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Cotton Seed Treatment in Lao PDR

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ABSTRACT

In 1992 and 1993 insecticide, trials were carried out in two locations in Lao PDR to compare the effectiveness of four insecticides (imidachloprid, benfuracarb, carbosulfan, furathiocarb) applied in seed treatment before sowing , and three modes of application of imidachloprid (powder, coating, pelting) in the control of early cotton pests. The results showed that such seed treatment could accelerate the plant emergence and reduced the rate of damping-off.

All the insecticides showed an effect against cotton aphid, leafhopper, whitefly, scale insect and grasshopper when compared to an untreated check, but variations in the level of efficiency were registered according to the active ingredients and the pests. Overall, imidachloprid was the most effective, with the longer residual effect.

Key words: cotton, seed treatment, pest, Integrated Pest Management, Lao

INTRODUCTION

In Lao PDR, at the beginning of growing season, cotton seedlings and young plants are attacked by several insect pests. The most important species are the leafhopper *Amrasca biguttula* Ishida (Homoptera, Cicadellidae) and the aphid *Aphis gossypii* Glover (Homoptera, Aphididae) which can affect the production (Castella *et al*., 1993). Several other species are also observed feeding on the plants during the vegetative phase of development, but in most cases the incidences remain low and they are not of economic importance. Among them the most common are the scale insect *Ferrisia virgata* Cockerell (Homoptera, Pseudococidae), the whitefly *Bemisia tabaci* (Gennadius) (Homoptera, Aleyrodidae), several unidentified species of thrips (Thysanoptera), and locusts and grasshoppers (Orthoptera).

A. biguttula is considered as the main cotton pest recorded from Southeast Asia (Matthews, 1994). Nymphs and adults injure cotton leaves through injection of toxic saliva while feeding inside veins. The first symptom is a yellowish turning to reddish coloration of the margin of leaves followed by dryness. Depending on the plant stage, the infestation level, and the duration of infestation, leafhopper attacks can reduce plant growth, cause the abortion of the first fruiting branch and increase shedding of squares and young bolls by affecting the photosynthesis. In case of early attacks the vegetative development remains limited and the plant becomes bush-like due to shortening of the internodes. Due to limitations of favourable cultural practices, disadvantages of chemical sprays, and lack of suitable biological control agents, breeding resistant cultivars could be the most practical and cheapest way to control leafhoppers, and therefore pubescence is a major source of resistance (Parnell *et al*., 1949; Renou *et al*., 1998). Nevertheless, during almost two weeks after germination, before appearance of hairiness, cotton plants are susceptible

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to leafhopper attacks and can be seriously affected by this insect (Renou *et al*., 1998).

A. gossypii is a sap-sucking pest widely distributed in the world. This is a very polyphagous insect which has been recorded from almost 900 host plants. On cotton, it develops on the lower surface of the leaves constituting colonies. It is responsible of two kinds of damage. On the one hand, the penetration of the stylets in the vegetal induces characteristic deformation of the leaves which become crumpled and curl down. On the other hand, it excretes droplets of honeydew deposited on open bolls when infestation occurs at the end of the season. The sugary exudate soils the fibre, producing sticky cotton, and is an organic substrate used by fungus to grow. Moreover *A. gossypii* is a vector of a virus disease, called cotton blue disease or leaf roll, presented in Lao PDR (Cauquil and Vaissayre, 1971).

Attacks of these pests at the beginning of the growing season often make it necessary to control the population in order to avoid an outbreak. Therefore, in most cases the farmers make one or two insecticide sprayings with knapsack sprayer equipped with a single lance. The active ingredient commonly used is dimethoate implemented at the rate of almost 300 g ai/ha. Besides the fact that this broad spectrum insecticide is noxious for the user, it is not environmently friendly and , among other undesirable effects, it eliminates some predators of the pests (Wilson *et al.*, 1998). One solution to avoid such a consequence, consists of treating the seeds with a systemic insecticide before planting (Graham, 1998).

The objective of this research work was to evaluate the efficacy of insecticides used for seed treatment in the control of early cotton pests in Lao PDR, and to compare methods used to treat the seed.

MATERIALS AND METHODS

The trials to study insecticide efficiency were performed in 1992 during the wet season at Napok Research Center (sowing date July 27) and in a farmer's field at Ban Hai (sowing date July 20). The comparison of modalities of treatment was carried out in 1993 during the dry season at Napok Center (sowing date December 2). These two localities are located in the vicinity of Vientiane Municipality (102.6°E – 18.0°N), at an altitude of 170 m above sea level, with an annual rainfall of 1400 to 1900 mm.

To evaluate insecticides efficiency, the seeds were slightly humidified, and then treated with powder insecticides in plastic bags. In 1993, this mode of seed treatment was compared to two other ones called caoting and pelting. The former consisted of covering the seeds with a thin layer of clay, and then spraying them with the insecticide diluted in water. The later consisted of mixing the slightly humidified seeds with insecticide and then covering each of them with a thin layer of clay.

Randomized Complete Block Design with 4 replications at Ban Hai in 1992 and Napok in 1993 and 6 replications at Napok in 1992 was employed. The elementary plot dimension was 54 m^2 (3 rows with 18 m long) in 1992 and 60 m^2 (3 rows with 20 m long) in 1993. Planting materials used were varieties of *Gossypium hirsutum* L.: P 288 and KK I at Napok in 1992 and 1993, respectively, and S 295 at Ban Hai in 1992. The modalities of studies in different trials are shown in Table 1. The counting of plant emergence and insects started 6 days after sowing. Registered data are given in Table 2. After recording data on MULTIPLAN software, all variables have been analysed using STATITCF software. Sometimes it was necessary to transform certain variables to improve further parameters of analysis: indices of normality, absence of residues and equality of deviation of residues. In this case, means mentioned in the table were taken into account of transformation.

It was noted that two contrasts were employed for the trials from Napok and Ban Hai in 1992, to complete the interpretations: contrast 1

Table 1 Modalities of the different trials carried out at Napok Station and Ban Hai in 1992 and 1993.

Active Ingredients	Types of treatment	Doses	Napok 1992	Ban Hai 1992	Napok 1993
No treatment	-	-	X	X	-
Benfuracarb	powder	0.80 %	X	X	-
Carbosulfan	powder	0.80 %	X	X	-
Furathiocarb	powder	0.80 %	X	X	-
Imidachloprid	powder	0.35 %	X	X	X
Imidachloprid	coating	0.35 %	-	-	X
Imidachloprid	pelting	0.35 %	-	-	X

Table 2 Data recorded according to the localities and the types of observation.

Observations	Napok 1992	Ban Hai 1992	Napok 1993
Emergence	X	X	X
Jassids	X	X	X
Aphids	X	X	X
Scale insects	X	-	-
Grasshoppers	X	-	-
Whitefly	X	-	-
Thrips	X	-	-
Damping-off	-	X	-
Production of squares	X	X	-
Production of flowers	X	X	-
Production of bolls	-	-	X
Height	X	X	-
Yield	-	X	X

opposed the check one (no treatment) to different seed treatments and contrast 2 was to compare the effect of imidachloprid to carbamates (Table 3). This method permitted one to compare one treatment (or several) with several other ones taken together. A contrast is defined as a linear combination between the p averages compared: $C = \Sigma\, \alpha i\ \bar{x} i$ where α is a coefficient and varies from 1 to p with $\Sigma \alpha i = 0$. The coefficients used are mentioned in Table 3. The level of significance was obtained by comparing the ratio of the sum of the squares of the standard deviations of the contrasts and the residual standard deviation using an F-test (Gouet, 1974).

Table 3 Coefficients used to test the contrasts.

Objects	Contrast 1	Contrast 2
No treatment	+4	0
Imidachloprid	-1	+3
Carbosulfan	-1	-1
Benfuracarb	-1	-1
Furathiocarb	-1	-1

RESULTS AND DICUSSION

1) Comparison of active ingredients

1-a) Emergence

No significant difference were revealed, either at Ban Hai or at Napok, concerning emergence (Tables 4, 5). In both localities, plant densities were normal and no insecticide phytotoxicity was detected. Nevertheless, at Ban Hai, the rate of 50 % of emergence was reached 8.1 days after sowing

Table 4 Percentages of emergence at different dates after sowing and dates of 50 % emergence at Ban Hai in 1992. (DAS = days after sowing).

Objects	Emergence of plant (%)			Date 50 % emergence
	6 DAS	9 DAS	12 DAS	(DAS)
No treatment	40.7	41.5	61.4	9.5
Benfuracarb	41.0	41.2	56.5	9.2
Carbosulfan	40.4	41.5	56.5	8.6
Furathiocarb	40.7	42.9	55.2	9.2
Imidachloprid	42.9	46.1	61.7	8.1
F-test (treatment)	0.23	1.25	1.25	0.72
Sign. Prob.	ns	ns	ns	ns
CV (%)	9.9	8.5	9.4	19.0
Transformation	-	-	arcsin r. (x)	-
Contrast 1 Sign. Pro.	ns	ns	ns	ns
Contrast 2 Sign. Pro.	ns	0.1	0.1	ns

Table 5 Percentages of emergence at different dates after sowing and dates of 50 % emergence at Napok in 1992. (DAS = days after sowing).

Objects	Emergence of plant (%)				
	6 DAS	9 DAS	12 DAS	15 DAS	45 DAS
No treatment	75.5	79.3	79.8	77.9	80.3
Benfuracarb	73.7	78.2	78.3	78.4	82.3
Carbosulfan	79.6	80.1	80.9	80.9	80.0
Furathiocarb	76.3	77.8	77.8	80.4	79.8
Imidachloprid	79.7	81.7	82.3	82.3	80.8
F-test (treatment)	1.12	0.53	0.74	0.92	0.90
Sign. Prob.	ns	ns	ns	ns	ns
CV (%)	7.9	6.7	6.5	5.8	3.1
Transformation	-	-	arcsin r.(x)	-	-
Contrast 1 Sign. Pro.	ns	ns	ns	ns	ns
Contrast 2 Sign. Pro.	ns	ns	ns	ns	ns

with imidachloprid while this percentage was obtained in average after 9 days with the other products, and after 9.5 days in untreated plots. Even if no significant difference have been pointed out, this result could originate, at least in part, from the effect of insecticide. Goddard and Leser (1997) mentioned that the presence of systemic insecticides tended to increase final stands over the untreated check, and Stringer and Mitchell (1997) concluded that with imidachloprid treated seed, seedling stand densities were slightly higher than those with furadan/disulfoton treated seed. Thus, an action of active ingredient on the emergence of plant and vigour of seedling could be envisaged.

1-b) Plant growth

Great difference was noted according to locality. The better growth was registered at Ban Hai where the plants reached 70 to 80 cm high 60 days after sowing. At Napok after the same period of time, in spite of the speeding-up of growth from 45 days after sowing, the plants were not taller than 25 cm (Figures 1, 2). This variation of one place to the other, was mostly the consequences of the influence of environmental conditions, like rainfall and soil fertility, or the plant physiology out was not due to pests incidence. However the data the recorded at Ban Hai, showed that with imidachloprid there was a plant tendency to be higher than when treated

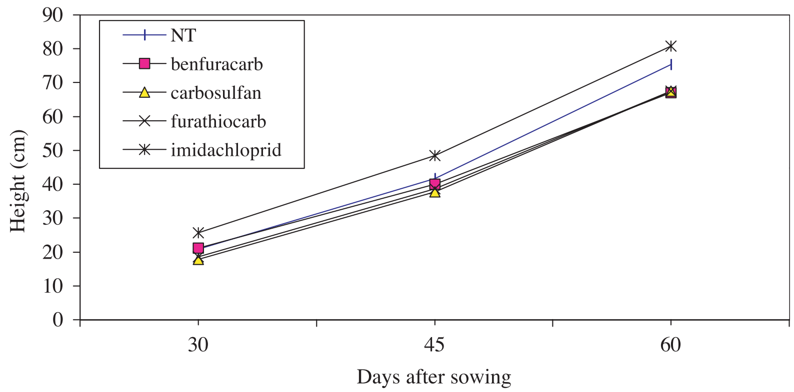

Figure 1 Growth of the plants at Ban Hai (1992).

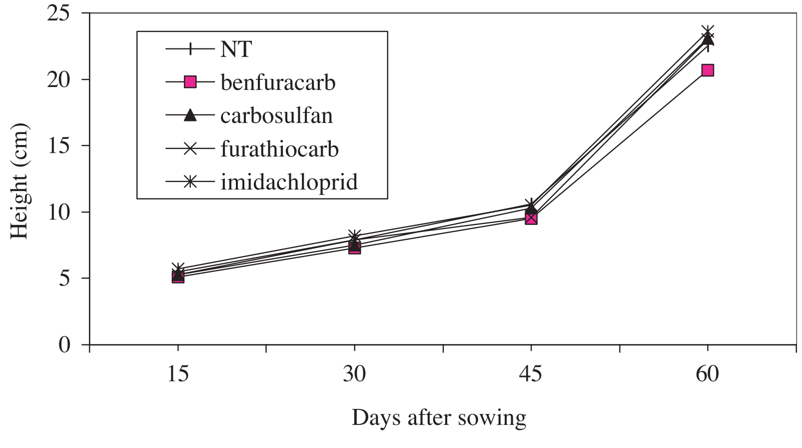

Figure 2 Growth of the plants at Napok (1992).

with other products as well as when untreated. This result could be connected to the previous observation concerning the rate of emergence and the plant vigor. Moreover, Van Duyn *et al*. (1998) reported that seedlings emerging from seeds treated with imidachloprid and aldicarb were significantly larger than those from the untreated plants. Stringer and Mitchell (1997) also mentioned that carbamate insecticides could result in a physiological effect manifested by more rapid plant development.

1-c) Effect on damping-off

Cotton seed and plant can be infested with various disease organisms, fungus and bacteria, which may cause it to decay in the soil, injure and kill seedlings, or have harmful effect on the plants. According to Angladette (1948) in Lao PDR, the most important disease is the cotton wilt caused by *Fusarium oxysporum* f. *vasinfectum* Atk. which can affect the seedlings a few days after emergence. The penetration of the fungus inside the plant can occur through wounds produced in the root during nematode penetration. Although no fungicide were used, a difference was noted in Ban Hai between treated and untreated seeds, 6 days after sowing (contrast 1, Table 6). Even if no significant difference was noted between the active ingredients (contrast 2, Table 6), the reduction of damping-off was particularly marked with furathiocarb and imidachloprid. One explanation could be a nematicide effect of the insecticides. Nevertheless, if such an effect has been reported with aldicarb, it does not occur with furathiocarb and imidachloprid (Burmester *et al.*, 1997).

1-d) Control of pests

Seed treatment allows control of different early pests which attack cotton plants at the beginning of the crop season. Nevertheless, the results demonstrated that the level of efficiency depended on the active ingredient used, and on the insect species (Tables 7, 8). Concerning aphids, the best control was obtained with imidachloprid. The control level with the three carbamates was generally lower, particularly at Ban Hai in 1992, where the untreated check was the most affected by this pest (Table 7). With regard to leafhopper, all the products had an effect on this insect. Nevertheless, the data recorded at Ban Hai in 1992, showed that the residual effect with carbamates was shorter than

Table 6 Incidences of damping-off at Ban Hai in 1992. (DAS = days after sowing).

Objects	Percentages of plants affected by damping-off			
	6 DAS	9 DAS	12 DAS	total
No treatment	6.8 b	1.3	0.0	2.2
Benfuracarb	4.5 ab	1.8	0.5	2.0
Carbosulfan	4.5 ab	1.8	0.3	1.9
Furathiocarb	2.8 a	1.8	0.5	1.8
Imidachloprid	3.0 a	2.0	0.5	1.9
F-test (treatment)	7.1	0.1	0.8	1.4
Sign. Prob.	0.05	ns	ns	ns
CV (%)	27.9	85.9	147.5	13.7
Transformation	-	-	-	log (x+1)
Contrast 1 Sign. Pro.	0.01	ns	ns	0.05
Contrast 2 Sign. Pro.	ns	ns	ns	ns

that with imidachloprid (Table 7). The former gave a satisfactory protection during the period of almost two weeks after planting, whereas the insecticide effect of the later was registered throughout the first month of the crop. Starting from about 45 days after sowing the population of leafhoppers decreased at Ban Hai, and it was not possible to detect longer effect of imidachloprid. But, trials carried out in

Table 7 Infestation by aphid and jassids at Ban Hai in 1992. (DAS = days after sowing).

Objects	% leaves with aphids		No. jassids/1000 leaves			
	15 DAS	30 DAS	15 DAS	30 DAS	45 DAS	60 DAS
No treatment	4.1	22.0 c	6.0 c	9.0 b	0.9	7.5
Benfuracarb	2.9	12.8 b	4.2 b	9.2 b	1.0	10.5
Carbosulfan	10.9	12.9 b	4.0 b	7.9 b	1.6	12.0
Furathiocarb	4.1	14.0 b	4.2 b	8.2 b	2.4	12.0
Imidachloprid	4.1	8.1 a	3.3 a	3.9 a	0.9	4.0
F-test (treatment)	1.9	23.8	81.1	29.9	1.1	2.5
Sign. Prob.	ns	0.01	0.01	0.01	ns	ns
CV (%)	87.0	14.7	6.9	10,9	89.1	47.4
Transformation	arc sin (root (x))		-	log (x+1)	log (x+1)	-
Contrast 1 Sign. Pro.	ns	0.01	0.01	0.01	ns	ns
Contrast 2 Sign. Pro.	ns	0.01	0.01	0.01	ns	0.01

Means followed by the same letter in the column are not significantly different as determined by DMRT at P>0.05.

Table 8 Efficiency of seed treatment against each insect pest / 10 plants at Napok in 1992.

Objects	Number of pests/10 plants					
	Thrips	Jassids	Aphids	Whitefly	Scale insects	Grasshoppers
No treatment	63.5 b	20.7 b	15.3	1.1 b	8.2 b	1.5 b
Benfuracarb	29.3 a	8.5 a	8.5	0.2 a	0.2 a	0.7 ab
Carbosulfan	43.5 ab	7.2 a	7.7	0.1 a	0.0 a	1.0 ab
Furathiocarb	48.2 ab	10.2 a	5.2	0.2 a	0.1 a	0.7 ab
Imidachloprid	31.8 a	6.8 a	4.2	0.0 a	0.6 a	0.0 a
F-test (treatment)	3.9	7.1	1.2	8.6	3.2	4.3
Sign. Prob.	0.05	0.01	ns	0.01	0.05	0.05
CV (%)39.1	49.4	124.0	109.0	157.1	82.8	
Transformation	-	-	-	log (x+1)	log (x+1)	log (x+1)
Contrast 1 Sign. Pro.	ns	0.01	0.1	0.01	0.01	0.01
Contrast 2 Sign. Pro.	ns	ns	ns	ns	ns	0.05

Means followed by the same letter in the column are not significantly different as determined by DMRT at P>0.05.

Thailand, showed that the persistence effect of this insecticide could be longer than 45 days after sowing (Genay, 1994). Attacks of thrips were observed only at Napok in 1992 (Table 8). In this case, two active ingredients, imidachloprid and benfuracab, rank first. Carbosulfan and furathiocarb were less efficient, and were not significantly different from the untreated check. Early appearance of scale insect was observed at Napok in 1992 (Table 8). In this experiment, the difference was noted between the level of infestation which occurred in the treated and the untreated plots, but no difference was pointed out regarding the four insecticides. Finally, in spite of low pest populations, the results acquired at Napok in 1992, showed that the different active ingredients tested had effect against whitefly and grasshoppers. In this case, imidachloprid was the most efficient insecticide in control of the later (Table 8).

1-e) Flowering and yield

No significant difference was found between the treated and untreated plots (Table 9). Only at Ban Hai the results indicated a superiority of imidachloprid in comparison with other insecticides ($P< 0.05$) (contrast 2) regarding yields, but no difference was noted with untreated check. Trials performed in the U.S.A. indicate that, when pest incidence is high enough, seed treatment with imidachloprid and aldicarb can increase the production over the untreated check by 30% and even 60% (Van Duyn *et al.*, 1998). Accordingly, the fact that no difference has been revealed could be the consequence of the small size of the experimental plots (Michel Bruno, pers. comm.) combined or not combined with too low pests injury at the beginning of crop season. To try to determine the profitability of seed treatment, further investigations should be performed. Actually, price of seed treatment per ha with carbamate and with imidachloprid are approrimately 10 and 20 US $ respectively, while seed cotton is sold by farmers at 22 cents per kg. That means that systemic insecticide must increase the production of at least 45 kg/ha for carbamates and 90 kg/ha for imidachloprid to be profitable.

2) Comparison of modes of application

No difference was noted between the three modes of application of imidachloprid (Table 10). They were equivalent in relation to pest control and yield. A similar study performed in Thailand led to the same conclusion (Genay, 1994). Consequently more sophisticated seed treatment methods like coating and pelting are notneeded; applying insecticide on moistened seeds would be sufficient.

CONCLUSION

In Lao PDR the most important early pests of cotton crop are leafhoppers (*A. biguttula*) and aphids (*A. gossypii*). The remaining species, scale insects, grasshoppers, whitefly (*B. tabaci*) and thrips, have a lower incidence on the crop.

Field studies carried out in 1992 in the vicinity of Vientiane, showed that seed treatment with benfuracarb, carbosulfan, furathiocarb, and imidachloprid employing whatever the mode of application, allowed one to control early cotton pests. As a general rule, the best protection as well as the longer residual effect was obtained with imidachloprid resulting in the most efficient control of leafhoppers, aphids and thrips. Concerning the later, a good control was also obtained with benfuracarb. Even if control level depended on the active ingredient, seed treatment represented a valuable and more environmentally friendly alternative to insecticide sprayings regarding the control of pests. However, no effect of seed treatment on the production was observed, and it should be of great interest to perform the same study throughout several cropping seasons. That should permit one to test insecticide effectiveness under different conditions of pest incidence, and to assess the economic interest of seed treatment to implement an integrated pest management strategy in Lao PDR.

Table 9 Production of flowers and yields at Ban Hai (1992) (DAS = days after sowing).

Objects	Number of squares/plant		Number of flowers/plant		Yield (Kg/ha of seed cotton)
	45 DAS	60 DAS	45 DAS	60 DAS	
No treatment	13.4	11.9	0.1	0.8	2043
Benfuracarb	10.5	10.8	0.0	0.5	1673
Carbosulfan	9.2	9.2	0.2	0.4	1565
Furathiocarb	9.6	9.6	0.0	0.4	1782
Imidachloprid	12.6	12.8	0.2	0.7	2262
F-test (treatment)	0.7	0.7	1.7	1.3	1.8
Sign. Prob.	ns	ns	ns	ns	ns
CV (%)	40.9	33.0	172.3	50.8	20.4
Transformation	-	-	-	-	-
Contrast 1 Sign. Pro.	ns	ns	ns	0.1	ns
Contrast 2 Sign. Pro.	ns	ns	0.1	ns	0.05

Table 10 Comparison of the efficiency of the three modes of application of imidachloprid (Napok, 1992).

Objects	% leaves infested by aphids	% leaves infested by jassids	No. of bolls/plant at harvest	Yield (kg/ha of seed-cotton)
Imida. powder	19.4	28.9	15.1	2020
Imida. coating	19.1	24.7	11.1	1768
Imida pelting	18.1	19.6	11.0	2106
F-test				
not analysed	3.2	2.7	4.6	0.3
Sign. Prob.	ns	ns	ns	ns
C.V. (%)	23.0	15.1	17.9	30.7
Transformation	-	-	-	-

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