The Efficacy of a Phytopesticide in Comparison with Perfekthion Against Sucking Pests of Cotton

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Abstract: The efficacy of neem product (phytopesticide FWB) was compared with perfekthion against sucking pests of cotton (jassids, thrips and whiteflies). Perfekthion proved to be more toxic but its effect lasted for 4 days only while neem product (FWB) was less toxic but its effect lasted for 6 days. Moreover, neem product is much safer and non-polluting.

Key Words: Phytopesticide, toxicity, binary regression models, relative potency, cotton pests

Bitkisel Bir Böcek Zehirinin Pamuğa Zarar Veren Emici Böceklere Karşı Etkisinin Perfekthionun Etkisiyle Karşılaştırılması

Özet: Neem ürününün (bitkisel böcek zehiri, FWB) pamuğa zarar veren emici üç böcek türüne karşı etkisi, perfekthionun etkisiyle karşılaştırılmıştır. Perfekthionun toksisitesinin daha yüksek olduğu ancak etkisinin sadece 4 gün sürdüğü bulunurken, neem ürününün toksisitesinin daha düşük olduğu ancak etkisinin 6 gün sürdüğü bulunmuştur. Üstelik neem ürünü çok daha az zararlı ve daha az kirleticidir.

Anahtar Sözcükler: Bitkisel böcek zehiri, toksisite, ikili regresyon modelleri, göreli kuvvet, pamuğa zarar veren böcekler

Introduction

Cotton is one of the major foreign exchange earning crops of Pakistan. However, due to pest and viral attacks, the yield has decreased during the last 3 years. In spite of spraying (5-7 or more) with conventional pesticides the situation has not improved. Although among sucking pests, the population of jassids and thrips is reduced by conventional pesticide spraying, but whitefly and leaf curl virus (LCV) infestations actually increase. Thus cotton yield has been reduced, resulting in monetary loss. There is a possibility that the whitefly develops resistance to conventional pesticides, and the injury to leaves by sucking pests may invite LCV attack.

In view of this, it was decided that phytopesticide be tested against sucking pests, because in the case of brinijal crops, Naqvi et al. (1) reported that neem pesticide controlled the white fly population better than malathion after 72 hours. Moreover, in the housefly, resistance to neem pesticide did not develop for up to 50 generations under selection pressure, whereas resistance to permethrin developed after 10 generations (2). For this reason we conducted greenhouse experiments which were followed by field experiments in Mirpuurkhas on the cotton variety MNH-93.

The data was noted, and probit dose-response models (3) (4) and (5) were fitted for the mortality concentrations of the two compounds, to estimate LC_{50}. The relative efficiency of the pesticides was studied in different populations of pests. The relative long-lasting effective time of two compounds was also compared by fitting parallel probit regression models.

Materials and Methods

Greenhouse experiments

FWB (neem extract) is the ethanolic extract of fresh whole berries. FWB was fractionated, and the active fraction was used for the determination of the LC_{50} of the neem sample (FWB) and perfekthion. Infested potted plants were kept in a greenhouse for experiments.

Preliminary experiments were done to determine the range of toxicity of the two compounds. Pretreatment readings were taken from each plant, selecting randomly 3 leaves from the top, 3 leaves from the middle and 3 leaves from the bottom, for the counting of jassids, thrips and whiteflies. After pretreatment seven concentrations of FWB (neem pesticide) namely, 2.0%, 2.5%, 3.0%, 3.5%, 4.0%, 4.5% and 5.0%, and five concentrations of perfekthion, namely, 0.01%, 0.02%, 0.03%, 0.04% and 0.05%, were sprayed on 3 plants each. A distance of at least 2 meters was maintained between each treatment. Posttreatment readings were taken after 24 hours and onwards.

The data was noted, and probit dose-response models (3) (4) and (5) were fitted for the mortality concentrations of the two compounds to estimate LC_{50}. The relative efficiency of the pesticides was studied among the different populations of pests. The relative long-lasting effective time (residual effect) of two compounds was also compared by fitting the parallel probit regression models (6).

Field experiments

In the field experiments, random design was used for spraying the cotton plots. Each plot consisted of a row 100 x 3 feet. T_1, T_2, and T_3 were treatment plots. Between each treatment a row was left as a buffer row (untreated). The control plot T_4 was also in the same field but after 3 rows. The same design was used for both pesticides (FWB and Perfekthion). Pretreatment readings were taken and further observations were made daily, at 24 hrs, 48 hrs, 72 hrs, 96 hrs, 120 hrs, 144 hrs and 168 hrs, to determine the effects of the two samples. The concentrations used in the field trial were 5% for neem sample (FWB) and 0.05% for perfektion.

Results and Discussion

In the greenhouse experiments, different concentrations of the two pesticides were used. Percent mortality was noted after 24 h and the data is given in Table 1 for the population of jassids, thrips and aphids after treatment with FWB.

To estimate the LC_{50} and relative effectiveness of FWB in controlling the population of three pests–jassids, thrips and aphids– three probit regression models with common slope were fitted. The hypothesis of parallelism is not significant at P value=0.0001. The probit regression model was also fitted on the average mortality for all three pests to estimate the overall LC_{50} of neem (FWB).

The sequence of effectiveness for the neem product (FWB) is thrips, jassids and aphids, respectively. The three parallel probit regression models fitted are shown graphically in Figure 1. The LC_{50} value for the three population of pests is given in Table 2. The average LC_{50} of neem product (FWB) for all three populations of pests is 2.3598%.

	CONCENTRATIONS (%)						
PESTS	2.0	2.5	3.0	3.5	4.0	4.5	5.0
JASSIDS	47.2	54.5	60.24	61.02	69.09	80.09	89.1
THRIPS	46.1	56.0	61.11	64.56	71.52	80.92	92.0
APHIDS	44.2	53.0	59.08	63.77	70.71	79.49	85.50
OVERALL	45.83	54.5	60.14	63.11	70.44	80.45	88.86

Table 1. Percent mortality of cotton pests after the application of neem sample FWB (Conc. 2.0-5.0%) after 24 h (Average of 5 replicates).

PESTS	PROBIT MODELS	LC_{50}
JASSIDS	$Y_i = \Phi^{-1}(p_i) = -0.9408 + -0.3963\ X_i$	2.373959
THRIPS	$Y_i = \Phi^{-1}(p_i) = -0.8966 + -0.3963\ X_I$	2.262427
APHIDS	$Y_i = \Phi^{-1}(p_i) = -0.9683 + -0.3963\ X_I$	2.44335
OVERALL	$Y_i = \Phi^{-1}(p_i) = -0.9345 + -0.3963\ X_I$	2.3595

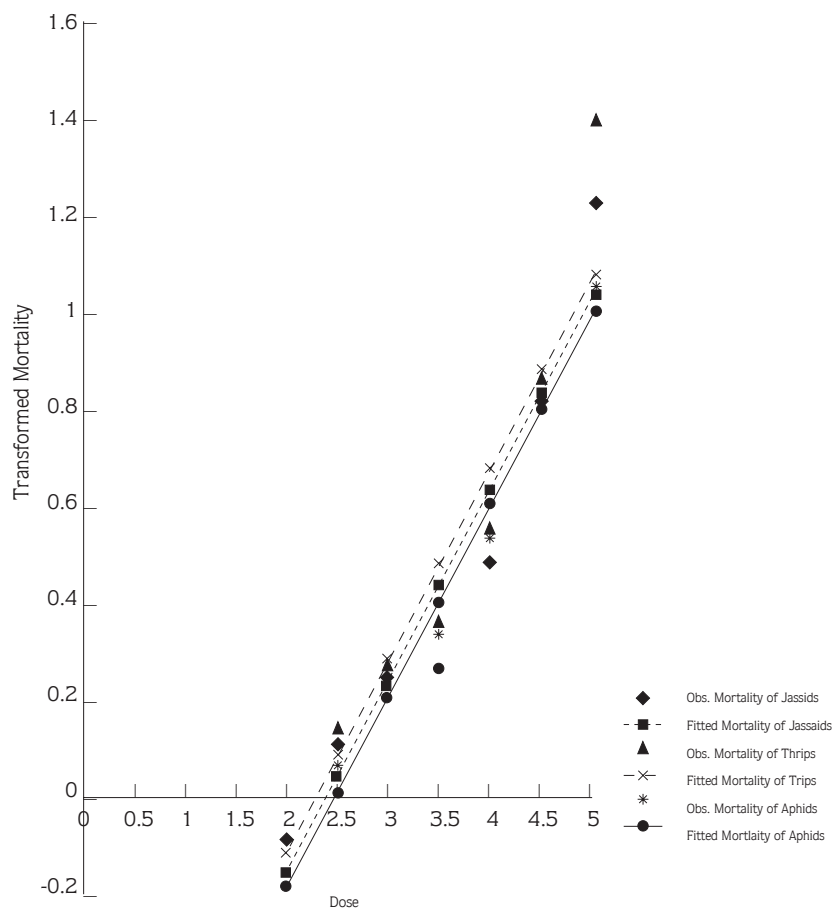Table 2. Fitted Probit regression models for Jassids, Thrips, Aphids & Overall.

Figure 1. Parallel Binary regression lines of Toxicity of Neem (FWB) against Jassids, Thrips & Aphids.

In the case of perfekthion, five concentrations were taken and the data is given in Table 3.

To estimate the LC_{50} and relative effectiveness of FWB in controlling the population of the three pests–jassids, thrips and aphids–we fitted the following three probit regression models with common slope. The hypothesis of parallelism is not significant at P value = 0.0001.

The three parallel fitted probit regresison models describe the relationship between the mortality of pest populations and the concentration of perfekhion, to estimate the median lethal dose (Table 4). The sequence of effectiveness for perfekthion is aphids, thrips and jassids, respectively. The LC_{50} values for all 3 populations of pests are given in Table 2 (a). The overall LC_{50} for perfekthion is 0.021%. The 3 parallel probit regression models fitted are shown graphically in Figure 2.

From the analysis given in Table 2 and Table 4, we conclude that the perfekthion is more toxic and neem product (FWB) is less toxic for aphids. We also find that FWB has higher LC_{50} (2.36%) as compared to

	CONCENTRATIONS (%)				
PESTS	0.01	0.02	0.03	0.04	0.05
JASSIDS	35	43	56	71	96
THRIPS	40	45	60	72	90
APHIDS	43	49	64	75	96
OVERALL	39.33	45.66	60.0	72.66	94.0

Table 3. Percent mortality of cotton pests after the application of perfekthion sample (Conc. 0.01-0.05) after 24 h.
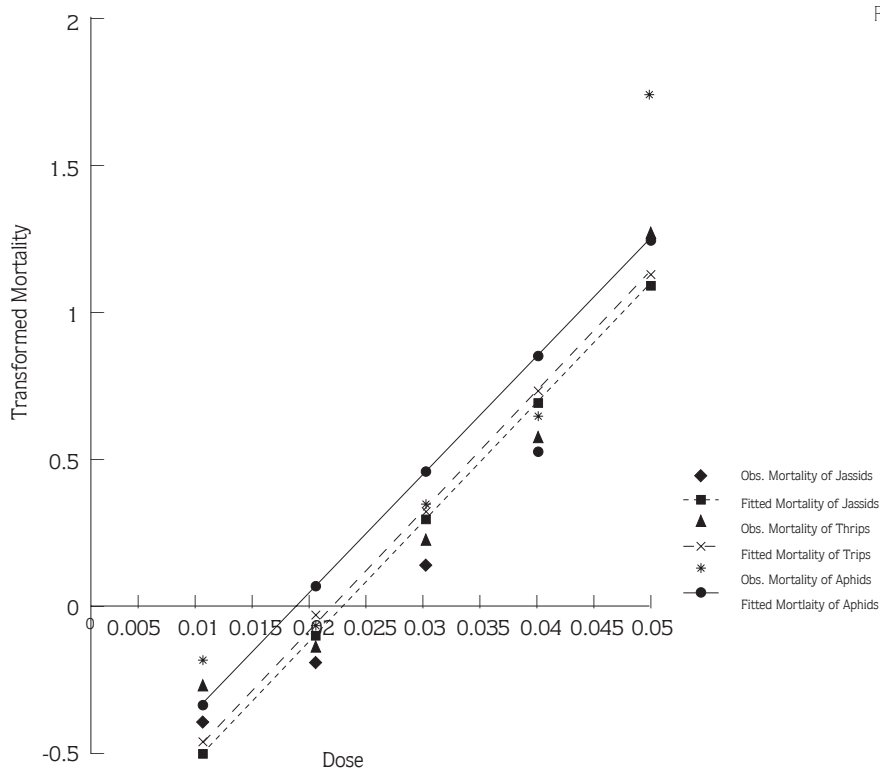
Figure 2. Parallel Binary regression lines of Toxicity of Prefekthion against the Jassids Thrips & Aphids.

perfekthion (0.021%). This means that perfekthion is more toxic than FWB. However, FWB is possiblly less hazardous to the non-target animals and safer for the environment.

Field Experiments

In the field experiments, the dose used for FWB was 5% and that for perfekthion was 0.05%. The posttreatment readings were taken up to 7 days. The data are given in Table 5. Experiments were done in triplicate and the average readings are given in Table 5.

The data of Table 5 were analyzed by fitting the parallel probit regression models with common slope for the average percentage mortality due to the highest concentrations (5% and 0.05%) of neem (FWB) and perfekthion, respectively. This analysis provides Information on the relative long-lasting time of effectiveness (residual effect) of insecticides. The fitted models and the ET_{90} (relative effective time or long lasting effective time for which the insecticide maintains/retains 90% mortality) of two pesticides are shown in Table 6.

From the fitted parallel probit regression given in Table 6, the effective times for neem (FWB) and perfekthion are 6 and 4 days, respectively. The fitted parallel probit regression lines are shown in Figure 3.

The statistical analysis in Table 6 indicates that in the case of FWB mortality remained high for up to seven days, due to either repellence or the phagodeterrence effect of neem products, which has been reported earlier (6-11). The residual effect (ET_{90}) of neem (FWB) is 1.5 times greater than that of perfekthion. Neem (FWB) controls sucking pets successfully, 1.5 times longer than perfekthion. Although phytopesticides have been tested and proved effective against a number of pests (12-14), very few attempts have been made against cotton pests. (15). Nurulain et al. (16) reported that neem extract controlled the dusky cotton bug better than malathion after 72 hours. Similarly, Lindquist et al. (17) reported that Margosan-O (neem product) controlled biofenthrin-resistant and -susceptible whiteflies at a dose of 20ml/L (67%) and 50ml/L (86%), respectively. Price and Schuster (18) also reported that *Bemesia tabaci* on sweet

PESTS	PROBIT MODELS	LC_{50}
JASSIDS	$Y_i = \Phi^{-1}(p_i) = -0.8911 + 39.98\, X_i$	0.02288
THRIPS	$Y_i = \Phi^{-1}(p_i) = -0.8607 + 39.88\, X_I$	0.021528
APHIDS	$Y_i = \Phi^{-1}(p_i) = -0.7342 + 39.98\, X_I$	0.018364
OVERALL	$Y_i = \Phi^{-1}(p_i) = -0.8270 + 39.89\, X_I$	0.02073

Table 4. Fitted Probit regression models for jassids, thrips, aphids, & overall.

	MORTALITY REMAINS AFTER DAYS						
PESTICIDES	1	2	3	4	5	6	7
FWB	98.92	97.33	97.14	95.0	93.0	90.06	90.0
PERFEKTHION	97.56	96.14	95.0	88.65	83.0	79.33	75.0

Table 5. Percent average mortality of three cotton pests (jassids, aphids & thrips) after the application of two pesticides, neem product (FWB) and perfekthion, after 1-7 days.

PESTICIDES	PROBIT MODELS	EFFECTIVE TIME (DAYS)
NEEM (FWB)	$Y_i = \Phi^{-1}(p_i) = 2.513 - 0.1999\, X_i$	6.16=6
PERFEKTHION	$Y_i = \Phi^{-1}(p_i) = 2.062 - 0.1999\, X_I$	3.90=4

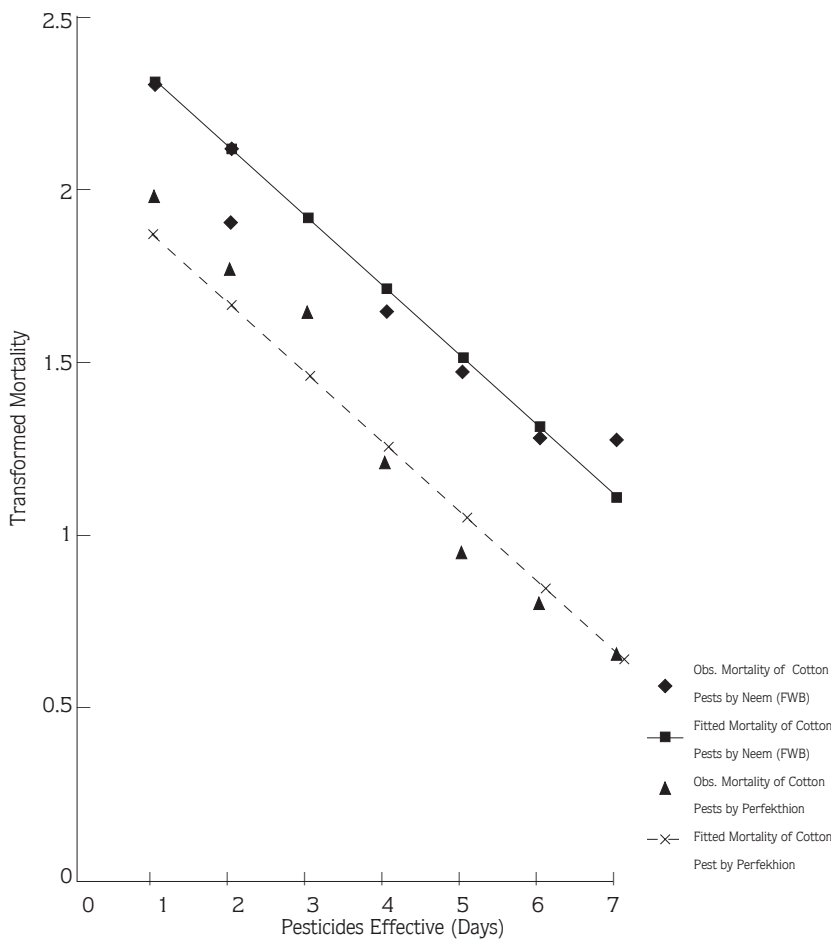Table 6. Fitted probit regression models of neem and perfekthion.

Figure 3. Parallel Binary regression Lines to Compare Toxicity of Neem (FWB) and Perfekthion.

potato crops was controlled by 3 sprayings of neem seed extract at a dose of 20 ppm.

The present findings and those reported in the literature indicate that phythopesticide (neem product) can control sucking pests successfully for a longer time, while they are less toxic and safer for the environment. Moreover, Verma (19) has reported that neem extract inhibits potato virus growth successfully. Thus it may be concluded that FWB may successfully control the infestation of sucking pests (jassids, thrips and aphids) on cotton crops and possibly the secondary infestation of LCV as well. The non-development of resistance against neem products is another merit for the safer use of these products against the infestation of various pests. These products control the pests by physiological disturbance, phagodeterrance and repellence rather than toxicity.

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