Environment and Ecology 40 (2A) : 554—559, April—June 2022
ISSN 0970-0420

# Field Bio-Efficacy of Chloropyrifos 50 % + Cypermethrin 5% EC against Fall Armyworm, Stem Borer and on Natural Enemy Maize During 2020-21 *harif* Season

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Received 19 February 2022, Accepted 24 April 2022, Published on 28 May 2022

## ABSTRACT

Field bio-efficacy were conducted to check the field efficacy of different doses of Chloropyrifos 50 % + Cypermethrin 5% EC against fall armyworm and stem borer infesting in maize. Results revealed that Chloropyrifos 50% + Cypermethrin 5% EC @ 2500 g.a.i./ ha recorded significantly least larval population (1.18 larvae per/plant) and percent plant damage (9.00%) followed by Chloropyrifos 50% + Cypermethrin 5% EC @ 1562.5 g.a.i./ ha (1.44 larvae per/plant) and percent plant damage (10.12%) which was at par with each other differed from other treatment. However, highest larval population and per cent leaf damage was recorded untreated control. Similar trend was noticed in the second application of insecticides with respect to larval population and percent plant damage.

**Keywords** *Spodoptera frugiperda, Chilo partellus,* Maize, Chloropyrifos 50 % + Cypermethrin 5% EC.

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## INTRODUCTION

Maize (*Zea mays* L.) is called as world's third largest cereal crop and also "Queen of Cereals". The insect pests of maize field include aphids, Shoot bugs, cutworms, stem borer, white grub, chaffer beetle, armyworm, gram pod borer, wireworm, hairy caterpillar (Arifie *et al*. 2019). There are many pests of maize crop that can cause damage to yield of maize. Mathur (1987) observed that over 250 species of insect are associated with maize yield losses in the field as well as in storage conditions.

In India, fall armyworm (FAW), *Spodoptera frugiperda* has been identified to occur on maize in many districts of Karnataka, Andhra Pradesh, Telangana and Maharashtra states since 2018. It was first identified on maize in Shivamogga district of Karnataka state (Sharanabasappa *et al*. 2018). Subsequently it was found feeding on sugarcane in the state of Maharashtra and Tamil Nadu (Chormule *et al*. 2019 Srikanth *et al*. 2018) and on Rice in Karnataka (Kalleshwaraswamy and Mahadevaswamy 2019). FAW was also reported from Anantapuram in Andhra Pradesh on Bajra and Sorghum (Venkateswarlu *et al*. 2018). It was reported to have spread from neighboring districts of Karnataka. In Chhattisgarh the FAW, *S. frugiperda* was first reported at Raipur in the month of August 2018 (Deole and Paul 2018).

In Karnataka, a quick roving survey suggested

the damage ranging from 9 to 62.5 % on maize (Ganiger *et al*. 2018, Ahylesh *et al*. 2018). The FAW persists on maize crop from the early crop stage till cob maturity, thus necessitating spraying of insecticides multiple times. Repeated application of chemicals with similar mode of action would hasten the development of resistance.

Hence, to check or curb the development of resistance to insecticides, it is essential to use the chemicals having different modes of action with combination to achieve the highest mortality of target pests. In the present investigations we assessed the bio-efficacy of insecticide with different doses in appropriate combination (combi-product) on the fall armyworm, stem borer and natural enemy in maize ecosystem.

## MATERIALS AND METHODS

Efficacy of Chloropyrifos 50 % + Cypermethrin 5% EC formulations were evaluated against FAW and stem borer on maize under field conditions at the most effective dose during 2020-21 *kharif* season at the Agricultural Research Station, Hagari, Karnataka. The field trial was laid out in a Randomized Complete Block Design (RCBD) in three replications with nine treatments by maintaining a plot size of 5 x 5m (25 sqmt) by leaving a gangway of 1m all around the individual treatment plots. The maize cultivar (S-6668 Plus) Hybrid corn was sown in *kharif* season with a spacing of 60 x 60 cm, by adopting all the recommended package of practices of maize under irrigated conditions given by University of Agricultural Sciences, Raichur, 2020-21 package of practices except plant protection measures.

The individual treatments were imposed with a knapsack sprayer using spray fluid at rate of 500 lit per ha. The spray was imposed twice, the first one was imposed at 30 days after sowing (DAS) and 2$^{nd}$ spray was imposed at 50 DAS, which was based on peak incidence of *S. fruziperda* and stem borer. The observations from different doses (Table 1) in combinations of Chloropyrifos 50 % + Cypermethrin 5% EC that were evaluated against *S. fruziperda* and stem borer were subjected to Randomized Complete Block Design analysis for further interpretations.

**Table 1.** Treatment details along with check.

| Sl. No. | Treatments | Dose (g.ai/ha) |
|---|---|---|
| 1 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 750 |
| 2 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1000 |
| 3 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1250 |
| 4 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1562.5 |
| 5 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 2500 |
| 6 | Chloropyrifos 50 % | 1000 |
| 7 | Cypermethrin 10 % EC | 750 |
| 8 | Thiamethoxam 12.6% + Lambdacyholothrin 9.5 % ZC | 125 |
| 9 | Untreated control | - |

Number of larvae on ten randomly selected plants from center rows was recorded at one day before and three, seven and ten days after each application. Mean value was worked out and the data was subjected to statistical analysis after suitable transformation. For recording per cent damage per plot, the same ten tagged plants per plot were visually observed for the extent of damage and rated as percentage (0-100%).

Predatory population viz., coccinellids and spiders were recorded on five tagged plants. Observation on predators were taken at ten days after each spray and expressed as per plant. The data was averaged and subjected to statistical analysis after suitable transformation.

Grains yield per plot was recorded separately and it was computed to hectare basis and the same was subjected for statistical analysis.

## RESULTS AND DISCUSSION

The larval population of fall army warm was recorded before imposing the treatments which was ranging from 2.43 to 2.96 larvae per plant during the experimental year. The experimental results revealed that Chloropyrifos 50% + Cypermethrin 5% EC @ 2500 g.a.i./ ha recorded significantly least larval population (1.18 larvae per/plant) followed by Chloropyrifos 50% + Cypermethrin 5% EC @ 1562.5 g.a.i./ ha (1.44 larvae per/plant), which was at par with each other and differed from other treatment. However,

**Table 2.** Bioefficacy of Chloropyrifos 50 % + Cypermethrin 5 % EC against fall army worm during Kharif 2020-21. DBS-Day before Spray, DAS-Days After Sprays. *Figures in parentheses are square root transformed values.

| Sl. No. | Treatment details | Dose (g.ai/ ha) | No. of larvae per plant | | | | | | | | Mean of two sprays | Percent reduction over control |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | I$^{st}$ spray | | | | II$^{nd}$ spray | | | | | |
| | | | 1DBS | 3DAS | 7DAS | 10DAS | 1DAS | 3DAS | 7DAS | 10DAS | | |
| 1 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 750 | 2.96 (1.99) | 2.38 (1.84) | 1.99 (1.73) | 1.78 (1.67) | 1.98 (1.73) | 1.89 (1.70) | 1.81 (1.68) | 1.63 (1.62) | 1.92 (1.71) | 52.35 |
| 2 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1000 | 2.53 (1.87) | 2.13 (1.77) | 1.89 (1.68) | 1.65 (1.62) | 1.97 (1.72) | 1.87 (1.70) | 1.73 (1.64) | 1.46 (1.60) | 1.81 (1.68) | 55.08 |
| 3 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1250 | 2.45 (1.83) | 2.12 (1.77) | 1.66 (1.62) | 1.52 (1.58) | 1.93 (1.72) | 1.80 (1.67) | 1.61 (1.61) | 1.11 (1.45) | 1.67 (1.52) | 58.56 |
| 4 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1562.5 | 2.73 (1.91) | 1.96 (1.73) | 1.41 (1.56) | 1.18 (1.45) | 1.88 (1.69) | 1.69 (1.64) | 1.00 (1.41) | 0.96 (1.40) | 1.44 (1.57) | 64.26 |
| 5 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 2500 | 2.61 (1.89) | 1.68 (1.62) | 1.19 (1.47) | 1.00 (1.41) | 1.81 (1.66) | 1.07 (1.43) | 0.89 (1.35) | 0.64 (1.26) | 1.18 (1.32) | 70.71 |
| 6 | Chloropyrifos 50 % | 1000 | 2.43 (1.84) | 2.44 (1.85) | 2.03 (1.74) | 1.84 (1.67) | 2.01 (1.73) | 1.98 (1.73) | 1.86 (1.69) | 1.78 (1.68) | 1.19 (1.82) | 50.62 |
| 7 | Cypermethrin 10 % EC | 750 | 2.59 (1.89) | 2.42 (1.84) | 2.04 (1.75) | 2.02 (1.72) | 2.12 (1.76) | 2.00 (1.73) | 1.94 (1.71) | 1.77 (1.66) | 2.04 (1.76) | 49.37 |
| 8 | Thiamethoxam 12.6% + Lambdacyholothrin 9.5 % ZC | 125 | 2.68 (1.93) | 2.43 (1.82) | 2.05 (1.73) | 1.99 (1.73) | 2.18 (1.78) | 2.06 (1.72) | 1.99 (1.73) | 1.86 (1.68) | 2.08 (1.77) | 48.38 |
| 9 | Un treated control | - | 2.69 (1.93) | 3.08 (2.03) | 3.80 (2.17) | 4.03 (2.23) | 4.00 (2.26) | 4.33 (2.29) | 4.33 (2.35) | 4.67 (2.40) | 4.03 (2.23) | |
| | | SEm(±) | 0.48 | 0.47 | 0.45 | 0.45 | 0.46 | 0.43 | 0.46 | 0.45 | 0.46 | - |
| | | CD (@5%) | 1.42 | 1.39 | 1.34 | 1.34 | 1.38 | 1.32 | 1.35 | 1.33 | 1.40 | - |

highest population was recorded untreated control (4.03 larvae per/plant) (Table 2).

The present results were in accordance with the findings of Bansode Sagar *et al*. (2020) that Chlorpyriphos at 0.5, 1 and 1.5 concentrations caused no mortality after 24 h of application. Higher concentrations i.e. 4, 4.5 and 5% of Chlorpyriphos caused 70, 73 and 95% mortality after 24 h of application, respectively. It is apparent that higher concentrations of Chlorpyriphos are needed to cause lethal effect on FAW, whereas lower concentrations caused no significant mortality.

In case of percent plant damage, due to FAW infestation was recorded maximum in untreated check (11.27 %) and least was noticed in Chloropyrifos 50% + Cypermethrin 5 % EC @ 2500 g.a.i./ ha recorded 9.00 % which is on par with next treatment Chloropyrifos 50 % + Cypermethrin 5 % EC @ 1562.5 g.a.i./ ha (10.12 %) (Table 3). Similar trend was noticed with respect to percent plant damage due to stem borer where in maximum plant damage was observed in untreated check (12.91 %) on cumulative mean basis. The statistical analysis of data showed that all the treatments are significantly superior in reducing the per cent plant damage by stem borer on maize. Among the different doses the Chloropyrifos 50% + Cypermethrin 5% EC @ 2500 g.a.i./ ha was recorded minimum infestation due to stem borer (7.84 %) when compared to all other treatments (Table 4). However the similar results obtained by the Devanapalli Vamsi and Kumar (2018) reported that the best and most economical treatment was Spinosad (1:1.59) followed by Chlorpyrifos 50% EC+ Cypermethrin 5% EC (1:1.52), Deltamethrin 2.8 EC (1:1.41) and Cypermethrin 25% EC (1:1.36), Imidacloprid 17.8SL (1:1.17), Dichlorvos 76EC (1:1.11), Dimethoate 30EC (1:1.07) as compared to Control (1:1.04). Again similar findings were reported by Bansode Sagar *et al*. (2020) and Siddalingappa *et al*. (2010) showed the mean infestation of Cypermethrin treated plot is (11.67%) and (10.78%) respectively in suppressing the stem borer incidence.

The coccinellids population ranged from 0.85 to

**Table 3.** Effect of Chloropyrifos 50 % + Cypermethrin 5 % EC against crop per cent damage per plot due to fall armyworm during *kharif*, 2020-21. DBS-Day Before Spray, DAS-Days After Sprays. *Figures in parentheses are angular transformed values.

| Sl. No. | Treatment details | Dose (g.ai//ha) | Percent damage per plot* Pre count | 10 DAS ($I^{st}$ spray) | 10 DAS ($II^{nd}$ spray) | Mean |
|---|---|---|---|---|---|---|
| 1 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 750 | 15.45 (23.14) | 11.55 (19.86) | 9.97 (18.40) | 10.76 (12.75) |
| 2 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1000 | 14.45 (22.23) | 11.05 (19.41) | 9.86 (18.30) | 10.46 (12.57) |
| 3 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1250 | 13.52 (21.56) | 10.82 (19.20) | 9.90 (18.39) | 10.39 (12.53) |
| 4 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1562.5 | 11.97 (20.23) | 10.55 (18.94) | 9.68 (18.12) | 10.12 (12.36) |
| 5 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 2500 | 10.74 (19.12) | 9.72 (18.15) | 8.27 (16.69) | 9.00 (11.62) |
| 6 | Chloropyrifos 50 % | 1000 | 14.86 (22.66) | 11.92 (20.19) | 10.05 (18.48) | 10.99 (12.89) |
| 7 | Cypermethrin 10 % EC | 750 | 15.88 (23.47) | 11.99 (20.25) | 10.27 (18.68) | 11.13 (12.99) |
| 8 | Thiamethoxam 12.6% + Lambdacyholothrin 9.5 % ZC | 125 | 16.56 (23.99) | 12.04 (20.29) | 10.33 (18.74) | 11.19 (13.01) |
| 9 | Untreated control | - | 23.72 (29.13) | 12.20 (20.43) | 10.34 (18.74) | 11.27 (13.06) |
| | | SEm(±) | 0.31 | 0.09 | 0.14 | 1.09 |
| | | CD (@5%) | 0.93 | 0.26 | 0.14 | 1.12 |

1.19 per plant on one day before applications insecticides. The coccinellids population was uniform in almost all the chemical treatments. The activity coccinellids was relatively reduced in the all treated plants as compared to untreated control (Table 5). Whereas, in case of spiders, on one day before spray, the spi-

**Table 4.** Effect of Chloropyrifos 50 % + Cypermethrin 5 % EC against per cent plant damage per plot due to stem borer during *kharif,* 2020-21. DBS-Day Before Spray, DAS-Days After Sprays.

| Sl. No. | Treatment details | Dose (g.ai//ha) | Percent damage per plot* Pre count | 10 DAS ($I^{st}$ spray) | 10 DAS ($II^{nd}$ spray) | Mean | Grain yield (q/ha) |
|---|---|---|---|---|---|---|---|
| 1 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 750 | 10.20 (18.61) | 9.71 (18.15) | 9.03 (17.48) | 9.37 (11.88) | 50.64 |
| 2 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1000 | 9.92 (18.35) | 9.20 (17.65) | 8.96 (17.41) | 9.08 (11.69) | 49.32 |
| 3 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1250 | 9.78 (18.22) | 9.06 (17.51) | 8.51 (16.95) | 8.79 (11.41) | 51.32 |
| 4 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1562.5 | 9.73 (18.16) | 8.55 (17.00) | 8.15 (16.58) | 8.35 (11.19) | 53.32 |
| 5 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 2500 | 8.53 (16.98) | 8.00 (16.43) | 7.67 (16.07) | 7.84 (10.83) | 58.00 |
| 6 | Chloropyrifos 50 % | 1000 | 10.43 (18.84) | 10.20 (18.61) | 10.03 (18.45) | 10.12 (12.36) | 54.00 |
| 7 | Cypermethrin 10 % EC | 750 | 10.75 (19.13) | 10.70 (19.08) | 10.43 (18.83) | 10.57 (12.64) | 53.04 |
| 8 | Thiamethoxam 12.6% + Lambdacyholothrin 9.5 % ZC | 125 | 10.74 (19.12) | 11.32 (19.65) | 10.89 (19.26) | 11.11 (12.97) | 48.00 |
| 9 | Untreated control | - | 11.16 (19.50) | 12.83 (20.98) | 12.99 (21.11) | 12.91 (14.03) | 40.00 |
| | | SEm(±) | 0.11 | 0.11 | 0.15 | 0.65 | |
| | | CD (@5%) | 0.23 | 0.34 | 0.44 | 1.98 | |

**Table 5.** Effect of Chloropyrifos 50 % + Cypermethrin 5 % EC against natural enemy population during *kharif*, 2020-21. DBS: Day Before Spray. DAS: Days After Spray. *Figures in parentheses are square root transformed value.

| Sl. No. | Treatment | Dose (g/ha) | Coccinellids 10 days after spray | | | | Spiders 10 days after spray | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 DBS | I$^{st}$ spray | II$^{nd}$ spray | Mean | 1 DBS | I$^{st}$ spray | II$^{nd}$ spray | Mean |
| 1 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 750 | 1.72 (1.65) | 1.38 (1.55) | 1.11 (1.46) | 1.24 (1.51) | 1.63 (1.64) | 1.38 (1.52) | 1.15 (1.48) | 1.26 (1.51) |
| 2 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1000 | 1.61 (1.60) | 1.31 (1.53) | 1.26 (1.43) | 1.28 (1.48) | 1.55 (1.61) | 1.01 (1.43) | 0.96 (1.41) | 0.98 (1.43) |
| 3 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1250 | 1.45 (1.57) | 0.99 (1.40) | 0.96 (1.38) | 0.97 (1.39) | 1.41 (1.58) | 0.90 (1.40) | 0.76 (1.32) | 0.83 (1.37) |
| 4 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 1562.5 | 1.62 (1.62) | 1.11 (1.47) | 0.98 (1.39) | 1.04 (1.43) | 1.80 (1.68) | 1.35 (1.53) | 0.96 (1.40) | 1.15 (1.45) |
| 5 | Chloropyrifos 50 % + Cypermethrin 5 % EC | 2500 | 1.63 (1.60) | 1.05 (1.41) | 0.94 (1.22) | 0.99 (1.34) | 1.69 (1.53) | 1.10 (1.44) | 0.80 (1.25) | 0.95 (1.41) |
| 6 | Chloropyrifos 50 % | 1000 | 1.83 (1.67) | 1.55 (1.58) | 1.30 (1.50) | 1.42 (1.54) | 1.67 (1.64) | 1.28 (1.49) | 1.20 (1.42) | 1.24 (1.45) |
| 7 | Cypermethrin 10 % EC | 750 | 1.55 (1.58) | 1.05 (1.41) | 1.00 (1.39) | 1.02 (1.40) | 1.50 (1.58) | 0.99 (1.40) | 0.58 (1.30) | 0.79 (1.34) |
| 8 | Thiamethoxam 12.6% + Lambdacyholothrin 9.5 % ZC | 125 | 1.99 (1.71) | 1.39 (1.53) | 1.32 (1.45) | 1.35 (1.49) | 1.95 (1.72) | 1.18 (1.46) | 0.95 (1.39) | 1.06 (1.42) |
| 9 | Untreated control | - | 1.88 (1.61) | 1.98 (1.63) | 2.00 (1.70) | 1.99 (1.69) | 1.70 (1.61) | 1.75 (1.65) | 1.92 (1.65) | 1.83 (1.57) |
| | | SEm(±) | 0.13 | 0.12 | 0.07 | 0.06 | 0.10 | 0.08 | 0.12 | 0.07 |
| | | CD (@5%) | 0.35 | 0.36 | 0.20 | 0.20 | 0.30 | 0.26 | 0.37 | 0.22 |

der's population ranged from 0.71 to 1.26 per plant. There was no adverse effect on spider population on ten days after each spray due to application of varying doses of Chloropyrifos 50% + Cypermethrin 5% EC when compared to untreated control plot (Table 5).

The yield varied between 40.00 to 58.00 q/ha during the experimental year. Chloropyrifos 50% + Cypermethrin 5% EC @ 2500 g.a.i./ha recorded significantly higher grain yield i.e., 58.00 q/ha over control (40.00 q/ha) which was on par with the lower dose Chloropyrifos 50% + Cypermethrin 5% EC (Table 4). The similar finding was reported by Devanapalli Vamsi and Kumar (2018) that yields among the treatment were significant. The highest yield was recorded in Spinosad (40.23 q/ha) followed by Chlorpyrifos 50%EC+ Cypermethrin 5%EC (38.60 q/ha), Deltamethrin 2.8EC (35.50 q/ha), Cypermethrin 25%EC (34.10 q/ha), Imidacloprid 17.8SL (29.60 q/ha), Dichlorvos 76EC (28.10 q/ha), Dimethoate 30EC (27.50 q/ha) as compared to Control (25.80 q/ha). When cost benefit ratio was worked out, interesting result was achieved. Among the treatments studied, the best and most economical treatment was Spinosad (1:1.59) followed by Chlorpyrifos 50%EC+ Cypermethrin 5%EC (1:1.52), Deltamethrin 2.8EC (1:1.41) and Cypermethrin 25%EC(1:1.36), Imidacloprid 17.8SL (1:1.17), Dichlorvos 76EC (1:1.11), Dimethoate 30EC (1:1.07) as compared to Control(1:1.04).

## CONCLUSION

Finally, from the present investigation the Chloropyrifos 50% + Cypermethrin 5% EC @ of 2500 g.a.i. /ha highly effective with highest reduction over the control and 1000 and 750 g.a.i. /ha was found optimum dose in reducing population of fall army warm, *S. frugiperda* on maize crop. Chlorpyrifos 50% + Cypermethrin 5% EC is not harmful to natural enemies of insect pest at all the dose.

## ACKNOWLEDGEMENT

The authors are thankful to M/S Gharda chemicals limited, B27/29, MIDC, Dombivli (E), Thane (Pin-421203) Maharashtra, India for providing necessary

facilities in carrying out the present investigation. Also thanks to the Director of Research, University of Agricultural Sciences, Raichur for continuous encouragement and support to conduct of research trail at Agriculture Research Station at Hagari.

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