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**Research Article**

# Management of insect-pests of paddy by organic approaches

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**ABSTRACT:** Management of paddy insect-pests by organic approaches was undertaken at Agricultural Research Station (ARS) farm, Gangavathi during Kharif 2011. Among the various organic treatments screened against insect pests and their safety to natural enemies NE's revealed that commercial neem @ 3ml/l recorded lower plant hopper population BPH (8.45/hill), WBPH (5.13/hill) and leaf folder damage (9.83%) at 3 DAS. This was followed by 'Agniasthra' 50 ml/l. Buprofezin 25% SC @ 1.0 ml/l which was recorded lower population of mirid bugs and spiders/ hill 7 days after spray followed by GCKE @ 10.0 ml and both are differed significantly from Sweet flag rhizome powder @ 20.0 g/l which was recorded higher population of mirid bugs and spiders per hill followed by Jeevamrutha @ 50.0 ml/l. The buprofezin 25% SC @ 1.0 ml/l significantly differ from other organic treatments which recorded higher yield of 72.88 q/ ha followed by commercial neem @ 3.0 ml/l (70.22 q/ ha).

**KEY WORDS:** BPH, mirid bugs and spiders, organic treatments, RLF, WPH.

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## INTRODUCTION

Among various constraints in rice production, damage due to insect pests is substantial and needs regular attention. Large-scale cultivation of high yielding varieties, monocropping, close planting, water regime, excessive use of nitrogenous fertilizers and irrational and abuse of agrochemicals have further aggravated the pest incidence. Over 1400 insect species attack standing and stored rice in the world (Grist and Lever, 1969) while, Kalode and Pasalu (1986) reported that over 100 species of insect pests attack rice crop at various stages of its growth.

According to Pathak and Dhaliwal (1981) the estimated loss due to insect pests was 24 per cent while the Cramer (1967) reported 35 per cent. Among the key pests of rice in India, yellow stem borer (*Scirpophaga incertulas* Walker), brown plant hopper (*Nilaparvata lugens* Stal), white backed plant hopper (*Sogatella furcifera* Hovarth), gallmidge (*Orseolia oryzae* Wood Mason), leaffolder (*Cnaphalocrocis medinalis* Guenee), caseworm (*Propayax stagnalis* Guenee) and gundhi bug (*Leptocorisa acuta* Thunb.) were found to cause substantial damage to crop, In India, moreover loss incurred due to a different insects pests of rice are reported to the tune of 15,120 million rupees which works out to be 18.60 per cent total losses (Chandramani *et al*., 2010). Thungabhadra project commissioned area is the major rice growing (Rice bowl) region (Vijaykumar 2002) in Karnataka wherein the crop is being affected by BPH, WBPH, GLH in *Kharif* and stem borer and leaf folder in *Rabi*. The primary and conventional mode of managing them is pesticide intensive approach (5-6 month of sprays). From time to time several insecticides have been tried and recommended for management of stem borer, leaf folder, brown plant hopper, white backed plant hopper and green leafhopper but few of them are showing resistance to some insecticides (Balasubramanian *et al*., 1983).

Naturally occurring biological control has a potential role to play in management of rice pests in of tropical South and South East Asia and there is a need to emphasize the impact of indigenous natural enemies as an essential part of IPM programmes (Way and Heong, 1994 and Ooi and Shephard, 1994).

In India, there is sufficient evidence to justify the vital role of natural enemies in suppressing the pest population in rice (Rao *et al*., 1983 and Chellaiah *et al*., 1989). However, use of *Trichogramma spp*. the only bio control agent presently available in rice was not found adequate (Pathak *et al*., 1996). Conservation of the natural enemy fauna in *situ* for suppressing the pest population seems to

be a very good alternative. Farmers' continue to resort to insecticidal use for checking pest incidence in their fields without being aware of either the natural bio control taking place or impact of the insecticides on the natural bio agents is essential to convince the farmers of its importance.

Organic agriculture and conservation agriculture is developing rapidly and increasing in its acreage. Almost 30.4 million ha area is managed organically by more than 7,00,000 farmers. The global organic land area has increased by almost 1.8 million ha compared to the previous year of 2005. Global demand for organic products remains robust with sales increasing by over five billion US $ per year (Kumarcharyulu and Amith, 2010).

India is bestowed with lot of potential to produce all varieties of organic products due to its agro-climatic regions. In several parts of the country, the inherited tradition of organic farming is an added advantage. This holds promise for the organic producers to tap the market which is growing steadily in the domestic market related to the export market. Currently, India ranks 33rd in terms of total land under organic cultivation area in the world. The cultivated land under organic certification is around 2.8 million ha. This includes one million ha under cultivation and the rest is under forest area. India exported 86 items during 2007-08 with the total volume of 37,533 metric tonns tons. The export realization was around 100.4 million US $ registering 30 per cent growth over the previous year (Anon., 2010).

## MATERIALS AND METHODS

Management of paddy insect-pests by organic approaches was undertaken at Agricultural Research Station (ARS) farm, Gangavathi during *kharif* 2011 season.

The variety BPT-5204 (Sonamasuri) was transplanted on second September, 2011 in a plot size of 4.5 x 2.5 m and at a spacing of 20 x 10 cm. The experiment was laid out in Randomized Block Design (RBD) having nine treatments *viz, Verticillium lecani*, Sweet flag rhizome powder, GCKE, *Pongamia pinnat*a aqueous extract, Jeevamrutha, Vijaya neem, Buprofezin 25% SC, Agniasthra and Untreated control in three replications. Agronomic practices required to raise the crop was followed as per the package of practice prescribed by University of Agricultural Sciences, Dharwad (Anon., 2009) except for the plant protection measures.

Treatments were imposed once the incidence of insect-pests reached economic threshold level. Observations on various insects-pests and beneficial fauna were registered a day prior, three, seven and fourteen days after treatments imposition. Totally two times treatments were imposed.

Observations on number of plant hoppers beneficial fauna were recorded on ten randomly selected hills in each per plot and was transformed to square root and values ($\sqrt{x}$ +0.5). Prior to statistical analysis. Similarly the observations were documented on percent leafolder damage and they are subjected to arc sine values. All the data were analyzed statistically and treatment means were compared following Duncan's Multiple Range Test (DMRT). The data recorded on all pets from first and second application was pooled, transformed suitably and analyzed.

## RESULTS AND DISCUSSION

### Kharif Season-2012

The population of Brown Plant Hopper (BPH) per hill was recorded during first and second spray the pooled data recorded one day before spraying BPH population varied from 12.98 to 14.35/hills among different treatments depicting no significant difference among different treatments.

Observations made on three days after spraying indicated that buprofezin 25% SC @ 1.0 ml/l found to be effective and recorded less number of brown plant hopper (6.92 /hill) followed by commercial neem @ 3.0 ml/l (8.45 BPH/ hill),these two were on par with the *Verticillium lecanii* @ 1.0 g/l (8.99 BPH/ hill), Agniasthra @ 30.0 ml/l (9.53 BPH/ hill).Other treatments viz., aqueous solution of *Ponagamia pinnata* @ 50.0 ml/l, Garlic chilli kerosene extract (GCKE) @ 10.0 ml/l recorded 10.17 and 10.30 BPH per hill respectively and all these were on par with each other. Highest number of BPH population was recorded in untreated control (14.50 BPH per hill). Similar trend was noticed on 7 and 14 days after spray (Table 1). However there was gradual decrease in the population load in commercial neem and burofezin 25% SC sprayed plots.

The population of WBPH recorded a day before spraying varied from 9.27 to 10.0 per hill in different treatments which showed no much variation in pest distribution in the experimental arena.

Observations recorded on three days after spraying indicated that buprofezin 25% SC @ 1.0 ml was superior which recorded lowest number (3.88 WBPH/hill) and differed significantly with commercial neem @3.0ml, (5.13 WBPH/hill), followed by *V. lecanii* @ 1.0 g (5.56 WBPH/

hill), Agniasthra @ 30.0 ml/l, *P. pinnata* @ 50.0 ml, Garlic chilli keroscene extract @ 10.0 ml as they recorded 6.27, 6.48, 6.63 WBPH per hill, respectively. These superior over Jeevamrutha @ 50.0 ml/l and sweet flag rhizome powder @ 20.0 g/l subsequently when population where registered on. However there was gradual reduction in pest load when days progressed (Table 1).The per cent damage of leaf folder recorded one day before spraying varied from 9.55 to 10.58 among different treatments depicting no significant difference among them.

Observations made on three days after spraying indicated that in all the treatments per cent damage was above ETL, there was no change as compared to one day before spray. On seven days after spraying, commercial neem @ 3.0 ml/l recorded significantly lower per cent damage of 5.37 followed by Agniasthra @ 30.0 ml/l which were recorded 5.74 per cent damage of leaf folder. Other treatments were *P. pinnata* @ 50.0 ml/l, GCKE @10.0 ml/l, Jeevamrutha @ 50.0 ml/l and *V. lecanii* @ 1.0 g/l which recorded 6.15, 6.43, 6.88 and 7.30 per cent damage of leaf folder, respectively. Among these treatments *P. pinnata* and (GCKE), Jeevamrutha and *V. lecanii* were on par with each other and differed with rest of the treatments. Untreated control recorded significantly 12.36 per cent damage of leaf folder. Similar effect was continued on 14 days after spray (Table 1).

The population of mirid bugs per hill one day before spraying varied from 15.61 to 17.17 among different treatments depicting no significant difference among them (Table 3).

Observations made on three days after spraying indicated that buprofezin 25% SC @ 1.0 ml/l recorded lower population of mirid bugs (15.51/hill) and rest of the treatments are increasing trend also on par with each other. Untreated control recorded higher population of 17.36 mirid bugs / hill.

On seven days after spraying of buprofezin 25% SC @ 1.0 ml/l which was recorded lower population of (16.75 mirid bugs/ hill) followed by GCKE @ 10.0 ml (17.17 mirid bugs/ hill) and both are differed significantly from Sweet flag rhizome powder @ 20.0 g/l which was recorded higher population of (19.07) mirid bugs per hill followed by Jeevamrutha @ 50.0 ml/l , *V. lecanii* @ 1.0 g/l, (18.64), (18.57), mirid bugs/ hill, respectively and differed with rest of the treatments. Untreated control recorded highest population of (20.15 mirid bugs/ hill).Similar trend was followed on 14 days after spray (Table 3).

The population of spiders per hill one day before spraying varied from 3.60 to 4.55 in different treatments depicting no significant difference among them.

Observations made on three days after spraying indicated that buprofezin 25% SC @ 1.0 ml/l which recorded lowest population of 3.81spiders/hill followed by GCKE @ 10.0 ml/l recorded 3.94 spiders/ hill as compared to a day before spray and rest of the treatments are increasing trend also on par with each other. Untreated control recorded higher population of 4.85 spiders/ hill.

On seven days after spraying buprofezin 25% SC @ 1.0 ml/l recorded lowest population of (3.63 spiders/ hill) followed by GCKE @ 10.0 ml/l (3.96 spiders/ hill) and both differed significantly from sweet flag rhizome powder @ 20.0 g/l which recorded (5.14 spiders/hill) followed by Jeevamrutha @ 50.0 ml and *V. lecanii* 1.0 g, (5.09 and 4.99 spiders/ hill) respectively. Next followed by commercial neem @ 3.0 ml (4.85), Agniasthra @ 30.0 ml/l (4.81), *P. pinnata* @ 50.0 ml (4.50) spiders/hill. Among these treatments sweet flag and Jeevamrutha were on par with control. Untreated control recorded higher population of 5.45 spiders per hill. Similar trend was followed on 14 days after spray (Table 2).

The yield and economics of various organic approaches evaluated for management of brown plant hopper, white backed plant hopper, yellow stem borer, leaf folder in paddy are presented in Table 5.

Commercial neem @ 3.0 ml/l and buprofezin 25% SC @ 1.0 ml/l both recorded higher yield of (70.22 q/ ha) and 72.88q/ha respectively, significantly differ from other organic treatments. The next important organic was *V. lecanii* @ 1g/l (66.67 q/ha) which was found to be on par with Agniasthra @ 30 ml/l (65.77 q/ha). Other treatments viz., *P. pinnata* @ 50 ml/l (62.22 q/ha), GCKE @ 10 ml/l (60.44 q/ ha) Jeevamrutha @ 50 ml/l (59.55) q/ ha) and sweet flag rhizome powder (57.77 q/ha) were recorded higher yield than the untreated control which registered lowest yield of 43.00 q/ha.

Highest net return were obtained in both commercial neem @ 3 ml/l (Rs. 71,940/ha) with BC ratio of 2.78 ha and buprofezin 25% SC @ 1 ml (Rs. 75,971/ha) with highest benefit cost ratio of 2.86. The next higher returns observed in *V. lecanii* @ 1 g/l (Rs. 66,534/ha) with BC ratio of 2.65 which was on par with Agniasthra @ 30 ml/l with net returns of Rs. 63,945/ha. Other treatments *viz*., *P. pin-*

**Table 1. Effect of different organic treatments against insects-pests of rice during Kharif-2011**

| C.D @ 5% | S.Em± | $T_9$ : Untreated control | $T_8$ : Agniastra Agniasthra | $T_7$ : Buprofezin 25% SC | $T_6$ : Commercial neem | $T_5$ : Jeevamrutha | $T_4$ : Pongamia pinnata queous extract | $T_3$ : Garlic chili kerosene extract | $T_2$ : Sweet flag rhizome powder | $T_1$ : Verticillium lecanii | Treatments | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | _ | 30.0 ml | 1.0 ml | 3.0 ml | 50.0 ml | 50.0 ml | 10.0 ml | 20.0 g | 1.0 g | Dosage/litre water | | |
| NS | 0.30 | 14.18 (3.83)$^{a}$ | 13.08 (3.69)$^{a}$ | 12.98 (3.67)$^{a}$ | 13.03 (3.68)$^{a}$ | 14.35 (3.85)$^{a}$ | 13.91 (3.80)$^{a}$ | 13.37 (3.72)$^{a}$ | 13.40 (3.73)$^{a}$ | 13.78 (3.78)$^{a}$ | 1 DBS | Number of BPH/ hill* | Pooled data |
| 0.15 | 0.05 | 14.50 (3.87)$^{g}$ | 9.53 (3.17)$^{cd}$ | 6.92 (2.72)$^{a}$ | 8.45 (2.99)$^{b}$ | 10.90 (3.38)$^{ef}$ | 10.17 (3.27)$^{de}$ | 10.30 (3.29)$^{de}$ | 11.51 (3.47)$^{f}$ | 8.99 (3.08)$^{bc}$ | 3 DAS | | |
| 0.08 | 0.03 | 15.65 (4.02)$^{h}$ | 9.02 (3.09)$^{d}$ | 4.13 (2.15)$^{a}$ | 5.32 (2.41)$^{b}$ | 10.73 (3.35)$^{f}$ | 9.98 (3.24)$^{e}$ | 10.22 (3.27)$^{ef}$ | 11.32 (3.44)$^{g}$ | 8.03 (2.92)$^{c}$ | 7 DAS | | |
| 0.24 | 0.08 | 18.48 (4.36)$^{f}$ | 9.74 (3.20)$^{c}$ | 1.20 (1.31)$^{a}$ | 2.22 (1.65)$^{b}$ | 13.00 (3.67)$^{de}$ | 11.69 (3.49)$^{d}$ | 11.40 (3.45)$^{d}$ | 14.17 (3.83)$^{e}$ | 9.19 (3.11)$^{c}$ | 14 DAS | | |
| NS | 0.16 | 10.00 (3.24)$^{a}$ | 9.45 (3.15)$^{a}$ | 9.52 (3.16)$^{a}$ | 9.33 (3.14)$^{a}$ | 9.55 (3.17)$^{a}$ | 9.32 (3.13)$^{a}$ | 9.33 (3.14)$^{a}$ | 9.27 (3.13)$^{a}$ | 9.33 (3.14)$^{a}$ | 1 DBS | Number of WBPH/ hill* | |
| 0.23 | 0.07 | 10.48 (3.31)$^{f}$ | 6.27 (2.60)$^{bcd}$ | 3.88 (2.09)$^{a}$ | 5.13 (2.37)$^{b}$ | 7.22 (2.78)$^{de}$ | 6.48 (2.64)$^{cd}$ | 6.63 (2.67)$^{cde}$ | 7.78 (2.88)$^{e}$ | 5.56 (2.46)$^{bc}$ | 3 DAS | | |
| 0.28 | 0.09 | 11.67 (3.49)$^{e}$ | 5.50 (2.45)$^{c}$ | 2.07 (1.60)$^{a}$ | 3.47 (1.99)$^{b}$ | 8.33 (2.97)$^{d}$ | 7.57 (2.84)$^{d}$ | 7.71 (2.86)d | 9.23 (3.12)$^{d}$ | 4.25 (2.18)$^{bc}$ | 7 DAS | | |
| 0.25 | 0.08 | 12.98 (3.67)$^{f}$ | 6.57 (2.66)$^{c}$ | 0.92 (1.19)$^{a}$ | 2.02 (1.59)$^{b}$ | 10.79 (3.36)$^{de}$ | 9.39 (3.14)$^{d}$ | 9.75 (3.20)$^{d}$ | 11.92 (3.52)$^{e}$ | 5.84 (2.52)$^{c}$ | 14 DAS | | |
| NS | 0.31 | 10.58 (18.98)$^{a}$ | 9.55 (18.00)$^{a}$ | 10.40 (18.81)$^{a}$ | 9.80 (18.24)$^{a}$ | 10.08 (18.51)$^{a}$ | 9.62 (18.06)$^{a}$ | 10.04 (18.47)$^{a}$ | 9.95 (18.38)$^{a}$ | 9.81 (18.25)$^{a}$ | 1 DBS | Leaf folder damage (%) ** | |
| 0.31 | 0.10 | 10.61 (19.01)$^{b}$ | 9.61 (18.06)$^{a}$ | 10.42 (18.83)$^{a}$ | 9.83 (18.27)$^{ab}$ | 10.20 (18.62)$^{ab}$ | 9.74 (18.18)$^{a}$ | 10.10 (18.53)$^{ab}$ | 9.97 (18.40)$^{a}$ | 9.84 (18.28)$^{a}$ | 3 DAS | | |
| 0.31 | 0.10 | 12.36 (20.58)$^{i}$ | 5.74 (13.86)$^{b}$ | 7.80 (16.22)$^{g}$ | 5.37 (13.40)$^{a}$ | 6.88 (15.20)$^{e}$ | 6.15 (14.36)$^{c}$ | 6.43 (14.68)$^{d}$ | 8.30 (16.74)$^{h}$ | 7.30 (15.68)$^{f}$ | 7 DAS | | |
| 0.21 | 0.07 | 16.85 (24.24)$^{i}$ | 4.50 (12.25)$^{b}$ | 9.23 (17.68)$^{g}$ | 4.15 (11.75)$^{a}$ | 8.00 (16.43)$^{e}$ | 7.35 (15.73)$^{c}$ | 7.65 (16.06)$^{d}$ | 9.55 (18.00)$^{h}$ | 8.43 (16.87)$^{f}$ | 14 DAS | | |

DBS: Day Before Spray, DAS: Day After Spray, NS: Non Significant

*Figures in parenthesis are transformed (√x+0.5) values and ** Arc sine transformed values

Means followed by the same letter (S) in the column are not significantly different by DMRT (P = 0.05).

**Table 2. Effect of different organic treatments against insects-pests of rice during Rabi-2012**

| C.D @ 5% | S.Em± | $T_9$ : Untreated control | $T_8$ : Agniastra Agniasthra | $T_7$ : Buprofezin 25% SC | $T_6$ : Commercial neem | $T_5$ : Jeevamrutha | $T_4$ : Pongamia pinnata aqueous extract | $T_3$ : Garlic chili kerosene extract | $T_2$ : Sweet flag rhizome powder | $T_1$ : Verticillium lecanii | Treatments | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | – | 30.0 ml | 1.0 ml | 3.0 ml | 50.0 ml | 50.0 ml | 10.0 ml | 20.0 g | 1.0 g | Dosage/litre water | | |
| NS | 0.19 | 5.40 (2.52)$^{a}$ | 6.20 (2.65)$^{a}$ | 6.00 (2.63)$^{a}$ | 5.90 (2.61)$^{a}$ | 5.70 (2.57)$^{a}$ | 5.50 (2.55)$^{a}$ | 4.97 (2.43)$^{a}$ | 5.00 (2.44)$^{a}$ | 5.50 (2.54)$^{a}$ | 1 DBS | Number of BPH/hill* | Pooled data |
| 0.39 | 0.13 | 7.47 (2.90)$^{a}$ | 4.10 (2.25)$^{ab}$ | 0.53 (1.23)$^{c}$ | 3.67 (2.16)$^{b}$ | 5.27 (2.49)$^{ab}$ | 4.43 (2.33)$^{ab}$ | 4.33 (2.30)$^{ab}$ | 5.50 (2.54)$^{ab}$ | 4.17 (2.26)$^{ab}$ | 3 DAS | | |
| 0.37 | 0.12 | 8.87 (3.14)$^{a}$ | 2.73 (1.93)$^{bc}$ | 0.37 (1.17)$^{d}$ | 1.90 (1.69)$^{cd}$ | 4.53 (2.34)$^{bc}$ | 4.20 (2.27)$^{bc}$ | 3.63 (2.14)$^{bc}$ | 5.67 (2.58)$^{ab}$ | 2.17 (1.77)$^{cd}$ | 7 DAS | | |
| 0.55 | 0.19 | 10.07 (3.32)$^{a}$ | 2.47 (1.83)$^{bcd}$ | 0.17 (1.08)$^{d}$ | 0.73 (1.31)$^{cd}$ | 4.03 (2.24)$^{b}$ | 3.13 (2.02)$^{bc}$ | 2.53 (1.87)$^{bcd}$ | 4.67 (2.34)$^{b}$ | 1.53 (1.58)$^{bcd}$ | 14 DAS | | |
| NS | 0.13 | 4.03 (2.24)$^{a}$ | 3.47 (2.10)$^{a}$ | 3.57 (2.13)$^{a}$ | 3.13 (2.03)$^{a}$ | 3.13 (2.01)$^{a}$ | 4.00 (2.23)$^{a}$ | 4.07 (2.25)$^{a}$ | 3.13 (2.03)$^{a}$ | 3.37 (2.08)$^{a}$ | 1 DBS | Number of WBPH/ hill* | |
| 0.33 | 0.11 | 5.67 (2.57)$^{a}$ | 2.50 (1.87)$^{bc}$ | 0.73 (1.30)$^{c}$ | 1.87 (1.68)$^{bc}$ | 3.00 (1.99)$^{b}$ | 2.73 (1.93)$^{bc}$ | 2.57 (1.88)$^{bc}$ | 2.93 (1.98)$^{b}$ | 2.07 (1.74)$^{bc}$ | 3 DAS | | |
| 0.26 | 0.09 | 5.37 (2.51)$^{a}$ | 1.60 (1.61)$^{bc}$ | 0.30 (1.14)$^{c}$ | 0.87 (1.36)$^{bc}$ | 2.43 (1.85)$^{b}$ | 2.37 (1.83)$^{b}$ | 2.03 (1.74)$^{b}$ | 2.53 (1.88)$^{b}$ | 1.33 (1.52)$^{bc}$ | 7 DAS | | |
| 0.31 | 0.11 | 4.27 (2.29)$^{a}$ | 1.57 (1.60)$^{bcd}$ | 0.13 (1.06)$^{d}$ | 0.50 (1.22)$^{cd}$ | 2.03 (1.72)$^{abc}$ | 1.93 (1.71)$^{abc}$ | 1.70 (1.63)$^{bcd}$ | 2.87 (1.96)$^{ab}$ | 0.97 (1.40)$^{bcd}$ | 14 DAS | | |
| NS | 1.16 | 7.25 (15.55)$^{a}$ | 7.40 (15.73)$^{a}$ | 8.16 (16.51)$^{a}$ | 8.03 (16.44)$^{a}$ | 7.45 (15.76)$^{a}$ | 7.62 (15.94)$^{a}$ | 7.13 (15.49)$^{a}$ | 8.54 (16.95)$^{a}$ | 7.89 (16.17)$^{a}$ | 1DBS | Leaf folder damage (%) ** | |
| 3.21 | 1.09 | 9.64 (18.05)$^{a}$ | 7.92 (16.30)$^{ab}$ | 8.25 (16.63)$^{ab}$ | 8.13 (16.52)$^{ab}$ | 9.33 (17.72)$^{ab}$ | 8.07 (16.44)$^{ab}$ | 7.45 (15.72)$^{b}$ | 9.10 (17.54)$^{ab}$ | 8.18 (16.56)$^{ab}$ | 3 DAS | | |
| 3.80 | 1.29 | 10.13 (18.53)$^{a}$ | 4.78 (12.54)$^{e}$ | 7.82 (16.15)$^{bcd}$ | 6.54 (14.70)$^{d}$ | 8.77 (17.17)$^{abc}$ | 7.12 (15.39)$^{cd}$ | 7.65 (15.93)$^{bcd}$ | 9.34 (17.77)$^{ab}$ | 8.34 (16.70) $^{abcd}$ | 7 DAS | | |
| 3.59 | 1.22 | 10.74 (19.12)$^{a}$ | 3.55 (10.83)$^{d}$ | 6.89 (15.05)$^{b}$ | 4.34 (11.97)$^{cd}$ | 7.35 (15.64)$^{b}$ | 5.62 (13.63)$^{bc}$ | 6.22 (14.38)$^{b}$ | 9.17 (17.57)$^{a}$ | 7.04 (15.24)$^{b}$ | 14 DAS | | |

DBS: DBS: Day Before Spray, DAS: Day After Spray, NS: Non Significant

*Figures in parenthesis are transformed (√x+1) values and **Arc sine transformed values

**Table 3. Effect of different organic treatments against Mirid bug, *Cyrtorhinus levidipennis* and spiders during Kharif-2011**

| Treatments | Dosage/litre of water | Pooled data | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number of Mirid bugs/hill | | | | Number of Spiders/hill | | | |
| | | 1 DBS | 3 DAS | 7 DAS | 14 DAS | 1 DBS | 3 DAS | 7 DAS | 14 DAS |
| $T_1$ : *Verticillium lecanii* | 1.0 g | 16.17 (4.08)$^{a}$ | 16.19 (4.09)$^{a}$ | 18.57 (4.37)$^{bc}$ | 22.54 (4.80)$^{cd}$ | 3.60 (2.02)$^{a}$ | 3.63 (2.03)$^{a}$ | 4.99 (2.34)$^{b}$ | 5.8 (2.51)$^{bc}$ |
| $T_2$ : Sweet flag rhizome powder | 20.0 g | 15.80 (4.04)$^{a}$ | 16.045 (4.07)$^{a}$ | 19.07 (4.42)$^{b}$ | 23.77 (4.93)$^{b}$ | 3.86 (2.09)$^{a}$ | 3.94 (2.11)$^{a}$ | 5.14 (2.37)$^{ab}$ | 6.17 (2.58)$^{ab}$ |
| $T_3$ : Garlic chili kerosene extract | 10.0 ml | 15.99 (4.06)$^{a}$ | 15.85 (4.04)$^{a}$ | 17.17 (4.20)$^{de}$ | 20.82 (4.62)$^{fg}$ | 4.10 (2.14)$^{a}$ | 3.94 (2.11)$^{a}$ | 3.96 (2.11)$^{d}$ | 4.95 (2.33)$^{e}$ |
| $T_4$ : *Pongamia pinnata* aqueous extract | 50.0 ml | 16.15 (4.08)$^{a}$ | 16.17 (4.08)$^{a}$ | 17.79 (4.28)$^{cd}$ | 21.42 (4.68)$^{ef}$ | 4.36 (2.21)$^{a}$ | 4.40 (2.21)$^{a}$ | 4.50 (2.24)$^{c}$ | 5.54 (2.46)$^{d}$ |
| $T_5$ : Jeevamrutha | 50.0 ml | 15.90 (4.05)$^{a}$ | 15.92 (4.05)$^{a}$ | 18.64 (4.37)$^{b}$ | 23.12 (4.86)$^{bc}$ | 4.22 (2.17)$^{a}$ | 4.24 (2.18)$^{a}$ | 5.09 (2.36)$^{b}$ | 6.03 (2.56)$^{bc}$ |
| $T_6$ : Commercial neem | 3.0 ml | 15.90 (4.05)$^{a}$ | 15.93 (4.05)$^{a}$ | 18.28 (4.33)$^{bc}$ | 22.22 (4.77)$^{cde}$ | 3.92 (2.10)$^{a}$ | 4.00 (2.11)$^{a}$ | 4.85 (2.31)$^{bc}$ | 5.67 (2.48)$^{cd}$ |
| $T_7$ : Buprofezin 25% SC | 1.0 ml | 15.85 (4.04)$^{a}$ | 15.51 (4.00)$^{a}$ | 16.75 (4.15)$^{e}$ | 20.00 (4.53)$^{g}$ | 3.98 (2.12)$^{a}$ | 3.81 (2.07)$^{a}$ | 3.63 (2.03)$^{e}$ | 4.56 (2.25)$^{e}$ |
| $T_8$ : Agniastra Agniasthra | 30.0 ml | 15.61 (4.01)$^{a}$ | 15.62 (4.02)$^{a}$ | 18.12 (4.31)$^{bcd}$ | 21.94 (4.74)$^{de}$ | 4.35 (2.20)$^{a}$ | 4.38 (2.21)$^{a}$ | 4.81 (2.30)$^{bc}$ | 5.56 (2.46)$^{d}$ |
| $T_9$ : Untreated control | – | 17.17 (4.20)$^{a}$ | 17.36 (4.23)$^{a}$ | 20.15 (4.54)$^{a}$ | 25.55 (5.10)$^{a}$ | 4.55 (2.25)$^{a}$ | 4.85 (2.31)$^{a}$ | 5.45 (2.44)$^{a}$ | 6.60 (2.66)$^{a}$ |
| S.Em± | | 0.03 | 0.02 | 0.04 | 0.03 | 0.12 | 0.06 | 0.02 | 0.03 |
| C.D @ 5% | | NS | 0.07 | 0.11 | 0.09 | NS | 0.17 | 0.07 | 0.09 |

DBS: Day Before Spray, DAS: Day After Spray, NS: Non Significant
*Figures in parenthesis are transformed ($\sqrt{x}$+0.5) values

*nata* @ 50 ml/l (Rs. 59,215/ha) with (2.46 ha), GCKE @ 10 ml/l (Rs. 55,917/ha), Jeevamrutha 50ml/l (Rs. 54,893/ha) and sweet flag rhizome powder (Rs. 51,095/ha) registered higher net returns compared to untreated control (28,763/ ha) with lowest benefit cost ratio of (1.71).

**Rabi Season-2012**

The population of Brown Plant Hopper (BPH) per hill was recorded during first and second spray the pooled data recorded one day before spraying BPH population varied from 4.90 to 6.20/hills among different treatments depicting no significant difference among different treatments in Rabi- 2012 season.

Observations made on three days after spraying indicated that buprofezin 25% SC @ 1.0 ml/l found to be effective and recorded less number of brown plant hopper (0.53 / hill) followed by commercial neem @ 3.0 ml/l (3.67 BPH/

**Table 4. Effect of different organic treatments against Mirid bug, *Cyrtorhinus levidipennis* and spiders during Rabi-2012**

| Treatments | Dosage/litre of water | Pooled data | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Number of Mirid bugs/hill | | | | Number of Spiders/hill | | | |
| | | 1 DBS | 3 DAS | 7 DAS | 14 DAS | 1 DBS | 3 DAS | 7 DAS | 14 DAS |
| $T_1$ : *Verticillium lecanii* | 1.0 g | 9.13 (3.18)[a] | 12.73 (3.70)[a] | 16.32 (4.15)[a] | 16.85 (4.21)[a] | 3.2 (2.05)[a] | 3.4 (2.08)[a] | 4.0 (2.23)[a] | 4.4 (2.32)[a] |
| $T_2$ : Sweet flag rhizome powder | 20.0 g | 10.40 (3.36)[a] | 13.26 (3.76)[a] | 17.11 (4.25)[a] | 18.12 (4.36)[a] | 3.5 (2.11)[a] | 4.2 (2.27)[a] | 4.8 (2.41)[a] | 5.2 (2.49)[a] |
| $T_3$ : Garlic chili kerosene extract | 10.0 ml | 9.85 (3.29)[a] | 11.08 (3.47)[a] | 14.05 (3.86)[a] | 15.55 (4.06)[a] | 3.9 (2.20)[a] | 4.0 (2.23)[a] | 3.7 (2.15)[a] | 3.9 (2.20)[a] |
| $T_4$ : *Pongamia pinnata* aqueous extract | 50.0 ml | 10.11 (3.33)[a] | 11.83 (3.58)[a] | 14.61 (3.94)[a] | 15.11 (4.00)[a] | 3.3 (2.06)[a] | 3.6 (2.14)[a] | 3.6 (2.14)[a] | 4.0 (2.23)[a] |
| $T_5$ : Jeevamrutha | 50.0 ml | 11.25 (3.48)[a] | 13.04 (3.73)[a] | 16.54 (4.18)[a] | 17.73 (4.32)[a] | 3.1 (2.01)[a] | 3.5 (2.12)[a] | 4.3 (2.30)[a] | 4.7 (2.37)[a] |
| $T_6$ : Commercial neem | 3.0 ml | 10.86 (3.44)[a] | 12.62 (3.66)[a] | 16.07 (4.12)[a] | 16.42 (4.16)[a] | 3.6 (2.14)[a] | 3.4 (2.09)[a] | 3.8 (2.18)[a] | 4.2 (2.27)[a] |
| $T_7$ : Buprofezin 25% SC | 1.0 ml | 10.22 (3.34)[a] | 9.73 (3.27)[a] | 11.69 (3.56)[a] | 13.10 (3.74)[a] | 3.8 (2.19)[a] | 3.0 (1.99)[a] | 3.2 (2.04)[a] | 3.6 (2.14)[a] |
| $T_8$ : Agniastra Agniasthra | 30.0 ml | 9.41 (3.18)[a] | 12.38 (3.64)[a] | 15.20 (4.00)[a] | 15.76 (4.07)[a] | 3.5 (2.10)[a] | 3.5 (2.12)[a] | 3.7 (2.16)[a] | 4.0 (2.23)[a] |
| $T_9$ : Untreated control | – | 9.80 (3.28)[a] | 14.11 (3.88)[a] | 17.83 (4.32)[a] | 19.69 (4.54)[a] | 3.4 (2.09)[a] | 4.6 (2.35)[a] | 5.4 (2.51)[a] | 5.8 (2.60)[a] |
| S.Em± | | 0.19 | 0.21 | 0.24 | 0.24 | 0.15 | 0.14 | 0.15 | 0.15 |
| C.D @ 5% | | NS | 0.63 | 0.70 | 0.72 | NS | 0.41 | 0.44 | 0.44 |

DBS: Day Before Spray, DAS: Day After Spray, NS: Non Significant
*Figures in parenthesis are transformed (√x+1) values

hill). The remaining organic treatments viz., *V. lecanii* @ 1.0 g, Agniasthra @ 30.0 ml/l, *P. pinnata* @ 50.0 ml, Garlic chilli kerosene extract @ 10.0 ml were found to be on par with each other as they recorded 4.17, 4.10, 4.43 and 4.33 BPH per hill, respectively. Highest number of BPH population was recorded in untreated control (7.47 BPH per hill). Similar trend was noticed on 7 and 14 days after spray (Table 2). However there was gradual decrease in the population load in commercial neem and burofezin 25% SC sprayed plots.

The population of WBPH recorded a day before spraying varied from 3.13 to 4.07 per hill in different treatments which showed no much variation in pest distribution in the experimental arena.

Observations made on three days after spraying indicated that buprofezin 25% SC @ 1.0 ml/l found to be effective and recorded less number of WBPH (0.73 / hill) followed by commercial neem @ 3.0 ml/l (1.87 WBPH/ hill). The remaining organic treatments viz., *V. lecanii* @ 1.0

**Table 5. Comparative yield, cost and return structures of different organics in paddy pest management (Kharif-2012 season)**

| Treatments | Grain yield (q/ha) | Gross return *(Rs./ha) | Cost of cultivation (Rs./ha) | Treatment cost (Rs./ha) | Total cost of cultivation (Rs./ha) | Net return (Rs./ha) | BC ratio |
|---|---|---|---|---|---|---|---|
| $T_1$: *Verticillium lecanii* 1 g | 66.67[c] | 106,656 | 40,037 | 85 | 40,122 | 66,534 | 2.65 |
| $T_2$: Sweet flag rhizome powder 2% | 57.77[f] | 92,432 | 40,037 | 1,300 | 41,337 | 51,095 | 2.23 |
| $T_3$ :Garlic chilli kerosene extract 2% | 60.44[e] | 96,704 | 40,037 | 750 | 40,787 | 55,917 | 2.37 |
| $T_4$: *Pongamia pinnata* aqueous extract 5% | 62.22[d] | 99,552 | 40,037 | 300 | 40,037 | 59,215 | 2.46 |
| $T_5$: Jeevamrutha 5% | 59.55[e] | 95,280 | 40,037 | 350 | 40,387 | 54,893 | 2.45 |
| $T_6$: Commercial Neem 3 ml | 70.22[b] | 112,352 | 40,037 | 375 | 40,412 | 71,940 | 2.78 |
| $T_7$: Buprofezin 25% SC 1 ml | 72.88[a] | 116,608 | 40,037 | 600 | 40,637 | 75,971 | 2.86 |
| $T_8$: Agniasthra 3% | 65.77[c] | 105,232 | 40,037 | 1,250 | 41,287 | 63,945 | 2.54 |
| $T_9$ :Untreated control | 43.00[g] | 68800 | 40,037 | 0.0 | 40,037 | 28,763 | 1.71 |
| S.Em± | 0.57 | _ | _ | _ | _ | _ | _ |
| C.D @ 5% | 1.75 | _ | _ | _ | _ | _ | _ |

*Rs. 1600 / quintal paddy
Mean in the same column followed by the same letter are not significantly difference according to, DMRT (P=0.05)

g, Agniasthra @ 30.0 ml/l, *P. pinnata* @ 50.0 ml, Garlic chilli kerosene extract @ 10.0 ml were found to be on par with each other as they recorded 2.07, 2.50, 2.73 and 2.57 WBPH per hill, respectively. Highest number of WBPH population was recorded in untreated control (5.67 WBPH per hill). Similar trend was noticed on 7 and 14 days after spray (Table 2). However there was gradual decrease in the population load in all other treatments.

The per cent damage of leaf folder recorded one day before spraying varied from 7.13 to 8.54 among different treatments depicting no significant difference among them.

Observations made on three days after spraying indicated that in all the treatments per cent damage was above ETL, there was no change as compared to one day before spray. On seven days after spraying, Agniasthra @ 30.0 ml/l and commercial neem @ 3.0 ml/l recorded significantly lower per cent damage of 4.78 and 6.54, respectively. Other treatments viz., *P. pinnata* @ 50.0 ml/l, GCKE @10.0 ml/l, Jeevamrutha @ 50.0 ml/l and *V. lecanii* @ 1.0 g/l which recorded 7.12, 7.65, 8.77 and 8.34 per cent damage of leaf folder, respectively were on par with each other. Untreated control recorded significantly 10.13 per cent damage of leaf folder. Similar effect was continued on 14 days after spray (Table 2).

The population of mirid bugs per hill one day before spraying varied from 9.13 to11.25 among different treatments depicting no significant difference among them. Similar effect was continued on 3, 7 and 14 days after spray. The population of spiders per hill one day before spraying varied from 3.1 to 3.9 in different treatments depicting no significant difference among them. Similar effect was continued on 3, 7 and 14 days after spray (Table 4).

The yield and economics of various organic approaches evaluated for management of brown plant hopper, white backed plant hopper, yellow stem borer, leaf folder in paddy are presented in Table 6.

Buprofezin 25% SC @ 1.0 ml/l and commercial neem @ 3.0 ml/l both recorded higher yield of 57.20 and 56.47 q/ha respectively were found on par with each other, sig-

**Table 6. Comparative yield, cost and return structures of different organics in paddy pest management (Rabi-2012 season)**

| Treatments | Grain yield (q/ha) | Gross return *(Rs./ha) | Cost of cultivation (Rs./ha) | Treatment cost (Rs./ha) | Total cost of cultivation (Rs./ha) | Net return (Rs./ha) | BC ratio |
|---|---|---|---|---|---|---|---|
| $T_1$: *Verticillium lecanii* 1 g | 49.60$^{b}$ | 69,440/- | 38,167/- | 85 | 38,252 | 31,188 | 1.82 |
| $T_2$: Sweet flag rhizome powder 2% | 38.40$^{f}$ | 53,760/- | 38,167/- | 1,300 | 39,467 | 14,293 | 1.36 |
| $T_3$: Garlic chilli kerosene extract 2% | 42.80$^{de}$ | 59,920/- | 38,167/- | 750 | 38,917 | 21,003 | 1.54 |
| $T_4$: *Pongamia pinnata* aqueous extract 5% | 46.00$^{cd}$ | 64,400/- | 38,167/- | 300 | 38,467 | 25,933 | 1.67 |
| $T_5$: Jeevamrutha 5% | 40.27$^{ef}$ | 56,378/- | 38,167/- | 350 | 38,517 | 17,861 | 1.46 |
| $T_6$: Commercial Neem 3 ml | 57.20$^{a}$ | 80,080/- | 38,167/- | 375 | 38,542 | 41,538 | 2.08 |
| $T_7$: Buprofezin 25% SC 1 ml | 56.47$^{a}$ | 79,058/- | 38,167/- | 600 | 38,767 | 40,291 | 2.04 |
| $T_8$: Agniasthra 3% | 48.93$^{bc}$ | 68,502/- | 38,167/- | 1,250 | 39,417 | 29,085 | 1.74 |
| $T_9$ :Untreated control | 29.87$^{g}$ | 41,818/- | 38,167/- | 0.0 | 38,167 | 3,651 | 1.10 |
| S.Em± | 3.60 | _ | _ | _ | _ | _ | _ |
| C.D @ 5% | 10.60 | _ | _ | _ | _ | _ | _ |

*Rs. 1400/quintal paddy

nificantly differ from other organic treatments. The next important organic treatment was *V. lecanii* @ 1g/l (49.60 q/ha) which was found to be on par with Agniasthra @ 30 ml/l (48.93 q/ha). Other treatments viz., *P. pinnata* @ 50 ml/l (46.00 q/ha), GCKE @ 10 ml/l (42.80 q/ha), Jeevamrutha @ 50 ml/l (40.27 q/ha) and sweet flag rhizome powder (38.40 q/ha) were recorded higher yield than the untreated control which registered lowest yield of 29.87 q/ha.

Highest net return were obtained in both commercial neem @ 3 ml/l (Rs. 41,538/ha) with BC ratio of 2.08 and buprofezin 25% SC @ 1 ml (Rs. 40, 291/ha) with highest benefit cost ratio of 2.04. The next higher returns observed in *V. lecanii* @ 1 g/l (Rs. 31, 188/ha) with BC ratio of 1.82 which was on par with Agniasthra @ 30 ml/l with net returns of Rs. 29,085/ha. Other treatments viz., *P. pinnata* @ 50 ml/l (Rs. 25,933/ha), GCKE @ 10 ml/l (Rs. 21,003/ha), Jeevamrutha 50 ml/l (Rs. 17,861/ha) and sweet flag rhizome powder (Rs. 14,293/ha) registered higher net returns compared to untreated control (3,651/ha) with lowest benefit cost ratio of (1.10).

Mahabaleshwara and Jayaprakash (2009) reported that Buprofezin 25% SC @ 1.0 ml/l recorded lowest BPH and WBPH population at 3 and 10 days after spray. Effectiveness of neem oil have been reported to be due to antifeedant and insecticidal properties against leaf and plant hoppers of rice as reported by Saxena and Khan (1985) and Sontakke (1993). They also reported that neem oil was found highly effective in reducing survival of BPH and WBPH and suppressing transmission of grassy stunt and ragged stunt viral diseases of rice decreased after three days of exposure. These findings are in accordance with Krishnaiah et al. (2000) reported that neem formulations viz., Neemagold and Nimbicidine at 4% were responsible for preventing resurgence of WBPH caused by deltamethrin under field conditions in rice. Muhammad Sagheer *et al*. (2008) reported that neem 5% reduced (6.08% leaf folder damage). The neem was reduced (4.52% leaf folder damage) reported by Muhammad Ashfaq *et al*. (2011).

Among different treatments highest mirid bugs were recorded in sweet flag rhizome and Jeevamrutha and these

treatments increased the mirid bugs and spiders population which were followed by *V. lecanii*, neem, Agniasthra, *P. pinnata* and GCKE. These also did not have any harmful effects on mirid bugs and instead the population significantly increased.

Sontakke (1993) reported that neem oil was safest for mirid bugs and spiders population.

The results of Mahabaleshwara and Jayaprakash (2009) indicated that different concentrations of buprofezin 25% SC was tested against mirid bugs population recorded at 10 days after spray in the year of 2005 and 2006 recorded 51.74 and 9.81 mirid bug/hill in Sirguppa.

Among the various organic approaches evaluated for management of brown plant hopper, white backed plant hopper, yellow stem borer, leaf folder in paddy. The buprofezin 25% SC @ 1 ml/l significantly differ with other treatments which recorded highest yield of (72.88 q/ha). These findings are in close agreement with Mahabaleshwara and Jayaprakash (2009) who tested different dosages of buprofezin 25% SC tested against BPH and WBPH population there was reduction in the pest population with increased yield of 5907 kg/ha and 6107 kg/ha in the year of 2005 and 2006 respectively with average yield of two season BC ratio of 3.38. The other organic *V. lecanii* @ 1 g/l recorded 66.67q/ha which was found to be on par with Agniasthra @ 30 ml/l (65.77q/ha). Kalitha *et al*. (2009) also reported that nimbicidine 0.03 EC @ 3 ml and *V. lecanii* used against rice stem borer and leaf folder reducing these pests also increased the average yield of 39.70 and 33.99 q/ha respectively in the year 2007-08. The commercial neem 5 ml/l recorded second highest yield (70.22 q/ha).These findings are in conformity with Nigam *et al*. (2010)

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