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Phyto-compatibility of a two-way pesticide mixture in rice

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Abstract
Fungicides, insecticides, fertilisers, and adjuvants are all applied at the same time in modern agriculture. The selection of chemicals for tank mixtures has not been thoroughly investigated, and thus poses a danger in pesticide application. The goal of this study was to see how a two-way mixture of Chlorantraniliprole 18.5 SC and Triflumezopyrim 10 SC affected the phytotoxicity of rice (*Oryza sativa* L.) as a test plant. After spraying the mixtures, the mean percent leaf injury of rice leaves ranged from 0.00-3.14 percent due to chlorosis, necrosis, hyponasty, and epinasty effects. On the 15th day of spraying, the SPAD readings ranged from 27.75 to 39.53. All of the parameters were not statistically different, indicating that the mixes had no phytotoxicity and were safe to use in rice.

Keywords: Insecticide mixtures, phytotoxicity, hyponasty, epinasty, compatibility

1. Introduction
Pesticides are poisonous chemicals that are applied to arable fields to control diseases, pests, and weeds in order to reduce yield losses and maintain high output. The inappropriate use of pesticides has resulted in pollution and a health concern for organisms exposed [1]. Insecticides account for 60% of the Indian crop protection market, according to a FICCI report (2015) [2], followed by fungicides and herbicides, which account for 18 and 16 percent of total pesticides, respectively. Pesticides are widely used in agriculture, resulting in high acute toxicity issues that can negatively affect plant growth and development, as well as inflict long-term damage to the environment and human life, even at trace amounts [3].

Tank mixes are pesticide mixtures that combine two or more products or pesticides plus fertilizers in a single tank for use in crops [4]. When compared to a single product application, a tank mixing of two or more chemical products may be a good application method, saving fuel and labour hours, generating less soil compaction, and possibly giving a greater pest control range and efficacy [5]. While tank mixes provide many benefits, they can also have phytotoxic effect on plants.

Phytotoxicity refers to any chemical agent that has a deleterious effect on plant growth, physiology, or metabolism, such as high amounts of fertilisers, pesticides, heavy metals, or nanoparticles [6]. Phytotoxic effects on plants include altered metabolism, growth inhibition, and death [7]. Disrupted physiological functions, such as photosynthesis, water and nutrient intake, cell division, or seed germination, cause changes in plant metabolism and growth [6].

Phytotoxicity in pesticide combinations might arise as a result of the activity of certain components in the preparation, or as a result of a short time interval between treatments. Plants that are weak and undernourished, those that have been over-fertilized with nitrogen, and plants that have been injured by parasites and pests are all more susceptible to pesticide activity. The sensitivity of a plant species, its variation or growth stage, or the compatibility of components in pesticide formulations can all affect phytotoxicity [8].

In 2012, the Central Insecticides Board and Registration Committee [9] recommended chlorantraniliprole (CAP), a diamide insecticide, against yellow stem borer and leaf folder of rice. In 2018, CIB & RC approved triflumezopyrim (TMP), a mesoionic insecticide, against brown plant hoppers in rice [9]. The effectiveness of these insecticides against their target pests has already been proven. Over an untreated control, chlorantraniliprole reduced YSB infestation (dead hearts and white ear heads) by 84 percent and 92 percent, respectively [10]. Similarly, triflumezopyrim outperformed imidacloprid against planthoppers [11, 12]. Because of the efficacy of chlorantraniliprole and triflumezopyrim against yellow stem borer and plant hoppers in rice, tank mixing of their formulations to treat both pests simultaneously are

possible. Phyto compatibility of chlorantraniliprole and triflumezopyrim in tank combinations has not been examined previously, this study seeks to investigate the phytotoxic compatibility of formulations, chlorantraniliprole with triflumezopyrim in rice plants.

2. Materials and Methods

2.1 Insecticides

Chlorantraniliprole 18.5 SC (Coragen™, DuPont, USA) and Triflumezopyrim 10 Sc (Pexalon™, powered by PYRAXALT™, DuPont, USA) purchased from local vendor. Recommended doses (RD) of these pesticides are chlorantraniliprole at 30 g a.i. ha^{-1} (Coragen 18.5 SC), and triflumezopyrim at 25 g a.i. ha^{-1} (Pexalon 10 SC).

2.2 Phytotoxicity check of the mixtures

The experiment was carried out in Department of Entomology, OUAT, Bhubaneswar. Rice seedlings (7-10 days old seedlings) of variety TN-1 were planted in pots with 10 cm diameter and 10 cm in depth. Ten mixtures of Chlorantraniliprole 18.5 SC with Triflumezopyrim 10 SC namely, CAP RD + TMP RD, CAP RD + TMP 75% RD, CAP RD + TMP 50% RD, CAP 75% RD + TMP RD, CAP 75% RD + TMP 75% RD, CAP 75% RD + TMP 50% RD, CAP 50% RD + TMP RD, CAP 50% RD + TMP 75% RD, CAP 50% RD + TMP 50% RD, CAP 25% RD + TMP 25% RD along with an untreated control (only water) were sprayed on the potted rice plants. The mixtures were sprayed at 45 days after transplanting. The parameters such as epinasty, hyponasty, chlorosis and necrosis were recorded on 1, 3, 5, 7 and 14 days after spraying (DAS). The extent of phytotoxicity was recorded based on the scale prescribed by CIB & RC. The per cent injury was calculated using the formula:

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

Visual ratings on a 0-10 scale were used to determine leaf injury: 0 – no phytotoxicity, 1-1 to 10%, 2-11 to 20%, 3-21 to 30%, 4-31 to 40%, 5-41 to 50%, 6-51 to 60%, 7-61 to 70%, 8-71 to 80%, 9-81 to 90%, 10-91 to 100% phytotoxicity. In addition, chlorophyll content was determined using SPAD meter on 15th DAS. (SPAD 502 plus Chlorophyll meter, Konica Minolta, Tokyo, Japan).

3. Results and Discussion

The mean per cent injury of rice leaves ranged from 1.20-3.14% due to chlorosis, 0.55-1.71% due to necrosis, 0.11-0.88% due to hyponasty and 0.00-0.67% due to epinasty by the spraying of Chlorantraniliprole 18.5 SC + Triflumezopyrim 10 SC mixtures on rice plant (Table 1.). The SPAD readings (chlorophyll content) ranged from 27.75-39.53 in rice leaves. There was no significant damage of rice leaves and change in chlorophyll content by the spraying of Chlorantraniliprole 18.5 SC + Triflumezopyrim 10 SC mixtures.

Table 1: Per cent leaf injury of rice leaves due to phytotoxicity by spraying of Chlorantraniliprole 18.5 SC + Triflumezopyrim 10 SC

S. NO	Treatments	Chlorosis			Necrosis			Hyponasty				Epinasty		SPAD
		3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	3 DAS	7 DAS	14 DAS	15 DAS
1.	CAP RD + TMP RD	2.66 (1.91)	2.99 (2.00)	3.11 (2.03)	1.22 (1.48)	1.55 (1.59)	1.66 (1.63)	0.22 (1.10)	0.33 (1.15)	0.33 (1.15)	0.00 (1.00)	0.22 (1.10)	0.44 (1.20)	32.58
2.	CAP RD + TMP 75% RD	1.93 (1.69)	2.26 (1.78)	2.26 (1.78)	1.24 (1.47)	1.71 (1.64)	1.71 (1.64)	0.23 (1.11)	0.45 (1.20)	0.56 (1.25)	0.23 (1.10)	0.34 (1.15)	0.34 (1.15)	32.68
3.	CAP RD + TMP 50% RD	1.48 (1.54)	1.92 (1.68)	2.14 (1.76)	0.79 (1.33)	0.90 (1.37)	1.01 (1.42)	0.34 (1.14)	0.45 (1.20)	0.56 (1.24)	0.11 (1.05)	0.23 (1.10)	0.23 (1.10)	31.28
4.	CAP 75% RD + TMP RD	2.39 (1.80)	2.84 (1.95)	3.06 (2.00)	0.80 (1.33)	1.14 (1.46)	1.26 (1.50)	0.33 (1.14)	0.56 (1.24)	0.56 (1.24)	0.12 (1.05)	0.35 (1.15)	0.35 (1.15)	28.48
5.	CAP 75% RD + TMP 75% RD	1.43 (1.55)	1.97 (1.72)	1.97 (1.72)	0.75 (1.29)	0.98 (1.39)	0.98 (1.39)	0.11 (1.05)	0.32 (1.14)	0.32 (1.14)	0.11 (1.05)	0.43 (1.19)	0.43 (1.19)	30.15
6.	CAP 75%RD + TMP 50% RD	2.77 (1.94)	3.21 (2.05)	3.33 (2.07)	0.56 (1.23)	0.78 (1.33)	0.89 (1.36)	0.55 (1.24)	0.77 (1.32)	0.88 (1.37)	0.22 (1.09)	0.44 (1.18)	0.54 (1.23)	29.55
7.	CAP 50%RD + TMP RD	1.20 (1.45)	1.78 (1.66)	1.99 (1.72)	1.13 (1.45)	1.35 (1.53)	1.46 (1.56)	0.46 (1.19)	0.69 (1.29)	0.81 (1.33)	0.23 (1.11)	0.45 (1.20)	0.66 (1.29)	27.75
8.	CAP 50% RD + TMP 75% RD	1.64 (1.62)	1.75 (1.63)	1.97 (1.71)	0.55 (1.23)	0.89 (1.34)	1.10 (1.42)	0.44 (1.18)	0.55 (1.22)	0.66 (1.27)	0.11 (1.05)	0.34 (1.15)	0.45 (1.20)	34.08
9.	CAP 50% RD + TMP 50% RD	1.65 (1.62)	2.09 (1.74)	2.09 (1.74)	0.56 (1.23)	0.89 (1.36)	1.00 (1.40)	0.33 (1.14)	0.55 (1.23)	0.66 (1.27)	0.33 (1.14)	0.45 (1.19)	0.67 (1.28)	37.28
10.	CAP 25% RD + TMP 25% RD	2.22 (1.78)	2.55 (1.86)	2.55 (1.86)	1.19 (1.24)	0.99 (1.41)	1.10 (1.44)	0.22 (1.09)	0.44 (1.19)	0.55 (1.23)	0.11 (1.05)	0.43 (1.19)	0.54 (1.23)	39.53
11.	Control	2.61 (1.89)	2.93 (1.97)	3.14 (2.03)	0.98 (1.40)	1.51 (1.58)	1.62 (1.62)	0.11 (1.05)	0.33 (1.14)	0.33 (1.14)	0.00 (1.00)	0.43 (1.18)	0.43 (1.18)	34.00
	SE (d)	0.21	0.19	0.18	0.17	0.13	0.13	0.12	0.14	0.13	0.08	0.12	0.11	15.00
	Tukey HSD at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Figures in parentheses are arc-sine transformed values. CAP: Chlorantraniliprole 18.5 SC, TMP: Triflumezopyrim 10 SC, RD: Recommended Dose, NS: Not Significant

There were no signs of chlorosis, necrosis, hyponasty and epinasty on the plants after spraying the mixtures of Chlorantraniliprole 18.5 SC + Triflumezopyrim 10 SC. The SPAD readings of rice plant treated with the mixtures were comparable to the untreated control, indicating that the mixtures had no significant phytotoxic effect on the rice plant (Fig 1.)

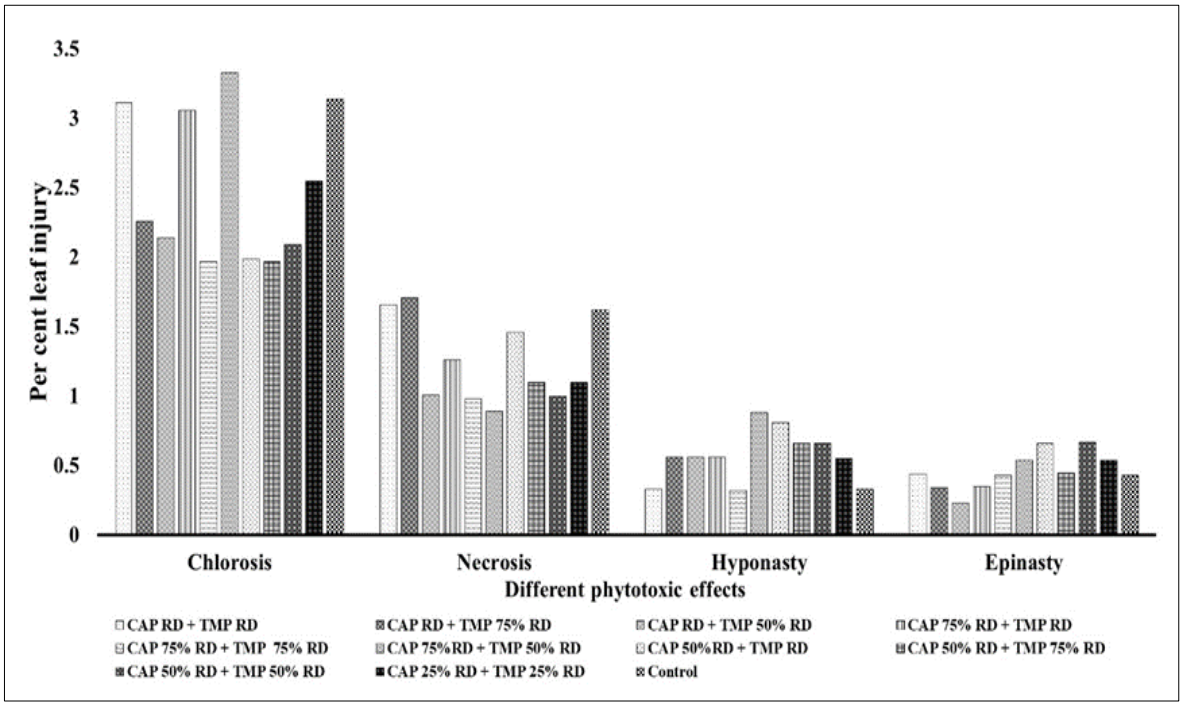

Fig 1: Per cent leaf injury due to treatment of Chlorantraniliprole 18.5 SC + Triflumezopyrim 10 SC

Sharma and Sood (2008) [13] observed no phytotoxicity on rice crops using mixtures of two fungicides, tricyclazole 75 WP and iprobenphos 48 EC, and two insecticides, indoxacarb 15 EC and cartap hydrochloride 50 SP. Moreover, the mixtures of 3 fungicides (hexaconazole 5 EC, validamycin 3 SL and tebuconazole 25 + trifloxystrobin 50 WG) and 6 insecticides (buprofezin 25 SC, pymetrozine 50 WG, acephate 75 SP, chlorantraniliprole 18.5 SC, dinotefuran 20 SG, imidacloprid + ethiprole 80 WG) did not exhibit any phytotoxicity symptoms in rice [14]. A combination of five insecticides (flubendiamide 480 SC, chlorantraniliprole 20 SC, cartap hydrochloride 50 SP, buprofezin 25 SC, and profenophos 50 EC) with each of the three fungicides (tricyclazole 75 WP, hexaconazole 5 EC, and propiconazole 25 EC) did not cause any phytotoxic symptoms (such as leaf tip injury, yellowing, wilting, vein clearing, necrosis, epinasty and hyponasty) on rice leaves [15]. The phytotoxicity is generally produced by the formulation adjuvants. Solvents present in formulations may cause phytotoxicity symptoms. In this study, the carrier in the formulations (SC) do not have organic solvents. The SC formulations are generally compatible with other formulations in tank mixtures and did not produce any incompatibility reactions.

4. Conclusion

It can be concluded that tank mixtures of Chlorantraniliprole 18.5 SC with Triflumezopyrim 10 SC are safe to rice plants. The biocompatibility of this mixture must be investigated in order to demonstrate its efficacy in practice. They could be a viable option in the present Integrated Pest Management (IPM) module in rice-growing nations due to their multi-pest target.

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