# Compatibility of recommended insecticides and fungicide for the control of coffee white stem borer (*Xylotrechus quadripes*) and leaf rust disease (*Hemileia vastatrix*)

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**ABSTRACT:** Pesticide usage is one of the important components in integrated pest and disease management (IPDM) programs in coffee. Being a pernneial crop, coffee is subjected to attack by several pest and diseases especially, white stem borer and leaf rust. Both this require the timely management measures to keep them under the economic threshold level. Because of the non availabilty of skilled labourers, timely operations are skipped in majority of the coffee plantations. This favours the build up of pest and diseases. Hence, to reduce the number of estate operations and to bridge the time gap, the compatibility of recommended insecticide chlorpyrifos 20EC, chlorpyrifos 50EC + cypermethrin 5EC along with a fungicide hexaconazole 5EC were evaluated in the laboratory by checking the efficacy against white stem borer and leaf rust which will appear simultaneously in the post monsoon season. Laboratory experiments revealed that the chemical mixures are physically compatible and found no changes in the efficacy against the targetted pest and disease when they sprayed together.

**Keywords**: Coffee, compatibility, fungicide, insecticide, leaf rust, white stem borer

## INTRODUCTION

Coffee (*Coffea Arabica* L.) is one of the popular and important commodity crop in India and its beverages are consumed by the people all over the world. In India, coffee is mainly cultivated by small growers and it requires lot of skilled labours to carry out timely management measures against pests and diseases, especially the white stem borer, *Xylotrechus quadripes* Chevrolat and the leaf rust disease caused by the fungus, *Hemiliea vastatrix* B.& Br.

White stem borer is a serious pest in recent years and causing considerable crop loss in arabica coffee. It affects nutrient uptake by making tunnels in the xylem tissues.The entire larval period is inside the stems and adult will come out from the stems by making holes, this period is called as flight period. There are two flight periods one from April to May and the other from October to December. Because of the concealed nature of the pest, timely operations are important to curtail this pest. Major management operations are mainly targeting the eggs and the early instar larvae apart from the tracing and uprooting of infested plant before the commencement of flight period. Leaf rust disease is also a serious problem in arbica coffee when the control measures are not taken up timely. In favourable condition, the damge is so devasting that the dead twigs could be seen due to severe defoliation of the rust affected leaves. Such severely infested bushes will invite the white stem borer problem. Pre monsoon Bordeaux mixture (0.5%) spray and post monsoon hexaconazole 5EC spray (2ml/l water) is recommended for the mangement of this fungus. Simultaneous appearence of rust disease and white stem borer flight is happening during post monsoon in coffee demands the necessity of fungicidal and insecticidal application at the same time.Because of the non availabilty of labourers, timely operations are skipped in majority of the coffee plantations and they are spraying cocktail solution to manage pest and disease problems.It is known that, pesticides are effective only when they are used in the right way, right time and at recommended dosage.

Hence, the present study aimed to check and assess the posibility of spraying recommended insecticides viz., chlorpyrifos 20EC and chlorpyrifos 50EC + cypermethrin 5EC along with a fungicide hexaconazole 5EC as a cocktail spray for the control of white stem borer and leaf rust with a single spray application.

## MATERIALS AND METHODS

The laboratory experiments on the posibilty of mixing recommended insecticides chlorpyrifos 20EC, chlorpyrifos 50EC+ cypermethrin 5EC along with with

a fungicide hexaconazole 5EC for the control of white stem borer and leaf rust were conducted at Central Coffee Research Institute (CCRI), Chikamagaluru, Karnataka, India during the year 2018. The treatment details are presented in table 1.

**Table 1. Details of insecticides and fungicide selected for the study**

| Treatment | Details |
|---|---|
| T1 | Chlorpyrifos 50EC + Cypermethrin 5EC @ 1.2 ml/l |
| T2 | Chlorpyrifos 20EC @ 3 ml/l |
| T3 | Chlorpyrifos 50EC + Cypermethrin 5EC + Hexaconazole 5EC @1.2 + 2 ml/l |
| T4 | Chlorpyrifos 20EC + Hexaconazole 5EC @ 3 + 2ml/l |
| T5 | Hexaconazole 5EC @ 2 ml/l |
| T6 | Control (water) |

**Physical compatibility**

The recommended quantity of selected chemicals was added to 100 ml of distilled water and stirred well for 4-5 minutes and left undisturbed for 30 minutes (Anonymous, 1988). Observations were recorded after 30 minutes with respect to foaming and sedimentation. Also, pH of insecticides and fungicides alone and in combinations were also recorded.

**Bio-efficacy studies against white stem borer**

The toxicity of individual insecticides, fungicide as well as the mixtures of insecticide and fungicide on white stem borer eggs and neonate larvae was assessed in the laboratory. White stem borer adults collected from insectary were transferred to insect rearing cages provided with white sheet for egg laying. After oviposition, egg layed white sheets were collected and used for the experiments. Each treatment was replicated three times with 50 numbers of respective stages. The respective life stages of WSB were transfered to Petri dishes and treated with a constant amount of spray solution using a hand sprayer. Water sprayed Petridish served as control. Sprayed Petridishes with egg and neonate larvae were dried for 30 min and placed in climatic chamber at (25±1 $^0$C). The mortality was recorded at 24 hours interval after imposing the treatment in case of larvae whereas egg eclosion was observed from 8$^{th}$ day onwards. Binocular stereo microscope \was used for making observations.

**Bio-efficacy studies against leaf rust spores**

The orange coloured urediniospores of the fungus *Hemileia vastatrix* were collected from infected leaves of susceptible arabica variety S.795 in gelatine capsules from CCRI farm. The fungicide and insecticide solutions were prepared with required concentrations. The collected spores were equally distributed to the test tubes containing different treatments and kept for 1 min. Control was maintained by mixing the urediniospores in sterilized distilled water. To study the germination of urediniospores, two percent water agar (WA) medium was prepared and 15 ml was poured on to 90 mm sterile Petri plates under controlled conditions. After solidification, 500 µl of the treated urediniospores suspension were transferred to the agar plates by spread plate method (Kamanna *et al*., 1993). The Petri plates were incubated overnight in dark room at 22 $^0$C. After 24 hrs of incubations period, observations on total number of urediniospores and total number of germinated urediniospores were counted. For each treatment, three replications were maintained. Ten microscopic fields (MF) were observed covering the whole Petri plate for each replication and the values were expressed in percentage.

Difference between the treatments on mortality rate of eggs, neonate larvae of white stem borer and percentage of rust spore germination were analysed using Analysis of variance (ANOVA) and means were separated by DUNCAN's Multiple Range Test (DMRT) (Panse and Sukhatme, 1985).

**RESULTS AND DISCUSSION**

**Physical compatibility**

The physical compatibility of the selected pesticides revealed that, there is no formation of foaming and sedimentation in all the 3 pesticide combinations after mixing. This indicates the selected pesticides are physically compatible with each other. Manohar (2005) observed that hexaconazole is physically compatible with insecticides like endosulfan (EC), spinosad (SC) and indoxacarb (SC). Bhat *et al.* (2012) reported

that hexaconozole and chlorpyrifos combination are physically compatible.

**Bio-efficacy studies against white stem borer**

The results on bio-efficacy studies of tested insecticides, fungicide and in combination are presented in table. 2. The study revealed that insecticide alone and in combination with fungicide also significantly effective in causing 100% mortality of eggs and neonate larvae of white stem borer compared to the fungicide alone and control. This indicates the fungicide hexaconazole 5EC @ 2 ml/l did not suppressed the insecticidal property of chlorpyriphos 20EC @ 3 ml/l as well as chlorpyrifos50 EC + cypermethrin 5EC @ 1.2 ml/l .Whereas, the fungicide tested alone is not having any significant mortality on egg and larvae of white stem borer.

**Table 2. Bio-efficacy of insecticides and fungicide on eggs and neonate larvae of *X. quadripes***

| Treatment details | Dosage (ml/ lit) | Mean egg mortality (%) | Mean larval mortality (%) |
|---|---|---|---|
| Chlorpyrifos 50EC + Cypermethrin 5EC | 1.2 | 100.00 ± 0.00a | 100.00 ± 0.00a |
| Chlorpyrifos 20EC | 3 | 100.00 ± 0.00a | 100.00 ± 0.00a |
| Chlorpyrifos 50EC + Cypermethrin 5EC + Hexaconazole 5EC | 1.2 + 2 | 100.00 ± 0.00a | 100.00 ± 0.00a |
| Chlorpyrifos 20EC + Hexaconazole 5EC | 3 + 2 | 100.00 ± 0.00a | 100.00 ± 0.00a |
| Hexaconazole 5EC | 2 | 6.00 ± 2.00b | 9.33 ± 1.15b |
| Control | water | 2.66 ± 1.15c | 3.33 ± 1.15c |

*Means followed by the same letter is not significantly different at P=0.05. The means are separated by DMRT.

Some of the earlier studies are also reported that mixing of fungicide hexaconozole with insecticides did not alter the insecticidal efficacy on insects. Pal *et al.,* (2013) reported hexaconozole 5% combined with flubendamide 3.5% significantly reduced the stem borer and sheath blight incidence in paddy. Koshy *et al.* (2001) studied the effect of combined application of Hexaconozole @ 2 ml with phorate @ 20 g/palm against leaf rot disease of coconut remained free from the disease and insect infestation compared to the surrounding untreated palms. Kumar *et al.* (2007) reported that chlorpyrifos is compatible with most of the commonly used pesticides which are neutral in pH. Ramesh Babu *et al.,* (2012) studied the combination product of chlorpyrifos + cypermethrin for their compatibility with fungicide, mancozeb and carbendazim against diamond back moth, which revealed better efficacy of combination product and resulted in higher yields. In coffee, pesticide combinations were studied earlier in controlling *Coccus viridis* by Sreedharan *et al*., (1981) to know the compatibility effects of synthetic pyrethroids (ambush 50 EC, permasect 25 EC and sumicidin 20 EC) with Bordeaux mixture in the laboratory and concluded that ambush 50 EC can be safely mixed with neutral Bordeaux mixture. Bhat *et al*. (2012) reported hexaconozole and chlorpyrifos are compatible and effective against coffee leaf rust pathogen. Whereas, the efficacy on white stem borer stages has not been studied by the workers.

**Bio-efficacy studies against leaf rust spores**

The bio-efficacy of tested chemicals against the inhibition of urediniospore germination are presented in table 3. The results indicated that the fungicide alone, hexaconazole 5EC @ 2 ml/l caused more inhibition of rust spores (99.99%) followed by chlorpyrifos 50 EC + cypermethrin 5EC combined with hexaconazole 5EC @ 1.2 + 2ml /l with 99.64% spore inhibition and chlorpyrifos 20EC combined with hexaconazole 5EC + 2ml/l (99.22%). All these combinations were significantly on par with each other and showing high compatibility in efficacy of hexaconazole. This reveals that the combination of recommended fungicide with insecticides did not affect the effectiveness of the fungicide hexaconazole against coffee leaf rust disease.

Interestingly, insecticides alone chlorpyrifos 50EC and chlorpyrifos 50EC + cypermethrin 5EC @ 1.2 ml/l caused 73.63% and 71.87%spore inhibition respectively followed by control with 10.6% inhibition. Thus even insecticides alone as exhibited antifungal property with moderate effect on the germination of urediniospores of coffee leaf rust fungus. Similar type of antifungal activity of insecticides were reported earlier. Backman

**Table 3. Mean percentage of urediniospore germination after 24 hours of treatment with insecticides and fungicide**

| Treatment details | Dosage (ml/lit) | urediniospore inhibition (%) (24 hr) |
|---|---|---|
| Chlorpyrifos 50EC + Cypermethrin 5EC | 1.2 | 73.63± 5.40b |
| Chlorpyrifos 20EC | 3 | 71.87± 4.84b |
| Chlorpyrifos50EC+ Cypermethrin5EC+ Hexaconazole 5EC | 1.2 + 2 | 99.64± 0.33a |
| Chlorpyrifos 20EC + Hexaconazole 5EC | 3 + 2 | 99.22± 0.55a |
| Hexaconazole 5EC | 2 | 99.99± 0.02a |
| Control | Water | 10.60 ± 6.67c |

*Means followed by the same letter is not significantly different at P=0.05. The means are separated by DMRT.

and Hammond (1981) reported that, the emulsifiable concentrate formulation of chlorpyrifos having better fungicidal efficacy than the granule formulation for the control of southern stem rot of peanuts. Hagan *et al*., (1986) also reported that chlorpyrifos significantly reduced the loci counts of southern stem rot caused by *Sclerotium rolfsii* on peanut. Endosulfan at 350 ppm concentration exhibited antifungal property by recording cent per cent inhibition of *Colletotrichum capsici* spore germination (Manohar, 2005). Antifungal activity of organo chlorinated insecticide, hexachloro cyclohexane (HCH) was reported by Babu *et al*. (1993) against *Rhizoctonia solani* which completely inhibited the radial growth at 260 ppm concentration.

Compatibility studies of pesticides and fungicide on *Hemilia vastatrix* under *in vitro* conditions showed that the spore germination was not affected by insecticide combination at the recommended concentrations. The present findings are in conformity with the results of Bhat *et al*., (2012), where in it was reported that mixing hexaconozole with chlorpyrifos and hexaconozole with chlorpyrifos and nelfmel are compatible and these combinations recorded 90.33% and 90% cured rust spots respectively by inhibiting the urediniospores germination.

Based on the laboratory results it is evident that insecticides and fungicide combination did not alter their efficacy and thus can be used simultaneously for the control of white stem borer and coffee leaf rust during post monsoon. By applying a mixture of insecticide and fungicide in time, the cost of control can be reduced. However, with this encouraging result further research is needed to understand the bio-efficacy and phytotoxicity effect of these combinations of chemicals under field conditions.

## ACKNOWLEDGEMENTS

The authors thank Director of Research, Coffee Board for guidance and facilities provided and the Coffee Board for financial assistance.

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*MS Received 13 May 2019*
*MS Accepted 18 June 2019*