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COMPATIBILITY OF CERTAIN INSECTICIDES WITH PROPICONAZONE AGAINST POD BORER AND DIE-BACK AND FRUIT ROT IN CHILLI

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Summary

The effect of test insecticides viz., indoxacarb(110.34 ppm), spinosad (99.83 ppm), novaluron (383.30 ppm) and cartap hydrochloride (224.32 ppm) I combination with propiconazole (0.76 ppm) on the mortality of *H. argimgera* larvae at their their respective LC_{50} values revealed that all the combinations showed no effect mechanism and there is no significant difference among them. When the indoxacarb 110.34 ppm (LC_{50}) and novaluron 383.30 ppm (LC_{50}) combined with propiconazole (750, 1000, 1250, and 1500ppm) resulted into synergism against third instar larvae of *H. armigera*. Spinosad 99.83 ppm (LC_{50}) showed synergistic effect when combined with propiconazole (500, 750, 1000, 1250 and 1500ppm), while cartap hydrochloride 224.32 ppm was recorded synergism when combined with propiconazole (1500ppm) against *H. armigera*. Similarly, the propiconazole (LC_{50}) value was mixed with four insecticides at their respective LC_{50} values and studied their effect on spore germination *C.capsici*. The antagonistic effect of propiconazole was displayed when it was mixed with selective insecticides at their LC_{50} values. When propiconazole 0.76 pm (LC_{50}) was combined with indoxacarb (75, 112.5, 150, 187.5 and 225 ppm), spinosad (90, 135, 180, 225 and 270 ppm), novaluron (50, 75, 100, 125, and 150 ppm) and cartap hydrochloride (250, 375, 500, 625 and 750 ppm), synergism existed against *C. capsici* spore germination.

सारांश

मिर्च में कीटनाशियों जैसे इन्डोक्साकार्ब (110.34 पी.पी.एम.) स्पिनोसाड (99.83 पी.पी.एम.), नोवा लुरान (383.30 पी.पी.एम.) तथा करटाप हाइड्रोक्लोराइड (242.32 पी.पी.एम.) के साथ प्रापीकोनाजोल (0.76 पी.पी.एम.) का परिक्षण हैलियोंथिस आर्मीजेरा सूंडी कं एल.सी. 50 मूल्य पर किया गया और परीक्षण से स्पष्ट हुआ कि संयुक्त रूप से सभी में सार्थक विभिन्नता नहीं पायी गयी। जब इन्डोक्साकार्ब (110.34 पी.पी.एम.) व नोवालुरान (383.30 पी.पी.एम.) को सयुक्त रूप सें प्रापीकोनाजोल (750, 1000, 1250 व 1500 पी.पी.एम.) का प्रयोग किया गया। तब हैलियोंथिस आर्मीजेरा तृतीय कवच छोड़ सूंडी पर सार्थक परिणाम प्राप्त हुआ। स्पिनोसाड (99.83 पी.पी.एम.) का सार्थक परिणाम प्रापीकोनाजोल (750, 1000, 1250 व 1500 पी.पी.एम.) के साथ रहा जबकि करटाप हाइड्रोक्लोराइड (242.32 पी.पी.एम.) का सार्थक परिणाम प्रापीकोनाजोल (1500 पी.पी.एम.) का साथ रहा। इसी प्रकार प्रापीकोनाजोल (एल.सी. 50) का मूल्य चार मिश्रित कीटनाशियों के साथ परीक्षण करने पर इनका प्रमाण कैप्सिकम कैप्सीसी के बीजाणु जमाव पर पाया गया। प्रापीकोनाजोल का प्रतिनाकारात्मक प्रभाव चयनित कीटनाशियों के साथ पाया गया। जब प्रापीकोनाजोल 0.76 पी.पी.एम. (एल.सी. मूल्य–50 को इन्डोक्साकार्ब (75, 112.5, 150, 187.5 व 225 पी.पी.एम.) स्पिनोसाड (90, 135, 180, 225 तथा 270 पी.पी.एम) नोवालुरान (50, 75, 100, 125 व 150 पी.पी.एम.) तथा करटाप हाइड्रोक्लोराइड (250, 375, 500, 625 व 750 पी.पी.एम.) के साथ प्रयोग करने पर कैप्सिकम कैप्सीसी के बीजाणु जमाव में विपरित सार्थक प्रभाव पाया गया।

Intorduction

Among the biotic stresses, gram pod borer, *Helicoverpa armigera* (Hub.) and die-back and fruit rot, *Colletotrichum capsici (*Syd.) Butler and Bisby are considered as the most important pests. Gram pod borer, *H. armigera* is one of the serious pest of chilli crop and being polyphagous, is found on large number of cultivated and wild plants throughout India and workdwide. Farmers around the world use chemical pesticides indiscriminately to control *H. armigera,* and the pest has developed resistance to many of the commonly used insecticides (Kranthi *et al*., 2001). The species of *Colletotrichum* are highly variable pathogens infecting many number of host plants. Over the past 30 years the performance of many commonly used fungicideds has been seriously affected by the development of resistance in the target pathogens. The combined application of insecticides and fungicides may result either in synergism or antagonism between them. Ali and Singh (2003) showed synergism of mancozeb + endosulfan mixture which resulted in increased efficacy of fungicide against *Cercospora* leaf spot of sesamum. The combination of monocrotophos

with mancozeb showed decreased insecticidal activity against red cotton bug (lakshminarayana and Subbaratnam, 2000).

Materials and Methods

The chemical compatibility of insecticides + fungicides combination was assessed by studying the biological effectiveness against the *H. armigera* and *C. capsici*. The *H. armigera* was reared on artificial diet, whereas the *C. capsici* was maintained on PDA medium. Toxicity of the insecticides and fungicides was tested against third instar larvae of *H. armigera* and on 10 days old culture of *C. capsici,* respectively. The data obtained with respect to mortality of larvae and on inhibition of fungus spore germination were subjected to probit analysis to arrive at LC_{50} values. After arriving the LC_{50} values of insecticides/ fungicides, the LC_{50} was/were mixed with different concentration of insecticides / fungicides and were tested against *H. armigera*/ *C. capsici*. These insecticides/ fungicides concertration were selected on the basis of their field recommended concertration for pest/ disease control and two lower and two higher concertrations than to field recommended concertration. The larvae of *H. armigera* were exposed to these mixtures in the same way as described and the mortality data was recorded at 72 h after exposure. The data were analysed to arrive LC_{50} value. This LC_{50} valued of insecticide were mixed with different concentrations of fungicide for assessing the occurrence of synergism, antagonism and no effect was assessed in respect of toxicity of insecticide to test insect when mixed with fungicides. The toxic effect of fungicides to *C. capsici* was studied following Slide Germination Technique. Glass Cavity slides(3″x1″) were seleclted for this study. The fungicidal fluid of 0.06 ml was placed by means of a micropipette and spread uniformly in the cavities. The slides were kept under a fan for drying of the fungicidal fluid. After complete drying, spore suspension of *C. capsici* was transformed at the rate of 0.03 ml in the cavity by micropipette, spread evenly and then incubated in moist chambers at room temperature. Rectangular plastic boxes with moistened tissue paper served as moist chamber. Over the moist tissue paper, 'U' shaped bent glass tube was placed, which served as a support for the slides. The sealed slides placed over the 'U' shaped glass tube inside the moist chambers were incubated for 24 h at room temperature (26- 30 ^{0}C). The incubation period of 24 h was pre-determined as maximum number of conidia germinated by this period. After specified period of incubation, the number of non germinated spores was counted by compound microscope under low power. Hundred spores were counted for each replication and each treatment was replicated thrice. The fungicide concertration that inhibited 50 per cent of spores (LC_{50}) of the test fungus was mixed with different concentration of insecticides. The spores of *C. capsici* were exposed to these mixtures and the spore germination was recorded at 24 h after incubation.

Results and Discussion

Effect of selected insecticides in combination with propiconazole at their LC_{50} values on mortality of *H. armigera*: The indoxacarb (110.34 ppm), spinosad (99.83ppm), novaluron (383.30 ppm) and fcartap hydrochloride (224.32 ppm) recroded 51.10, 52.22, 51.11 and 50.00 per cent corrected mortality of *H. armigera* in combination with propiconazole (0.76 ppm). The results showed that there was no significant change in the insecticidal activity when mixed with proiconazole and no effect was displayed in all the above combinations.

Effect of indoxacarb (LC_{50}) in combination with propiconazole on mortality of *H. armigera* : The toxic effect of indoxacarb at 110.34 ppm (LC_{50}) in combination with different concentrations of propiconazole on mortality of *H. armigera* was studied (Table 2). Indoxacarb 110.34 ppm + propiconazole 500ppm recorded 53.33 per cent corrected mortality which is not significantly differing when compared with indoxacarb 110.34 ppm tested alone indicating no activity or equalism in their efficacy. When the concertration of propiconazole was increased to 750, 1000, 1250 and 1500 ppm along with indoxacarb 110.34 ppm, a significant increase in per cent corrected mortality of 61.11, 72.22, 77.77 and 84.44 per cent , respectively was found and all of them werrre displaying synergistic activity when compared with indoxacarb 110.34 ppm (LC_{50}) alone. The results are in accordance with the work of Manohar (2005) who reported that combination of indoxacarb LC_{50} (83.2 ppm) + chlorothalonil at 3125 ppm resulted in thte maximum mortality of 56.66 per cent of *S. litura* larvae.

Effect of spinosad (LC_{50}) in combination with propiconazole on mortality of *H. armigera* : It is be observed from the data that 61.11 per cent corrected mortality of test insect was recorded with spinosad at

Table 1. Effect of Selected Insecticides in Combination with Propiconazole at their LC_{50} on Mortality of *H. armigera*

No.	Concentration	Non germinated spores (%)
1	Indoxacarb 110.34ppm + Propiconazole 0.76ppm	51.10(46.72)[a]
2	Spinosad 99.83ppm + Propiconazole 0.76 ppm	52.22(47.51)[a]
3	Novaluron 383.30ppm + Propiconazole 0.76ppm	51.11(45.85)[a]
4	Cartap hydrochloride 224.32 ppm + Propiconazole 0.76 ppm	50.00(46.43)[a]
5	Indoxacarb 110.34 ppm	53.33(46.92)[a]
6	Spinosad 99.83 ppm	53.33(46.92)[a]
7	Novaluron 383.30 ppm	56.66(49.92)[a]
8	Cartap hydrochloride	55.55(48.18)[a]
	S.Em ±	0.64
	C.D. (0.05 %)	2.87

Figures in parentheses are angular transformed values
Figures indiacated by same letters are not significantly different from one another as per DMRT C.D. (0.05%): critical difference at 5 per cent level
SEm ± : Standard Error of Mean

99.83 ppm in combination with propiconazole 500ppm (Table 3). When the concentration of propiconazole was increased to 750, 1000, 1250 and 1500 ppm, a significant increase in the corrected mortality of 72.22, 77.77, 84.44, 89.99 per cent, respectively was recorded displaying synergistic activity when compared with spinosad 99.83 ppm (LC_{50}) tested alone . All the concerntrations of propiconazole displayed synergism and the per cent corrected mortalities differed significantly among themselves and were found to be greater than the larval mortality recorded in spinosad at its LC_{50} value (53.33%). These results are in accordance with studies of Tripathi *et al.*, (1983) who reported that mancozeb(0.2%) enhanced the insecticidal activity of phosphamidon (0.02%) in combination resulting higher mortality of mustard aphid, *L. erysimi* after 48 hrs of treatment.

Table 2. Effect of indoxacarb (LC_{50}) in Combianation with Different Concentration of Propiconazole Against *H. armigera*

No.	Concentration	Corrected mortality at 72 hrs after treatment (%)
1	Indoxacarb 110.34 ppm + Propiconazole 500 ppm	53.33(46.91)[e]
2	Indoxacarb 110.34 ppm + Propiconazole 750 ppm	61.11(51.42)[d]
3	Indoxacarb 110.34 ppm + Propiconazole 1000 ppm	72.22(58.20)[c]
4	Indoxacarb 110.34 ppm + Propiconazole 1250 ppm	77.77(61.88)[b]
5	Indoxacarb 110.34 ppm + Propiconazole 1500 ppm	84.44(66.79)[a]
6	Indoxacarb 110.34 ppm (LC_{50})	53.33(46.92)[e]
	S.Em ±	0.56
	C.D. (0.05 %)	1.62

Figures in parentheses are angular transformed values
Figures indiacated by same letters are not significantly different from one another as per DMRT

Effect of novaluron (LC_{50}) in combination with propiconazole on mortality of *H. armigera:* The effect of novaluron at 383.30 ppm(LC_{50}) in combination with different concentrations of propiconazole on mortality off *H.armigera* was recorde with novaluron 383.30 ppm + propiconazole 500ppm which significantly diffred and was lower when compared to novaluron 383.30 ppm (LC_{50}) tested alone indicatin antagonism. When the concertration of propiconazole was increased to 750, 1000,1250, and 1500 ppm, a significant increase in the corrected mortality of 61.11, 72.22, 77.77 and 84.44 per cent, respectively of *H. armigera* was recorded indication the synergistic activity. All the combinations significantly differed among themselves. However, the present results are varying with Dikshitulu (1985) who reported that even though cypermethrin in combination with carbendazim resulted in synergism but it decreases with increased concertration of carbendazim against red cotton bug, *D. cingulatus*.

Effect of cartap hydrochloride (LC_{50}) in combination with propiconazole on mortality of *H. armigera:* The combination of cartap bydrochloride 224.32 ppm + propiconazole 750, 1000, 1250 and 1500 ppm resulted in per cent corrected mortality values which were greater that 55.55 per cent recorded in cartap hydrochloride 224.32 ppm (Table 5). All the above

Table 3. Effect of Spinosad (LC_{50}) in Combianation with Different Concentration of Propiconazole Against *H. armigera*

No.	Concentration	Corrected mortality at 72 hrs after treatment (%)
1	Spinosad 99.83 ppm + Propiconazole 500 ppm	61.11(51.42)[e]
2	Spinosad 99.83 ppm + Propiconazole 750 ppm	72.22(58.20)[d]
3	Spinosad 99.83 ppm + Propiconazole 1000 ppm	77.77(61.88)[c]
4	Spinosad 99.83 ppm + Propiconazole 1250 ppm	84.44(66.69)[b]
5	Spinosad 99.83 ppm + Propiconazole 1500 ppm	89.99(71.72)[a]
6	Spinosad 99.83 ppm (LC_{50})	53.33(46.91)[f]
	S.Em ±	0.56
	C.D. (0.05 %)	1.62

Figures in parentheses are angular transformed values
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combinations were synergistic and differed significantly among themselves. The antagonism was displayed in the combination of cartap hydrochloride (LC_{50}) + propiconazole 500 ppm when compared with cartap gydrochloride (LC_{50}) alone. Similarly, no change in the activity of either components when mixed together was observed by Reddy and Krishnaiah (1997) with buprofezin (0.02 % a.i.) + captafol (0.16% ai.i.) against BPH *in vivo*. And by Srinivas Babu nd Sharma (2003) with imidacloprid (20gm a.i./ha) + propiconazole(0.01 %) against wheat aphid.

Effect of propiconazole in combination with insecticides at heir LC_{50} values on mortality of *c.capsici.:* The antagonistic effect of propiconazole was displayed when it was mixed with indoxacarb (110.34ppm), spinosad(99.83ppm), novaluron (383.30 ppm), and cartap gydrochloride(224.32 ppm), which recorded 33.67, 38.67, 37.33 and 36.33 percent non-germinated spores, respectively against propiconazole alone (LC_{50}), which resulted in 56.33 per cent of non germinated spores(Table 6). Among the above concentrations, propiconazole (0.76 ppm) + indoxacarb (110.34 ppm) and propiconazole (0.76 ppm) +spinosad(99.83 ppm) were on par with each other and differed significantly when compared with propiconazole (0.76 ppm) tested alone.

Effect of propiconazole in combination with indoxacarb against *C. capsici* : Propiconazole at 0.76 ppm (LC_{50}) in combination with 75, 112.5, 150, 187.5 and 225 ppm concentrations of indoxacarb recorded 61.00, 62.22, 63.67, 64.67 and 65.33 per cent non-germinated sproed of *C. capsisi,* respectively (Table 7). As there was greater inhibition of spore germination than 53.44 per cent (propiconazole at 0.76 ppm) in all the treatments, the phenomenon of synergism existed with all th combinations tested and all these significantly diffred wheen compared with propiconazole at 0.76 ppm (LC_{50}) alone. Manohar (2005) reported that moncozeb 97.00 ppm (LC_{50}) when mixed with indoxacarb at 110, 145 and 185 ppm concentrations reduces the fungicidal action which decreased with the increase in concentration by rcording a minimum of 2.02 per cent and a maximum of 6.07 per cent inhibition of spore germination at 110 and 118 ppm concentrations of indoxacarb with mancozeb, respectively.

Effect of propiconazole in combination with spinosad against *C. capsici* : Propiconazole at 0.76 ppm (LC_{50}) in combination with 90, 135, 180, 225 and 270 ppm concentrations of spinosad recorded 65.00, 64.33, 62.00, 58.00 and 54.00 per cent non germinated spores of *C. capsici,* respectively (Table 8). The synergism was observed in all the combinations since the per cent non- germinated sproes were greater and significantly differed when compared to propiconazole at 0.76 ppm(LC_{50}) tested alone. The results of Manohar (2005) indicated that spinosad in combination with mancozeb showed antagonism at lower concentrations and synergism at higher concentrations against *C. capsici*.

Table 4. Effect of Novaluron (LC_{50}) in Combianation with Different Concentration of Propiconazole Against *H. armigera*

No.	Concentration	Corrected mortality at 72 hrs after treatment (%)
1	Novaluron 383.30 ppm + Propiconazole 500 ppm	53.33(46.91)[f]
2	Novaluron 383.30 ppm + Propiconazole 750 ppm	61.11(51.42)[d]
3	Novaluron 383.30 ppm + Propiconazole 1000 ppm	72.22(58.20)[c]
4	Novaluron 383.30 ppm + Propiconazole 1250 ppm	77.77(61.88)[b]
5	Novaluron 383.30 ppm + Propiconazole 1500 ppm	84.44(66.69)[a]
6	Novaluron 383.30 ppm (LC_{50})	56.66(49.92)[e]
	S.Em ±	0.56
	C.D. (0.05 %)	1.62

Figures in parentheses are angular transformed values
Figures indiacated by same letters are not significantly different from one another as per DMRT

Table 5. Effect of Cartap hydrochloride (LC_{50}) in Combianation with Different Concentration of Propiconazole Against *H. armigera*

No.	Concentration	Corrected mortality at 72 hrs after treatment (%)
1	Cartap hydrochloride 224.32 ppm+ Propiconazole 500 ppm	51.11(45.63)[f]
2	Cartap hydrochloride 224.32 ppm + Propiconazole 750 ppm	61.11(51.42)[d]
3	Cartap hydrochloride 224.32 ppm + Propiconazole 1000 ppm	72.22(58.20)[c]
4	Cartap hydrochloride 224.32 ppm + Propiconazole 1250 ppm	77.77(61.88)[b]
5	Cartap hydrochloride 224.32 ppm + Propiconazole 1500 ppm	84.44(66.69)[a]
6	Cartap hydrochloride 224.32 ppm (LC_{50})	55.55(48.18)[e]
	S.Em ±	0.56
	C.D. (0.05 %)	1.62

Figures in parentheses are angular transformed values
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Table 6. Effect of Propiconazole in combination with selected insecticides at their LC_{50} on spore germination of *C. capsici*

No.	Concentration	Non germinated spores (%)
1	Propiconazole 0.76ppm + Indoxacarb110.34 ppm	33.67(35.44)[f]
2	Propiconazole 0.76ppm + Spinosad 99.83ppm	38.67(38.40)[d]
3	Propiconazole 0.76ppm + Novaluron 383.30ppm	37.33(37.64)[c]
4	Propiconazole 0.76ppm + Cartap hydrochloride 224.32ppm	36.33(37.06)[b]
5	Propiconazole 0.76ppm(LC_{50})	56.33(48.63)[a]
	S.Em ±	0.43
	C.D. (0.05%)	1.25

Figures in parentheses are angular transformed values
Figures indiacated by same letters are not significantly different from one another as per DMRT

Effect of propiconazole in combination with novaluron against *C. capsici*: Propiconazole at 0.76ppm (LC_{50}) in combination with 50, 75, 100, 125 and 150 ppm concentrations of novaluron recorded 65.67, 64.33, 64.00, 63.00 and 62.00 per cent non-germinated spores of the test fungus, *C. capsici,* respectively. There was greater inhibition of spore germination in all the tested combinations than 53.44 per cent (propiconazole at 0.76 ppm), therefore the phenomenon of synergism was shown in all the combinations. All the treatments differed significantly with that of propiconazole (LC_{50}) alone which recorded 53.44 per cent non-germinated spores of *C. capsici*.

Effect of propiconazole in combination with cartap hydrochloride against *C. capsici* : There was increase in inhibition of spore germination and hence, the phenomenon of synergism existed with all the concertrations of cartap hydrochloride when compared to propiconazole at its LC_{50} value which recorded 53.44 per cent non-germinated spores of *C.capsici*. Lakshminarayana and Subbaratnam (2000) also reported similar enhancement of fungicidal activity of mancozeb when mixed with acephate which also increased with increasein concentration against *C. gloeosporioides*.

Table 7. Effect of Propiconazole (LC_{50}) in combination with different concentrations of indoxacarb on spore germination of *C. capsici*

No.	Concentration	Non germinated spores (%)
1	Propiconazole 0.76ppmIndoxacarb 75 ppm	61.00(51.35)[d]
2	Propiconazole 0.76ppm + Indoxacarb 112.5pmm	62.22(54.35)[cd]
3	Propiconazole 0.76ppm + Indoxacarb 150pmm	63.67(52.53)[b]
4	Propiconazole 0.76ppm + Indoxacarb 187.5pmm	64.67(53.94)[ab]
5	Propiconazole 0.76ppm + Indoxacarb 225pmm	65.33(56.94)[a]
6	Propiconazole 0.76ppm(LC_{50})	53.44(46.97)[e]
	S.Em ±	0.43
	C.D. (0.05%)	1.25

Figures in parentheses are angular transformed values
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Table 8. Effect of Propiconazole (LC_{50}) in combination with different concentrations of spinosad on spore germination of *C.capsici*

Treat. No.	Concentration	Non germinated spores (%)
1	Propiconazole 0.76 ppm + Spinosad 90 ppm	65.00(53.74)[a]
2	Propiconazole 0.76 ppm + Spinosad 135 ppm	64.33(53.35)[b]
3	Propiconazole 0.76 ppm + Spinosad 180 ppm	62.00(51.94)[c]
4	Propiconazole 0.76 ppm + Spinosad 225 ppm	58.00(49.62)[d]
5	Propiconazole 0.76 ppm + Spinosad 270 ppm	54.00(43.13)[e]
6	Propiconazole 0.76 ppm(LC_{50})	53.44(46.97)e
	S.Em ±	0.43
	C.D. (0.05 %)	1.24

Figures in parentheses are angular transformed values
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