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Role of adjuvants in the efficacy of insecticides against insect pests of rice

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ABSTRACT

Role of neem oil, APSA-80 and neem seed powder as adjuvants in increasing the efficacy of commonly used insecticides was studied against different insect pests of rice. Efficacy of insecticides at their recommended doses, i.e. Monocrotophos, chlorpyriphos, phosphamidon as foliar sprays @ 0.5 kg a.i. ha^{-1} and carbofuran, phorate as granular applications @ 1 kg a.i. ha^{-1} were compared with adjuvants mixed with half the dose of insecticide. Neem oil combination of insecticides as foliar spray was found most effective against brown plant hopper (BPH), yellow stem borer (YSB) and gundhi bug. Combination of APSA-80 also enhanced the efficacy to the level of only insecticide treatment but was inferior to the neem oil combination. Neem seed powder combination with insecticide granules was found effective against YSB and BPH but not against gundhi bug.

Key words: *Adjuvants, neem oil, APSA-80, neem seed powder, insecticides*

Insecticides play a major role in the production system of rice. In spite of their much highlighted hazardous effects on the environment, on its users and on the non target organisms, they are still relied upon by the rice farmers for better management of different pests. Among several disadvantages of chemical insecticide applications, decrease in the efficiency of commonly used insecticides against insect pests is a major concern as it invites repeated application at higher doses as well. Increasing the efficacy of commonly used insecticides by adding adjuvents was thought to be a proper step for effective pest management in rice. Attempt has already been made to establish the synergistic effect of neem oil on insecticides (Kareem *et a*l, 1989; Krishnaiah *et al*, 1990; Jena, 2004). In the present study, neem oil, neem seed and a commercially available adjuvent APSA-80 (Amway India Enterprises) were evaluated in combination with insecticides against brown plant hopper (BPH) and yellow stem borer (YSB) of rice in green house as well as in rainfed shallow low land situation during wet season 2002 and 2004.

MATERIALS METHODS

Green house evaluation. Five commonly used insecticides, *viz.*, monocrotophos (Monocil 36 WSC), phosphamidon (Dimecron 86 WSC), chlorpyriphos (Classic 20 EC), Carbofuran (Furadan 3G) and phorate (Thimet 10 G) were evaluated. Sixty day old healthy plants of TN1 grown in trays (45cm l x 30cm w x 25cm h)were treated with insecticides alone and in combination with 3 adjuvents separately. In the case of only insecticide application, EC and WSC formulations were applied as foliar sprays @ 0.5 kg *a.i.* ha^{-1} (calculated @500 lt. spray solution ha^{-1}) whereas 2 granular insecticides were used as standing water application @ 1 kg.a.i ha^{-1}. Adjuvents were combined with half the dose of insecticides. Neem oil and APSA-80 were added to foliar sprays @ 0.2 and 0.05% respectively (2 and 0.5 ml litre^{-1} of insecticide solution) whereas coarse powder of neem seed was added to granular insecticides @ 50 kg ha^{-1}. Foliar spray was applied till run-down condition and granular application were made in standing water of 4 cm height. Each treatment was replicated 4 times including untreated control.

To determine the immediate knock down effect and persistent toxicity, fifth instar nymphs of greenhouse reared BPH were used. Insects were released @ 20 insects hill^{-1} after 2 hours of the treatment. They were kept confined to the plants by long necked glass chimneys, the open upper end of

which was covered with a piece of muslin cloth. Insect mortality was recorded after 24 hours of release. The process of releasing insects and observing the mortality was repeated at 2 days intervals, each time with a fresh lot of insects, till no mortality was observed. The data thus obtained was corrected as per Abbot's formula (Abbot, 1925) and the efficacy of different treatments was assessed as per the method followed by Pradhan, 1965.

Field evaluation. Experiment was laid with variety Savitri with 8 treatments comprised of three insecticides such as monocrotophos, chlorpyriphos and carbofuran combined with 2 adjuvants at Central Rice Research Institute, Cuttack during the years 2002 and 2004. Thirty day old seedlings were transplanted in a randomized block design for 9 treatments including untreated control. Each treatment was replicated 4 times , each replication being a micro plot of 25 m^2 area. All the recommended agronomic practices were followed to grow a healthy crop. Brown plant hopper made its appearance from last week of August and remained active till 4th week of September. Yellow stem borer infested the crop from 2nd week of September and prevailed upto November. During 2004, gundhi bug infested the crop at milk stage. Depending on the pest occurrence, treatments were made at 60 and 70 days after transplanting (DAT) for BPH, at PI stage for YSB and at milk stage against gundhi bug. Observations were taken on BPH population after 48hrs of each treatment. Dead hearts (DH) and white earheads (WEH) were recorded at 50 DAT and after flowering stage of the crop respectively. Gundhi bug population was also recorded by sweepnet after 2 days of the treatment. Grain yield data was recorded after harvest. Data thus obtained was subjected to statistical analysis and relative efficacy of the treatments was worked out.

RESULTS AND DISCUSSION

Perusal of the Table 1 showed that under green house evaluation, insecticide treatments alone were effective upto 3 days showing insect mortality above 50 per cent except phosphamidon and phorate which were effective only for 24 hrs. But all the insecticides were more effective when aided with adjuvants. Among the adjuvants used, neem oil showed best performance in terms of longer persistency and increased knock-down effect against BPH. The efficacy was 1.56, 1.7 and 2.45 times more in neem oil combination of monocrotophos, chlorpyriphos and phosphamidon treatments respectively in comparison to only insecticide treatments. Combination of APSA-80 also increased the efficiency to 1.12, 1.06 and 1.82 times more with monocrotophos, chlorpyriphos and phosphamidon respectively. But as the efficacy of phosphamidon itself was low, increase in efficacy due to adjuvants, particularly APSA-80, was not encouraging. The same low efficacy was also observed with both the granular insecticides @ 1kg a.i. ha^{-1}. The efficacy was increased to 1.72 and 2.72 times more in half the dose of carbofuran and phorate respectively when combined with neem seed powder. However, carbofuran was more effective than phorate treatment.

In field condition, the average number of BPH $hill^{-1}$ ranged from 7 to 43 after first application during 2002 and from 16 to 36 during 2004 in different treatments against 80 and 68 respectively in untreated control. The population in different treatments came down to a range of 5 to 20 against 102 in untreated control after the second application. Among the treatments, neem oil combination was found to be best in reducing the population of BPH to a minimum. Combination of APSA-80 was more or less on par in activity with only insecticide treatments. This was also encouraging because the adjuvant made the insecticide effective at half the dose (0.25 kg a.i. ha^{-1}) of only insecticide treatment (0.5 kg a.i.ha^{-1}). Neem seed combination with carbofuran reduced the pest population significantly than only carbofuran treatment. First and second instar nymphs were found dead and floating on water surface after second application of the treatments whereas the population in untreated control comprised mainly of alive nymphs. This showed that application of insectides + adjuvants twice at 10 days intervals could kill the newly hatched nymphs as a result there was a drastic reduction of the pest population (Table 2).

During 2002, initial incidence of yellow stem borer in the form of dead heart formation, was significantly low in neem oil and neem seed powder combinations than APSA-80 and only insecticide treatments. Combination of APSA-80 showed efficacy on par with only insecticide treatments. But during 2004, significant difference in dead heart formation was not observed among the treatments. This might be due to low pest population at the initial stage as the dead heart formation ranged from 2.63 to 9.74 per cent including

Table.1. Effect of adjuvents on persistent toxicity of insecticides against BPH.

Treatments	%mortality after different DAT				PT index	RT
	1	3	5	7		
Monocrotophos	100	67	23	12	353.50	1
Monocrotophos+NO	100	90	80	45	551.25	1.56
Monocrotophos+APSA	100	73	40	13	395.50	1.12
Chlorpyriphos	94	57	20	3	304.50	1
Chlorpyriphos+NO	100	97	63	35	516.25	1.7
Chlorpyriphos+APSA	100	60	18	7	323.75	1.06
Phosphamidon	90	43	13	0	182.50	1
Phosphamidon+NO	100	80	52	23	446.25	2.45
Phosphamidon+APSA	93	60	27	10	332.50	1.82
Carbofuran	76	53	16	5	262.50	1
Carbofuran+NS	85	80	60	33	451.50	1.72
Phorate	55	20	7	0	102.50	1
Phorate+NS	66	60	25	8	278.25	2.72

DAT= Days after treatment, PT= persistent toxicity, NO=Neem oil , APSA=APSA-80, NS= Neem seed powder, RT=Relative toxicity

Table 2. Effect of adjuvents on BPH population in field condition.

Treatments	No. of BPH hill^{-1}			
	2002		2004	
	60 DAT	80 DAT	60 DAT	80 DAT
Monocrotophos	32(3.45)	12(2.53)	24(3.20)	13(2.59)
Monocrotophos + NO	7(2.03)	2(0.80)	16(2.80)	8(2.21)
Monocrotophos + AP	23(3.18)	11(2.45)	21(3.08)	12(2.54)
chlorpyriphos	43(3.77)	17(2.88)	36(3.61)	14(2.65)
chlorpyriphos + NO	21(3.08)	10(2.37)	16(2.79)	7(2.09)
chlorpyriphos + AP	31(3.44)	17(2.85)	21(3.06)	13(2.41)
Carbofuran	42(3.75)	22(3.13)	36(3.61)	15(2.76)
Carbofuran + NS	30(3.37)	19(3.00)	23(3.14)	20(3.03)
Untreated control	80(4.39)	112((4.72)	68(4.22)	91(4.52)
CD (P=0.05)	0.28	0.40	0.28	0.29

DAT : days after transplanting; *Average of 50 hills; ** Figures in parenthesis are transformed log values

untreated control. But significant reduction in white earhead formation at a later stage of crop growth was observed with neem combinations during both the years followed by APSA-80 which was next in the order of effectiveness (Table 3).

Gundhi bug infested the crop at it's milk stage during 2004, and therefore the treatments were repeated again. Significant reduction of gundhi bug population was observed after second day of application in all the foliar spray treatments than untreated control. Neem oil combination was more effective in reducing the pest population closely followed by APSA-80. Granular application of carbofuran, both alone and with neem seed powder, did not show promising effect against gundhi bug. Grain yield was comparatively more in neem oil combination than in other treatments. Insecticides + APSA-80 treatments were next in the order of efficacy with grain yield equivalent to only insecticide treatment. However, neem seed powder + carbofuran gave equivalent yield to only carbofuran treatment inspite of it's efficacy against YSB. This may be due to high gundhi bug incidence at flowering stage of the crop (Table 3).

From the above observations it is evident that

Table 3. Effect of adjuvents on YSB and gundhi bug in field condition

Treatments	2002			2004			
	%DH	%WEH	Yield (t ha^{-1})	%DH	GB/Sweepnet	%WEH	Yield(t ha^{-1})
Monocrotophos	10.5 (18.9)*	11.8 (20.1)	4.4	2.5(8.5)	2(1.1)**	8.8(17.1)	5.6
Monocrotophos+NO	5.8 (13.8)	7.0(15.3)	4.8	5.2(12.7)	1(0.5)	3.6(10.6)	6.2
Monocrotophos+AP	11.3 (19.6)	11.2 (19.5)	4.6	3.0(9.9)	6(1.9)	6.01(14.2)	6.0
chlorpyriphos	10.9 (19.2)	12.9 (21.0)	4.5	5.1(12.6)	10(2.4)	9.8(18.3)	5.3
chlorpyriphos+NO	7.6 (15.9)	6.9 (15.2)	4.6	4.2(11.9)	3(1.4)	2.7(9.4)	6.0
chlorpyriphos+AP	10.0 (18.4)	11.8 (20.1)	4.5	2.6(9.2)	5(1.8)	6.6(14.7)	5.3
Carbofuran	12.4 (20.6)	12.4 (20.6)	5.3	3.6(10.8)	17(2.9)	2.4(8.8)	5.5
Carbofuran+NSP	6.6 (14.9)	5.7 (13.7)	5.5	3.7(11.0)	16(2.8)	2.8(9.1)	5.1
Untreated control	20.4 (26.3)	19.1 (77.6)	3.3	9.7(18.2)	23(3.2)	12.5(20.7)	4.3
CD (P=0.05)	2.5	3.1	0.8	4.8	0.5	4.0	0.5

*Figures in parenthesis are transformed arcsin values
** Figures in parenthesis are transformed log values
· DH = dead heart, WEH = White ear head, GB= gundhi bug
· NO = neem oil, AP = APSA-80 , NSP = neem seed powder

all the three adjuvants are capable of increasing the efficacy of insecticides against important insect pests such as brown plant hopper, yellow stem borer and gundhi bug in rice but neem oil can perform better than APSA-80 and neem seed powder. Furthermore, their combination can reduce the dose of insecticides to half thereby reducing the cost as well as pesticide load to the environment. So, these products can be effectively utilized in the integrated pest management (IPM) system of rice.

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