of coccinellids were observed in organic method as compared to conventional method of cultivation. Madhukar (2005) [6] also reported that the population of lady bird beetles, *Micraspis*

discolour was more in *rabi* than *kharif* season. Incidence of insect pests was low in organically grown rice with high populations of natural enemies or predators was highest than conventional system as reported by Venkat *et al.* (2012) [12].

Effect of different rice cultivation systems on incidence of parasites

Data revealed that there were no significant differences between the treatment means with respect to per cent parasitisation at all the sampling dates (Table 3). However, the total parasitisation varied from 6.9 per cent (organic cultivation) to 7.9 per cent (biodynamic cultivation) during second fortnight of March. During the second fortnight of March *Telenomus* was the predominant egg parasitoid followed by *Trichogramma* and low incidence of *Tetrastichus* was noticed.

During the first fortnight of April the total parasitisation varied from 7.5 per cent (conventional cultivation) to 9.9 per cent (biodynamic cultivation), with *Trichogramma* being the predominant egg parasitoid. Contrastingly, *Telenomus* parasitisation was more during first and second fortnight of April while *Tetrastichus* parasitization was negligible.

Borah *et al.* 2001; Srinivasan *et al.* 2001 [2, 11], also reported the safety of neem formulations to egg parasitoids. Manju and David (2004) [7] reported that the parasitism was higher in neem cake treated plots and sprayed with neem products by 26.28 per cent than on NPK treated plots with no plant protection (20.92 per cent).

Table 1: Effect of different cultivation systems on spider population at Rajendranagar during *Rabi* season 2017-18

S. No	Treatment	Spider population per m ²							
		40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	110 DAT
1	Organic cultivation	4.2 ^b (2.10)	6.6 ^b (2.65)	9.4 ^{ab} (3.14)	12.8 ^a (3.64)	11.6 ^b (3.45)	10.2 ^{ab} (3.24)	6.4 ^b (2.62)	4.8 ^a (2.27)
2	Biodynamic cultivation	6.8 ^a (2.69)	8.6 ^a (3.0)	11.0 ^a (3.39)	14.4 ^a (3.85)	15.6 ^a (4.00)	12.4 ^a (3.59)	9.6 ^a (3.17)	5.4 ^a (2.42)
3	Conventional cultivation	6.4 ^{ab} (2.60)	8.0 ^{ab} (2.90)	9.0 ^b (3.07)	11.0 ^b (3.38)	10.8 ^b (3.35)	10.0 ^{ab} (3.23)	8.0 ^{ab} (2.90)	5.4 ^a (2.42)
4	Control	4.8 ^{ab} (2.29)	6.4 ^b (2.62)	8.8 ^b (3.04)	9.8 ^b (3.20)	9.4 ^b (3.14)	8.2 ^b (2.94)	6.6 ^b (2.65)	6.4 ^a (2.62)

*Figures in parenthesis are arc sine transformed values; Means followed by same alphabets in same column are significantly not different (P=0.05) LSD; DAT- days after transplanting.

Table 2: Effect of different cultivation systems on coccinellid population at Rajendranagar during *Rabi* season 2017-18

S. No	Treatment	Coccinellid population per m ²							
		40 DAT	50 DAT	60 DAT	70 DAT	80 DAT	90 DAT	100 DAT	110 DAT
1	Organic cultivation	1.8 ^a (1.44)	4.2 ^{ab} (2.13)	5.8 ^b (2.49)	7.0 ^b (2.72)	8.2 ^b (2.94)	9.4 ^a (3.13)	5.2 ^a (2.37)	2.4 ^a (1.64)
2	Biodynamic cultivation	3.0 ^a (1.17)	5.0 ^a (2.32)	7.4 ^a (2.80)	9.6 ^a (3.16)	10.8 ^a (3.35)	11.4 ^a (3.44)	6.6 ^a (2.66)	2.6 ^a (1.67)
3	Conventional cultivation	1.0 ^a (1.16)	3.0 ^c (1.17)	5.0 ^{bc} (2.33)	6.8 ^b (2.69)	8.8 ^{ab} (3.04)	10.2 ^a (3.26)	5.6 ^a (2.45)	1.8 ^a (1.44)
4	Control	1.4 ^a (1.32)	3.0 ^{bc} (1.85)	3.8 ^c (2.06)	4.2 ^c (2.16)	6.0 ^c (2.54)	6.4 ^b (2.62)	5.4 ^a (2.42)	3.4 ^a (1.92)

*Figures in parenthesis are arc sine transformed values; Means followed by same alphabets in same column are significantly not different (P=0.05) LSD; DAT- days after transplanting.

Table 3: Effect of different cultivation systems on per cent parasitisation at Rajendranagar during *Rabi* season 2017-18

S. No	Treatment	Per cent parasitisation			
		II FN March	I FN April	II FN April	I FN May
1	Organic cultivation	6.9 ^a (3.9)	8.3 ^a (4.2)	9.5 ^a (5.1)	9.5 ^a (5.0)
2	Biodynamic cultivation	7.9 ^a (4.4)	9.9 ^a (4.7)	12.0 ^a (6.5)	11.3 ^a (6.2)
3	Conventional cultivation	7.0 ^a (3.9)	7.5 ^a (3.9)	9.3 ^a (5.2)	9.6 ^a (5.9)
4	Control	6.7 ^a (3.4)	8.0 ^a (4.6)	9.0 ^a (5.5)	9.0 ^a (5.4)

*Figures in parenthesis are arc sine transformed values; Means followed by same alphabets in same column are significantly not different (P=0.05) LSD; DAT- days after transplanting.

The factors responsible for the differences in natural levels of parasitisation and predator abundance in different systems of rice cultivation might lie in the spheres of fertilization, plant protection or their consequences such as weed flora, plant density or microclimate.

The population of natural enemies in conventional cultivation system was low probably due to toxic nature of chemicals. The negative effect of chemical insecticides on the population of natural enemies was reported by many workers (Dhaliwal and Arora, 2001; Nandarajan and Kumar, 2000).

Thus, from the results it can be concluded that the use of chemical pesticides causes significant reduction in the population of natural enemies of pests. This may reduce the efficiency of biological control of insect pest in rice field and can cause severe outbreak. Botanicals are less harmful and biodynamic preparations can be used in rice field for pest management without causing adverse effects on natural enemies and environment.

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