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Studies on the Physical, Chemical Compatibility and Phytotoxic Effects of Some Insecticides and Fungicides Combinations in Rice Crop

K. Pullam Raju[1*], P. Rajasekhar[1], C.P.D. Rajan[2] and N. C. Venkateswarlu[1]

Department of Entomology[1], Department of Plant Pathology[2],

S.V. Agricultural College, Tirupati

*Corresponding Author E-mail: pullamrajuk@yahoo.co.in

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ABSTRACT

Five insecticides and three fungicides at recommended concentrations were tested under laboratory conditions for physical compatibility and evaluated the phytotoxic effects of fifteen pesticidal combinations on rice crop under field conditions. Out of the 15 combinations of insecticides and fungicides tested, neither foaming nor sedimentation occurred indicating that all the 15 combinations were physically compatible. The pH of pesticide combinations slightly varied with some combinations, some combinations were slightly alkaline, some were slightly acidic, while remaining were neutral in reaction.

Phytotoxic symptoms such as injury to leaf tip, yellowing, wilting, necrosis, vein clearing, epinasty and hyponasty of leaves were not observed on rice crop due to application of combination of insecticides and fungicides.

Key words: *Rice, Pesticides, Compatibility, Phytotoxicity*

INTRODUCTION

Rice (*Oryza sativa* L.) is the primary source of food for more than half of the world's population. Occurrence of insect pests and diseases together in rice demands the necessity of insecticidal and fungicidal application at a time. Insects like rice stem borer, leaf folder and diseases like blast and stem rot occur simultaneously in a crop season demanding combination spray of insecticides and fungicides. Hence, a trial on compatibility of insecticides and fungicides was carried out using common fungicides and insecticides used in rice ecosystem.

MATERIALS AND METHODS

Experiments for compatibility of insecticides and fungicides against pests of rice were carried out in the laboratory and in the fields of Agricultural Research Station, Nellore during *rabi*, 2012 – 2013 and 2013 – 14.

a. Evaluation of physical compatibility between insecticides and fungicides

The physical compatibility of 15 combinations involving 5 insecticides (Flubendiamide 480 SC @ 0.1 ml/l, Chlorantraniliprole 18.5 SC @ 0.3 ml/l, Cartap hydrochloride 50 SP @ 2.0 g/l, Buprofezin 25 SC @ 2.0 g/l,

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Profenophos 50 EC @ 2.0ml/l) and 3 fungicides (Tricyclazole 75 WP @ 0.6 g/l, Hexaconazole 5 EC @ 2.0 ml/l and Propiconazole 25 EC @ 1.0 ml/l) were evaluated with jar compatibility test.

In this test, initially 500 ml of standard hard water (0.34 g calcium chloride and 0.139 g of magnesium chloride hexahydrate in 1 litre of double distilled water) was taken in 1 litre jar to which 1 insecticide and 1 fungicide were added in the order of Wettable powder (WP) followed by Dry flowables (DF), Flowables (F), Emulsifiable concentrates (EC) and finally by solubles designated as either solubles (S), soluble liquids (SL), or soluble concentrates (SC)

The volume of insecticide and fungicide mixture was made up to 1 litre with hard water, agitated by shaking the jar and left undisturbed for 30 minutes. Observations were recorded after 30 and 60 minutes with respect to foaming and sedimentation. Also, p^H of insecticides and fungicides alone and in combinations were recorded and designated according to Bickelhaupt, Donald[1], as following:

Reaction		**pH**	**Reaction**		**pH**
Extremely acidic	:	< 4.5	Neutral	:	6.6 – 7.3
Very strongly acidic	:	4.5 – 5.0	Slightly alkaline	:	7.4 – 7.8
Strongly acidic	:	5.1 – 5.5	Moderately alkaline	:	7.9 – 8.4
Moderately acidic	:	5.6 – 6.0	Strongly alkaline	:	8.5 – 9.0
Slightly acidic	:	6.1 – 6.5	Very strongly alkaline	:	> 9.1

b. Evaluation of the phytotoxicity on rice crop due to combination of insecticides and fungicides in the field

Preparation of pesticide combinations

A total of 24 treatments were tested to study the phytotoxic effects of combination of insecticides and fungicides. The treatments include, five insecticides (flubendiamide, rynaxypyr, cartap hydrochloride, buprofezin and profenophos), three fungicides (tricyclazole, hexaconazole and propiconazole) and their 15 combinations along with untreated control. For each treatment, 3 litres of tank mix of insecticide and fungicide were prepared as per the dosages and each treatment was replicated thrice. The details of pesticide combinations and their doses are given below:

Details of the treatments for chemical compatibility and phytotoxic reaction of insecticides and fungicides

Trt	**Pesticide particulars**	**Dosage (g or ml/lit.)**	**Trt**	**Pesticide particulars**	**Dosage (g or ml/lit.)**
T_1	Flubendiamide 480 SC	0.1	T_{13}	$T_2 + T_7$	0.3 + 2.0
T_2	Rynaxypyr (Chlorantraniliprole) 20 SC	0.3	T_{14}	$T_2 + T_8$	0.3 + 1.0
T_3	Cartap hydrochloride 50 SP	2.0	T_{15}	$T_3 + T_6$	2.0 + 0.6
T_4	Buprofezin 25 SC	2.0	T_{16}	$T_3 + T_7$	2.0 + 2.0
T_5	Profenophos 50 EC	2.0	T_{17}	$T_3 + T_8$	2.0 + 1.0
T_6	Tricyclazole 75 WP	0.6	T_{18}	$T_4 + T_6$	2.0 + 0.6
T_7	Hexaconazole 5 EC	2.0	T_{19}	$T_4 + T_7$	2.0 + 2.0
T_8	Propiconazole 25 EC	1.0	T_{20}	$T_4 + T_8$	2.0 + 1.0
T_9	$T_1 + T_6$	0.1 + 0.6	T_{21}	$T_5 + T_6$	2.0 + 0.6
T_{10}	$T_1 + T_7$	0.1 + 2.0	T_{22}	$T_5 + T_7$	2.0 + 2.0
T_{11}	$T_1 + T_8$	0.1 +1.0	T_{23}	$T_5 + T_8$	2.0 + 1.0
T_{12}	$T_2 + T_6$	0.3 + 0.6	T_{24}	Untreated control	--

The pesticide doses were choosen based on the standard recommendations given in the package of practices of Acharya N.G. Ranga Agricultural University. The pesticides were

sprayed at 45, 60 and 90 DAT coinciding with tillering, booting and flowering stages with the help of Knapsack sprayer on the foliage uniformly. Observations were recorded 1 day before spraying and also on 1, 3, 5, 7 and 10 days after spraying. Observations for the specific parameters like leaf tips and surface injury, necrosis, wilting, vein clearing, hyponasty and epinasty are noted by using phytotoxicity scale. The extent of phytotoxicity was recorded based on the scale prescribed by Central Insecticide Board and Registration Committee (CIB and RC). The per cent injury was calculated by using the formula:

$$\text{Per cent injury} = \frac{\text{Total grade points}}{\text{Max. grade x No. of leaves observed}} \text{x} 100$$

Leaf injury was assessed by visual ratings in a 0-10 Scale i.e.,

Scale		Phytotoxicity	Scale		Phytotoxicity
0	:	No phytotoxicity	6	:	51 to 60 %
1	:	1 to 10 %	7	:	61 to 70 %
2	:	11 to 20 %	8	:	71 to 80 %
3	:	21 to 30%	9	:	81 to 90 %
4	:	31 to 40 %	10	:	91 to 100 %
5	:	41 to 50 %			

RESULTS AND DISCUSSION

Study of physical and chemical compatibility of common insecticides and fungicides:

The physical compatibility vis-à-vis jar compatibility test for foaming, sedimentation and pH of the mixtures containing the insecticides and fungicides are presented in table 1.

Among 15 combinations of insecticides and fungicides tested neither foaming nor sedimentation was observed in all 15 combinations of insecticides and fungicides tested and found to be physically compatible (Plate 1, 2, 3, 4 and 5). Similar experiments conducted by Kamala *et al*.[4], revealed that carbosulfan in combination with copper oxychloride in standard hard water did not produce any sediment and / or creamy matter which showed that the combination was compatible. Manohar[6], observed that endosulfan + hexaconazole, spinosad + hexaconazole and indoxacarb + hexaconazole were physically compatible. Varadarasan *et al*.[13], showed that copper oxychloride was compatible physically and biologically with the insecticides like chlorpyriphos, triazophos, monocrotophos, quinalphos, profenophos and a synthetic pyrethroid, lambda-cyhalothrin at recommended doses. Also Kubendran *et al*.[5], observed that flubendiamide + thiacloprid @ 25 ml / ha with di ammonium phosphate (2%), quinalphos (0.05 %) and copper oxychloride (0.25 %) did not produce creaming matter or sediment at the top or bottom of the 100 ml cylinder. Raja Goud[8], had reported that propiconazole in combination with each of the insecticides viz., novaluron and indoxacarb was physically compatible since no foaming was observed with 0.0 and 1.8 ml of sedimentation, respectively which was less than the limits of 2 ml / 100 ml as specified by ISI.

Thus it is evident from the jar compatibility test that out of 15 combinations of insecticides and fungicides showed neither foaming nor sedimentation indicating that all the 15 pesticide combinations were physically compatible.

The quality of water can be an important factor in optimum pest control. The effects of pH in spray water can diminish the effectiveness of some insecticides. Among the pesticides tested for pH, flubendiamide, profenophos, hexaconazole, propiconazole, flubendiamide + hexaconazole, flubendiamide

+ propiconazole, rynaxypyr + tricyclazole, rynaxypyr + hexaconazole was slightly alkaline (7.5, 7.4, 7.5, 7.4, 7.6, 7.6, 7.4 and 7.4, respectively). The pH of the pesticides, cartap hydrochloride + tricyclazole and buprofezin + tricyclazole was slightly acidic (6.2 and 6.5, respectively). The pH of the pesticides, cartap hydrochloride, cartap hydrochloride + hexaconazole and cartap hydrochloride + propiconazole was moderately acidic (6.0, 5.9 and 5.8, respectively). The pH of buprofezin with tricyclazole was slightly acidic (6.5), while it was neutral (7.0) with buprofezin alone. Cartap hydrochloride, cartap hydrochloride + hexaconazole, cartap hydrochloride + propiconazole was moderately acidic (6.0, 5.9 and 5.8, respectively), but the combination with cartap hydrochloride + tricyclazole was slightly acidic. Flubendiamide, profenophos alone was slightly alkaline (7.5 and 7.4), but in combinations flubendiamide + tricyclazole was neutral (7.2), flubendiamide + hexaconazole, flubendiamide + propiconazole was slightly alakaline (7.6 and 7.6), whereas rynaxypyr alone (7.0) was neutral, but in combinations rynaxypyr + tricyclazole and rynaxypyr + hexaconazole was slightly alkaline (7.4 and 7.4).

In the present study, pH of the pesticides changed when they were combined. Thus four combinations were slightly alkaline, two combinations were slightly acidic, two combinations were moderately acidic and seven combinations were neutral (Table 2). According to The University of Arizona reports, compatibility can be influenced by the pH (acidity or alkalinity) of a solution, a neutral solution has a pH of 7. Various pesticides are unstable in alkaline solutions (pH > 7), but quite stable in solutions that are slightly acidic (pH of approximately 6). The best pH for most of the pesticides is about 6, although a solution range of 6 to 7 is satisfactory. The classification of pesticides based on pH range is presented in table 2.

UAP[12], reported that *Bacillus thuringiensis* was stable at pH 4 and 7, while metalaxyl MZ was stable at pH 7 and below. According to John *et al*.[3], use of high pH water leads to alkaline hydrolysis that may affect the performance of many pesticides and they also reported that Avaunt and Aphistar appeared to lower the pH when they were mixed with alkaline water. Varadarasan *et al*.[13]. also reported the pH of quinalphos (8.76), which is alkaline, had decreased after mixing with copper oxychloride. In the present study even though minor pH changes were noticed either towards acidity or alkalinity, there was no reduction in the efficacy of insecticides, fungicides and their combinations.

Phytotoxic effects of pesticides and their combination treatments on rice crop:

The results of field experiments with rice crop indicated that there were no phytotoxic effects of the combinations of five insecticides (flubendiamide, rynaxypyr, cartap hydrochloride, buprofezin and profenophos) with each of the three fungicides (tricyclazole, hexaconazole and propiconazole). The combinations were observed for the phytotoxic symptoms like injury to the leaf tip, yellowing, wilting, vein clearing, necrosis, epinasty and hyponasty in leaves when sprayed on rice crop along with the scale of phytotoxicity. The observations on 1st, 3rd, 5th, 7th and 10 days after spraying indicated that all the combinations of pesticides did not cause any phytotoxic effects on rice crop.

Prajapathi *et al*.[7], also endorsed that mixing of cartap hydrochloride with hexaconazole and propiconazole seldom showed any phytotoxic effects on the rice foliage. Similar results of no phytotoxic effects on rice crop were reported by Sharma and Sood[9], with 2 fungicides namely tricyclazole and iprobenphos and 2 insecticides, indoxacarb and cartap hydrochloride. Suganthy *et al*.[10], reported no phytotoxic effects of imidachloprid when mixed with azoxystrobin, wettable sulphur, carbendazim, etc., on cotton, bhendi and chilli crops.

Bhuvaneswari and Raju[2], also concluded that the 3 fungicides (hexaconazole, validamycin and tebuconazole + trifloxystrobin) along with 6 insecticides

(buprofezin, pymetrozine, acephate, chlorantriniliprole, dinotefuron, imidachloprid + ethiprole) also showed no phytotoxicity symptoms in rice crop in any of the treatment combinations. The results of the present study are in accordance with the results of the above workers.

Table 1: p^H of the pesticides sprays fluid alone and their combinations

Sl.No.	Treatment particulars	p^H	Nature of reaction
T_1	Flubendiamide 480 SC	7.5	Slightly alkaline
T_2	Rynaxypyr 20 SC	7.0	Neutral
T_3	Cartap hydrochloride 50 SP	6.0	Moderately acidic
T_4	Buprofezin 25 SC	7.0	Neutral
T_5	Profenophos 50 EC	7.4	Slightly alkaline
T_6	Tricyclazole 75 WP	7.2	Neutral
T_7	Hexaconazole 5 EC	7.5	Slightly alkaline
T_8	Propiconazole 25 EC	7.4	Slightly alkaline
T_9	Flubendiamide + Tricyclazole	7.2	Neutral
T_{10}	Flubendiamide + Hexaconazole	7.6	Slightly alkaline
T_{11}	Flubendiamide + Propiconazole	7.6	Slightly alkaline
T_{12}	Rynaxypyr + Tricyclazole	7.4	Slightly alkaline
T_{13}	Rynaxypyr + Hexaconazole	7.4	Slightly alkaline
T_{14}	Rynaxypyr + Propiconazole	7.3	Neutral
T_{15}	Cartap hydrochloride + Tricyclazole	6.2	Slightly acidic
T_{16}	Cartap hydrochloride + Hexaconazole	5.9	Moderately acidic
T_{17}	Cartap hydrochloride + Propiconazole	5.8	Moderately acidic
T_{18}	Buprofezin + Tricyclazole	6.5	Slightly acidic
T_{19}	Buprofezin + Hexaconazole	6.7	Neutral
T_{20}	Buprofezin + Propiconazole	7.0	Neutral
T_{21}	Profenophos + Tricyclazole	7.0	Neutral
T_{22}	Profenophos + Hexaconazole	7.1	Neutral
T_{23}	Profenophos + Propiconazole	7.3	Neutral

Table 2: Classification of pesticides based on P^H range

Sl.No.	Nature of reaction	P^H range	Pesticides spray fluid
1	Extremely acidic	< 4.5	--
2	Very strongly acidic	4.5 – 5.0	--
3	Strongly acidic	5.1 -5.5	--
4	Moderately acidic	5.6 – 6.0	Cartap hydrochloride 50 SP Cartap hydrochloride + Hexaconazole Cartap hydrochloride + Propiconazole
5	Slightly acidic	6.1 -6.5	Cartap hydrochloride + Tricyclazole Buprofezin + Tricyclazole
6	Neutral	6.6 -7.3	Rynaxypyr 20 SC Buprofezin 25 SC Tricyclazole 75 WP Flubendiamide + Tricyclazole Rynaxypyr + Propiconazole Buprofezin + Hexaconazole Buprofezin + Propiconazole Profenophos + Tricyclazole Profenophos + Hexaconazole Profenophos + Propiconazole
7	Slightly alkaline	7.4 – 7.8	Flubendiamide 480 SC Profenophos 50 EC Hexaconazole 5 EC Propiconazole 25 EC Flubendiamide + Hexaconazole Flubendiamide + Propiconazole Rynaxypyr + Tricyclazole Rynaxypyr + Hexaconazole
8	Moderately alkaline	7.9 – 8.4	--
9	Strongly alkaline	8.5 – 9.0	--
10	Very strongly alkaline	>9.1	--

Source : Bickelhaupt (2012)

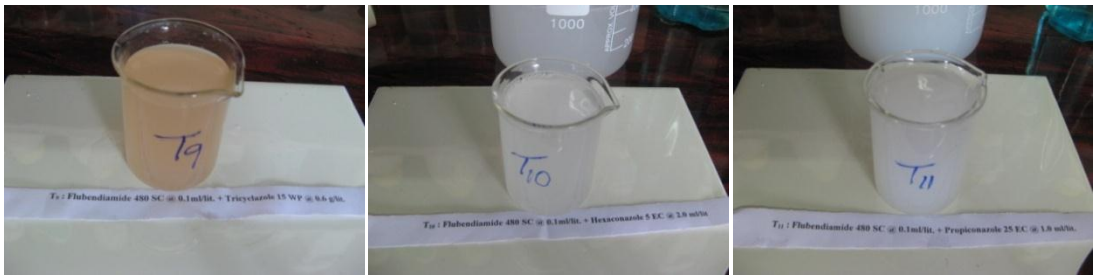

Plate 1. Physical compatibility of flubendiamide with tricyclazole, hexaconazole and propiconazole

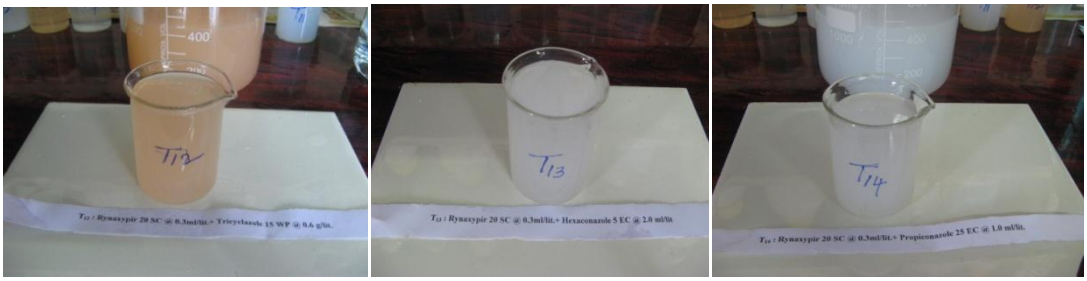

Plate 2. Physical compatibility of rynaxypyr with tricyclazole, hexaconazole and propiconazole

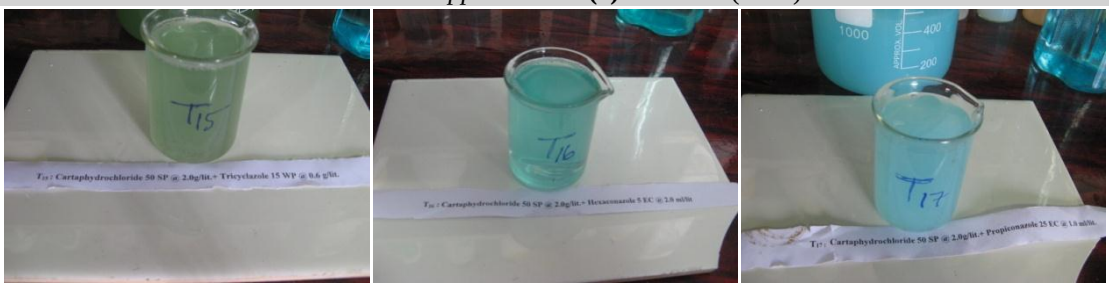

Plate 3. Physical compatibility of cartaphydrochloride with tricyclazole, hexaconazole and propiconazole

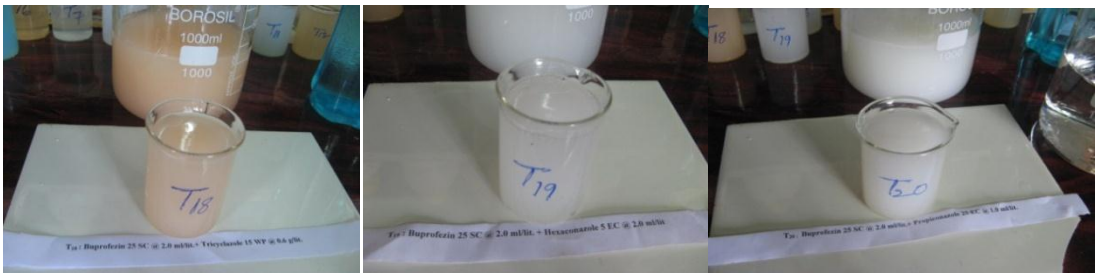

Plate 4. Physical compatibility of buprofezin with tricyclazole, hexaconazole and propiconazole

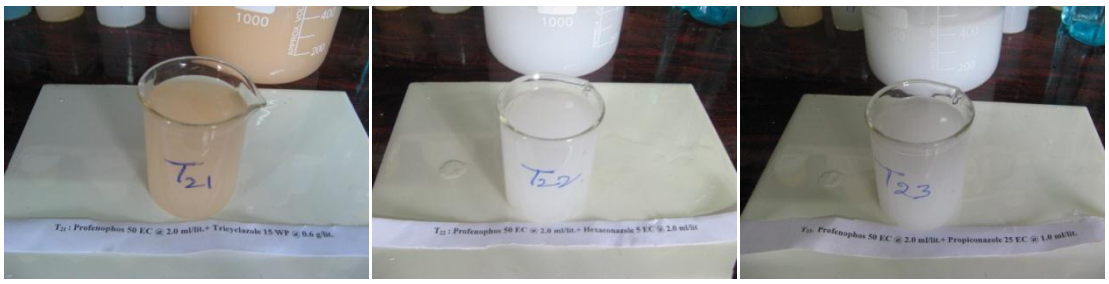

Plate 5. Physical compatibility of profenophos with tricyclazole, hexaconazole and propiconazole

CONCLUSION

The studies conducted on physical and chemical compatibility of the combination of insecticides and fungicides showed neither foaming nor sedimentation indicating that all the 15 pesticide combinations were physically compatible. The studies on phytotoxic effects clearly indicated that there were no injury to leaf tips, yellowing, wilting, necrosis, vein clearing, epinasty and hyponasty of leaves, when combinations were sprayed suggesting all the combinations were safe to the rice crop.

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