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SOME RECENT STUDIES ON RICE PESTS IN GUYANA

B.K. Rai[1/]

INTRODUCTION

Rice is the dominant crop grown on the flat coastal lands and is the second most important economic crop after sugarcane. In the spring and autumn seasons about 30,000 and 80,000 ha. are cultivated, annually. With emphasis on new plant type, heavier fertilization and multiple cropping which lead to greater production per unit area and time; pest incidence is increasing and is bound to increase further, as is happening in other parts of the world (Pradhan, 1969). However, if problems are recognized soon enough, they could be solved by careful research and planning; since pest control technology is in a healthy situation to confront the new demands of changed/improved agriculture. Studies on incidence of pests, more effective and less costly insecticides and quick application of insecticides; have been in progress at the Central Agricultural Station and some of the results obtained are presented in this paper.

A. A TECHNIQUE FOR LOW-VOLUME DRIFT SPRAYING OF PADDIES

The term drift spraying denotes a method of applying insecticidal spray whereby it is released at a height above the crop to be treated and cross winds carry and distribute the spray droplets on to the vegetation, downwind. This method has been successfully used for the control of locusts in Africa (Courshee, 1959). Normally the wind velocity on the coastland of Guyana, ranges between 10 to 15 km./hr. from 8.00 a.m. to 6.00 p.m. (Cleare, 1961). In view of this it was decided to resort to drift spraying of paddies to cut down the time required for spraying of insecticides.

1/ Central Agricultural Station, Mon Repos, Guyana, South America.

The spraying equipment popular in Guyana, is a motorized knapsack or back pack sprayer (70 c.c.). It has four adjustments for getting different flow rates of insecticides. One low-volume attachment, comprising of a drilled metallic plate with a strainer, available commercially, was used to get still lower flow rates of insecticides. This attachment is mounted in the flow line of insecticide.

The drift of insecticidal sprays treated, up to two months old paddies, at least to a distance of 9 metres when the outlet of insecticide was kept along the wind and about $\frac{3}{4}$ - 1 metre above the ground. When wind velocity was high (15 km./hr.), the spray outlet was kept about $\frac{3}{4}$ metre above the ground while when wind velocity was low (10 km./hr.), the spray outlet was kept about one metre above the ground. When wind velocity approached or exceeded 20 km./hr., spraying was not carried out. Rice caterpillar, Spodoptera frugiperda S. & A., dipterous stem maggot, Hydrellia sp. n., nr. spinicornis Cresson, jassids and fulgorids (under identification) generally attack when plants are up to two months old.

The drift of insecticidal sprays treated, more than two month old or flowering crop, at least up to 6m. when the outlet of insecticide was kept along the wind and 15 to 30 cm. above the crop. When wind velocity was high (15 km./hr.), the spray outlet was kept about 15 cm. above the crop while when wind velocity was low (10 km./hr.), the spray outlet was kept, 30 cm. above the crop. When wind velocity was very much higher, spraying was not done. Long horned grass hoppers, Neoconocephalus sp. and Caulopsis cuspidata Scudder attack starts late in season and continues along with paddy bug, Oebalus poecila (Dallas) in the flowering crop.

Drift spraying of a field is started from leeward side and the person spraying moves across the wind. Motor is kept at maximum acceleration. Insecticide is released along the wind. Having reached the other end of the field, person moves windward 6 metres (12 steps) or 9 metres (18 steps) depending upon the stage of crop and again starts moving across the wind and releasing insecticide along the wind (Fig. 1).

Information on control of various pests of paddy by drift spraying is presented in Table 1. By drift spraying, one tankful of insecticidal spray (II litres) can treat from about 0.25 to 3.0 ha. and it takes about 21 to 60 minutes to treat an hectare, depending upon the pest to be controlled. According to the United States Department of Agriculture, less than 5.5 litres of spray per ha. is considered ultra low-volume (Lofgren, 1970).

B. CAUSES OF WHITE HEAD OR PADDY

Erect, empty and white heads of paddy are generally associated with stem borer attack but quite often it was not found to be so. White heads of paddy along with stem, were collected from at least eight places in each of the four rice areas in Guyana. Also, number of white heads per 1.5 m^2 in the randomly selected observation fields was recorded. The stems bearing white heads were split open and the following causes were assigned (Table II):

Table II. Causes of white head of paddy

Causes	Percent white heads due to, in	
	Spring, 1969	Autumn, 1969
Stem borer	36.1	26,8
'Break in stem'	52,5	16,6
External Injury	2,9	12,0
No. of white heads studied	1,560	1,661

B.G. 79 and D110 were the pre-dominant varieties. No obvious cause could be assigned to a certain percentage of white heads.

Stem borers: If the stem had an alive or dead stage of the stem borer, or even an empty borer gallery, the white head was considered to have been caused by stem borer, of which two species i.e., Rupella albinella Cram. and Diatraea saccharalis F. (Pyralidae. Lepidoptera) were known. D. saccharalis was found to be heavily parasitized by Amazon fly, Metagonistylum minense Tns. (Larvaevoridae: Diptera). In the spring and autumn crop of 1969, borers were responsible for about 26% of the white heads observed.

'Break in stem': If the stem with a white head was found to have internal localized shearing of internal tissues, the white head was considered to be due to 'break in stem.' Generally localized rotting and shearing was observed above the 2nd or 3rd internode from the base of the plant. An organism resembling, Zanthomonas oryzae was repeatedly isolated but the reinoculation tests were negative.

In a replicated field experiment, the two treatments were: (i) application of insecticides after every 10 days to control insects and (ii) no application of insecticides. At the time of harvest, the white heads from each plot (plot size was 0.013 ha) were collected and analyzed. The data are presented in Table III. In the treated plots, only 19 white heads were caused by borers against 71 in untreated plots. Break in stem was responsible for 115 white heads in treated plots against 120 white heads in untreated plots. This observation indicates that insects may not be involved in causation of the 'break in stem'.

Table III.

Data on white heads of paddy

Replication	No. of White heads observed	No. of white heads due to		
		Stem border	'Breat in stem'	External injury
		Untreated plots		
I	83	36	30	11
II	84	21	53	9
III	57	14	37	6
Total	224	71	120	26
		Treated plots		
I	62	3	36	16
II	66	1	50	15
III	45	15	29	5
Total	173	19	115	36

In an individual case, 'break in stem' caused 71% white heads, but on an average, it caused 52.5 and 16.6% white heads in spring and autumn crop respectively (Table II).

External Injury: Rats and long-horned grasshoppers were observed to feed on side of the stem which resulted in white head. External injury to stem was not a major cause in spring 1969 but in Autumn, 1969, it was responsible for 12% of white heads since an outbreak of long-horned grasshoppers, *Neoconocephalus* sp. and *Caulopsis cuspidata* Scudder (Tettigonidae: Orthoptera) had occurred.

18.4 and 44.5% of white heads in spring and autumn crops respectively could not be assigned any of the above causes.

The number of white heads varied from almost nil tc 65,000 per hectare. Very large number of white heads were observed in some fields fertilized with nitrogenous fertilizers and the causes were 'break in stem' and stem borers.

C. INCIDENCE OF STEM BORER AND 'BREAK IN STEM' IN NEW VARIETIES

During the spring crop of 1971, new varieties like Star Bonnet and Hybrids bred at Mon Repos, were cultivated by the farmers. In the month of March, 1971, a survey was carried out to assess the incidence of stem borer and 'break in stem' in these varieties vis-a-vis that in B.G. 79, a local variety.

Fifteen plants from each field surveyed, were uprooted; number of tillers counted; stems were split open to find the incidence of stem borer or 'break in stem'. The data obtained are presented in Table IV which indicated that:

(i) Incidence of borer was maximum in Star Bonnet, i.e., to the extent of 33.5% against 6.2% in the presently cultivated variety B.G. 79. The hybrid R had borer incidence percentage 14.6 which was also more than B.G. 79 while the other three hybrids had borer incidence percentage between 3.9 to 9.4 against 6.2 of B.G. 79.

(ii) In all the varieties, a great percentage of borer incidences was in apparently healthy tillers. In such tillers, most probably, borer incidence started so late that white heads did not appear.

(iii) B.G. 79 is most susceptible to 'break in stem' to the extent of 3.7% against 0.0% and 0.4% in Hybrid S and Star Bonnet respectively. Causes of white head also indicate that Star Bonnet and Hybrid S were comparatively more resistant to 'break in stem'. However, the incidence of 'break in stem' is of low order i.e., 0 to 3.7% to 33.5% of borer, when data of all varieties are taken together.

The young paddy plants of all the new high yielding varieties were observed to be infested with larvas of a dipterous borer, Hydrellia sp. n. nr.

spinicornis Cresson. Under certain conditions as yet undetermined, this pest assumed serious proportions. The varieties with higher tillering rates have a better chance of withstanding this and other pests which appear in early stages of the growth of the paddy plant. The average number of tillers per plant was 6.3 to 7.5 for hybrids, 4.7 for B.G. 79 and 3.3 for Star Bonnet.

D. TECHNIQUE FOR DETECTION OF BUG DAMAGED PADDY GRAINS

The Stink bug, Oebalus poecila (Dallas) damaged paddy grains, produce discoloured rice. Without a suitable, quick test for determining the extent of damaged paddy, the producers cannot know the quality of their produce and the buyers cannot know the quality of their buy.

A large number or methods were tried and the under-mentioned method was found to be quite good. Paddy sample (30 gm.) was inmersed in 10% sodium hydroxide solution (100 ml.) at 70c° and was allowed to remain in that solution for 10 -15 minutes at 70c°, by regulated heat. Paddy varieties like Star Bonnet, B.G. 79 and D 110 which had lightly pigmented coat, required about 10 minutes of heating while a variety like Blue Belle which had a heavily pigmented coat, required about 15 minutes of heating, to show up the bug damaged spots. After heating, paddy was washed two to three time in water and was spread in a white enamel tray, under a film of water. Bug damaged grains showed round target spots. Ready reckoning tables for working out percent damaged paddy from number of damaged grains observed in a fixed weight of sample could be made separately for varieties with different average weights per grain.

Fifteen samples of paddy, having bug damaged grains ranging between 0.5 to 14% as revealed by the method described above, were processed to get parboilded rice. Percentage by weight of discoloured grains fue to bug damage in parboiled rice was worked out by visually separating the discoloured grains. The results of percentage damaged grains as obtained by treating the paddy with Na OH and by parboiling, compared favourably.

Wilbur et al. (1970) obtained good contrast between bug damaged and undamaged grains by heating dehusked paddy to 54c°in 0.03 - 1.5 N hydrochloric acid for 1 minute. Since paddy requires to be dehusked before this technique could be used, the Na OH method as described earlier is considered better.

E. INCIDENCE OF PADDY BUG

The paddy bug causes both quantitative and qualitative losses by sucking the developing grains and leaving target spots on the paddy which lead to production of dis-coloured rice. An estimate of qualitative loss is expected to indicate the bug incidence.

Rice farmers bring their paddy for sale to rice mills, invariably soon after harvest. Samples of paddy were drawn from various lots of paddy that came for sale at a big rice mill, each at East Coast, Demerara and Essequibo. 30 gm. paddy from each sample was analyzed for percentage of bug damaged grains by the technique described earlier.

The data on extent of quality loss of paddy for Autumn, 1969 presented in Table V indicate that:

(i) 24.7, 39.0 and 63.5% samples of paddy (all varieties together) harvested in early, mid and late autumn season respectively, had more than 0.5% bug damaged grains. The greater incidence of bug damaged paddy in later harvests, suggest that the bugs migrate from harvested fields to ripening ones. The situation would become serious for fields maturing late in season when almost all other fields were harvested. The applied significance of this observation is that the cultivators whose paddies are in milk or dough stage when their neighbours are harvesting, should be more careful about the bug incidence in their paddies.

(ii) Mixed varieties of paddy had higher incidence of bug damaged grains than the pure varieties, irrespective of the time of harvest. It could be due to prolonged availability of susceptible stage in field since different varieties may star flowering at different times.

The data on extent of quality loss of paddy for Autumn, 1969, Spring, 1970 and Autumn, 1970 are presented in Table VI;

Table VI, Paddy bug damage incidence

Percent bug damaged grains	Percent of sample		
	Autumn, 1969	Spring, 1970	Autumn, 1970
0,0	92,1	93.8	89.0
0.5	43.0	71.0	40.6
1,0	17,7	50.5	17.9
1.5	6.6	38.0	6.9
2,0	3,0	32.5	2.4
2.5	1.5	26,5	0.0
3.0	0,6	20.5	
4.0	0,3	15.3	
5.0	0.0	9.3	
10.0		2.3	
18.0		0.8	
25.0		0.4	
35.0		0.2	
50.0		0.0	
Total no. of samples analyzed	332	483	246

Which indicate that about 40% of samples of paddy in autumn crops of 1969 and 1970 and 71% of samples in spring, 1970; had more than 0.5% bug damaged grains and thus got less money than they would have got otherwise. According to the grading system in vogue, at more than 0.5% damaged paddy, the price paid is reduced.

About 80,000 and 30,000 ha. of rice are cultivated in Autumn and Spring crop respectively. In view of the above results about 32,000 and 21,000 ha. will require to be treated for bug control, during the Autumn and Spring crop respectively, each year. The cost of insecticide alone, to treat this area works out to G$300,000.00 per year. The immensity of paddy bug menace is obvious.

F. PROCESSING OF PADDY TO REDUCE BUG DAMAGED GRAINS

White rice: Fifteen samples of paddy, having bug damaged grains ranging between 0.5 to 14%, were processed to obtain unpolished white and parboiled rice. The data presented in Fig. II indicate that white rice shows about 2/3 as much discoloured grains as parboiled rice.

Further, a sample of paddy with 9.9% bug damaged grains, showed 6 and 2% bug damaged grains in unpolished and polished white rice respectively.

Three subsamples of 50 gm. each of polished white rice, were separated into brokens and whole grains and were analyzed for bug damaged grains. On an average whole grains and brokens contained 0.17 and 17.1% bug damaged grains respectively. Thus it is evident that most of the bug damaged grains pass into the brokens.

Since white rice shows less bug damaged grains than the parboiled rice; undamaged whole and broken grains of polished white rice were boiled to see if the signs of damage appeared after boiling. The results were negative.

These datas clearly show that it is possible to get a very good quality of white rice from bug damaged paddy.

Parboiled rice: Paddy bug damaged grains are generally lighter than the normal ones. It was observed that if paddy was dropped in water and the floating grains were immediately skimmed off, then the settled paddy was comparatively free of bug damaged, unripe and shrivelled grains and a better grads of parboiled rice was obtained.

Three samples of paddy variety D110 were skimmed in water and 20% common - salt solution. Data presented in Table VII show that when grains floating over water were immediately removed, the percentage of bug damaged grains dropped to 0.9 from 1.3 and 1.7 in the unskimmed paddy.

Table VII. Skimming of paddy to remove bug damaged grains

Variety	% skimmings (Wt.)		%discoloured grains		
	Water	20% salt	Whole paddy	Settled paddy	
				Water	20% salt
D 110	7.5	11.0	1.7	0.9	0.2
D 110	5.6	14.7	1.7	0.9	0.2
D 110	5.3	11.4	1.3	0.9	0.1

When grains floating over 20% common-salt solution were removed, the settled paddy had 0.1 - 0.2% damaged grains against 1.3 - 1.7% in the unskimmed paddy.

During the parboiling process, paddy is soaked in hot or cold water. If floating paddy is not immediately removed then lighter floating grains comprising of unripe, shrivelled and bug damaged grains, obsorb water, become heavier and settle down. In order to produce a better grade of rice, the floating grains should be immediately removed on soaking of paddy in water.

Guyana Rice Marketing Board, has a series of electronic separators, through which final product is passed and the discoloured grains get separated from both white and parboiled rice.

G. CONTROL OF PADDY MOTH, Sitotroga cerealella (Olive)

Paddy is stored in bags, in naturally ventilated bonds. A preliminary survey of paddy bonds carried out in 1970 indicated that paddy moth, Sitotroga cerealella (Olive.), was the major pest followed by Rhizopertha dominica (Fab.) and Tribolium castaneum (Herbst.). These findings are similar to those reported by Cleare (1962).

To control the infestation of paddy moth, phostoxin and methyl bromide fumigation has been recommended but most of the bonds in Guyana are such that fumigation is not possible. Since, moths come out of the bags, mate and lay eggs; it is logical that a persistent, quick knook-down insecticide applied to bags, should control the moth infestation.

MATERIALS AND METHODS

Technical grades of insecticides of low mammalian toxicity, were formulated as emulsions in the laboratory. Further, commercial wettable powders of iodfenphos and carbaryl were also used. 2 ml, of insecticide fluid was sprayed from Potter's spray tower on each of the two sides of pieces of jute sackings. The spray was allowed to dry. At 0.01% concentration, the deposit of a.e. was 2.4 ugm./cm^2. One piece of jute sacking was placed in a petri dish and then the petri dish was covered with another piece of jute sacking. Bond collected adult S. cerealella, Rhizopertha dominica and Tribolium castaneum, were enclosed in between the sacking for 24 hours, after which mortality observations were recorded, There were four replications of 10 - 15 insects each for each treatment. Insects were exposed to insecticidal residues at different intervals.

For working out the time taken by moths to get knocked down on exposure to residues of insecticides, petri dishes were sprayed with insecticides under Potter's spray tower. Spray was allowed to dry and then 10 - 12 moths were enclosed in each pair of dish. There were three replications for each treatment. The petri dishes were observed continuosly and time for knock down of 1st, 2nd, 3rd,....

moth was recorded. Log. time for knock down was plotted against probit knock down and time required for knock down of 50% moths (Kd. t. 50) was worked out.

Commercial 50% phoxim E.C. (Baythion) was used for trials in bonds. Motorized knapsack sprayer (70 cc.) was used for spraying the bonds.

RESULTS AND DISCUSSION

Laboratory tests: Nine insecticides tested for their duration of effectiveness on jute sacking against the adult S. *cerealella* indicated (Table III) that phoxim, pirimiphos methyl, iodfenphos and lindans were effective for longer duration than the others. Kd.t. 60 for phoxim, pirimiphos methyl, iodfenphos and lindane were 18, 39, 112 and 118 minutes respectively at 0.1% concentration and 21, 39, 166 and 159 minutes respectively at 0.05% concentration.

Table VIII. Corrected percent kill of adult S. cerealella, exposed to insecticides on jute sacking

Treatment	Age of residues in days				
	3	15	30	60	90
Phoxim* 0.1%	100	100	100	97	97
Phoxim 0.05%	100	100	100	95	89
Pirimiphos methyl 0.1%	100	100	100	100	91
Pirimiphos methyl 0.05%	100	100	98	92	77
Iodfenphos 0.1%	98	100	100	86	89
Iodfenphos 0,05%	100	96	91	73	87
Iodfenphos suspension 0,1%	100	98	100	92	75
Iodfenphos suspension 0,05%	100	84	85	73	70
Lindane 0.1%	100	100	100	98	84
Lindane 0.05%	100	100	97	96	83
Tetrachlorvinphos 0.1%	100	100	100	68	40
Tetrachlorvinphos 0.05%	100	100	100	75	55
Fenitrothion 0.1%	98	23	0		
Fenitrothion 0.05%	84	17	0		
Trichlorphon 0.1%	100	52	0		
Trichlorphon 0.05%	100	27	0		
Malathion 0,1%	25				
Malathion 0,05%	20				
Carbaryl suspension 0.1%	13				
Carbaryl suspension 0.05%	10				

A maximum of 14% mortality in control was observed.

Thus phoxim and pirimphos methyl knocked down the moths much faster than iodfenphos or lindane. In view of these results and that the acute oral LD. 50

to rats of phoxim and pirimiphos methyl is more than 1,000 mg./kg. (Mc, Donald and Gillenwater, 1967) and 2,050 mg./kg. (Anon., 1970a) respectively against 1,375 mg./kg. of malathion (Gaines, 1960), these two insecticides are of potential importance in control of the paddy moth.

Control of infestation: Since large quantities of phoxim 50% E.C. (Baythion) were available, three bonds heavily infested with the paddy moth were sprayed with phoxim 0.25%, using a motorized knapsack sprayer. The air blast speed of the sprayer was kept low so that droplets of spray directly settled over the bags. The stacks of paddy were sprayed with phoxim emulsion. The deposit of insecticide on bags worked out to 150 mgm. a.i./metre^2 of stack surface. Within twenty minutes of spraying, almost all moths in the bonds were killed. The data on the pre-and post-treatmen population of the moths (average of 20 spot observations) of one bond are given below: -

Pre-treatment population

2.5 moths per 0,3 m^2 of stack surface

Post-treatment population

5 days - 0,2 moths/0,3 m^2 of stack surface

9 days - 0,0	do
14 days - 0,1	do
22 days - 0,1	do
29 days - 0.0	do
32 days - 0.0	do
39 days - 0,1	do
44 days - 0.0	do
51 days - 0.0	do

On the 14th day after treatment, some bags were found open and they had some moths sitting on loose paddy. These bags were sewn and sprayed. Basically similar results were obtained in the other two bonds. It took about 45 minutes to treat a bond properly stacked and containing about 25,000 bags.

Prevention of infestation: Infestation by the moth could be completely prevented (up to six months) by applying phoxim 0.25% emulsion spray on to the bagged paddy, either as each layer of bags is laid or after the stacks are completed (Table IX).

Table IX. Prevention of infestation of paddy with *S. cerealella*
Phoxim 0.25% a.i. spray applied with motoblo on to the bags

	Bond No. 1 Bags treated layer by layer	Bond No. 2 Completed stacks sprayed	Bond No. 3 Stacks not treated control
1. Date stacks laid/treated	24/9/70 to 19/12/70	23/10/70 to 11/11/70	October 1970
2. gm. a.i. used	5,300	505	-
3. No. of bags of paddy in hand.	94,021	61,870	Not calculated
4. No. of moths observed	Nil, till May, 1971	Nil, till April, 1971 when paddy was milled out.	23/11/70 3.6/0.3 m^2 of stack surface 27/11/70 6.5/0.3 m^2 of stack surface. 15/12/70 48.2.0.3 m^2 of stick surface. 26/12/70 to May, 1971 Moths uncountable.
5. One litre of 50% E.C. treated	9,000 bags 564 tons.	60,000 bags or 3,800 tons	-
6. Insecticide worth G$ 1.00 treated	470 bags or 3 tons.	3,270 bags or 209 tons.	

Data presented in Table X show that percentage of grains damaged by insects is much more in the bond where S. cerealella was not controlled than in those where it was controlled.

Table X. Extent of damage to bagged paddy in storage by Sitotroga cerealella and other pests.

Observations recorded 5th month after storage in 3 different bonds.

Treatment	Site of stack sampled	% grain bored	No. of insects recorded in (4 x 500 g. paddy)					
			R.d.	T.c.	S.c.	C.f. sp.	L.p.	Predatory bug
1. Sitotroga cerealella controlled	Side	1.37	253	33	0	17	0	5
	Middle	.43	208	2	0	43	3	1
	Top	.81	4942	10	0	9	0	0
2. Sitotroga cerealella controlled	Side	2.00	3466	48	0	25	5	67
	Middle	0.50	326	14	2	27	0	6
	Top	0.31	507	5	0	16	0	3
3. Infested with Sitotroga cerealella	Side	11.60	435	13	3	258	1	10
	Middle	3.80	442	33	0	29	5	0
	Top	16.37	677	1	0	244	0	46

R.d. - Rhizopertha dominica (F.)
T.c. - Tribolium castaneum (Hbst.)
S.c. - Sitophilus oryzas L.)
C.F. - Cryptolestes sp.
L.p. - Lophocateres pusillus (Klug)

Residues on jute of phoxim and pirimiphos methyl are quite toxic to Rhizopertha dominica (Table XI) while pirimiphos methyl is quite toxic to Tribolium castaneum (Table XII).

Table XI. Corrected percent kill of adult Rhizopertha dominica, exposed to residues of insecticides on jute sacking.

Treatment	Rhizopertha dominica				
	Age of residues in days				
	7	15	30	60	90
Phoxim 0.1%	100	93	92	77	43
Phoxim 0.05%	79	80	79	33	15
Pirimiphos methyl 0. 1%	73	45	56	55	24
Pirimiphos methyl 0.05%	30	23	20	17	21
Iodfenphos 0.1%	45	62	-	50	31
Iodfenphos o.05%	39	36	-	34	17
Fenitrothion 0.1%	82	80	54	50	7
Fenitrothion 0.05%	76	80	43	33	2
Malathion 0.1%	73	88	56	41	30
Malathion 0.05%	66	73	30	34	7
Lindane 0.1%	55	65	0		
Lindane 0.05%	52	33	0		
Tetrachlorviphos 0.1%	48	40	0		
Tetrachlorviphos 0.05%	39	50	0		
Carbaryl 0.1%	76	53	0		
Carbaryl 0.05%	42	35	0		
Trichlorphon 0.1%	33	18	0		
Trichlorphon 0.05%	30	10	0		

A maximum of 15% mortality in control was observed.

Table XII. Corrected percent kill of Tribolium castansum, exposed to residues of insectides on jute sacking.

Treatment	Age of residues in days				
	3	10	30	60	90
Pirimiphos methyl 0.1%	100	80	75	56	21
Pirimiphos methyl 0.05%	33	30	10	7	0
Phoxim 0.1%	34	28	0		
Phoxim 0.05%	13	0	0		

Three days old residues of 0.1 and 0.05% lindane, iodfenphos, tetrachlorvinphos, malathion, carbaryl, trichlorphon and fenitrothion gave less than ten percent kill. The percentage mortality in control varied from 0 to 5 percent.

These pests when crawled out on to the treated jute surface, got killed. However, they continued to breed inside the bag as is evident from Table X.

The amount of insecticide used for the control of S. cerealella depends upon the size of stacks. In the present studies, some of the stacks were as big as 60m x 6m x 7m, while an average size was 18m x 13m x 7m. One litre of 50% E.C. treated about 60,000 bags or 3,800 ton of paddy when bags were sprayed after stacking adn G$1.00 worth of insecticide treated about 3,270 bags or 209 tons of paddy when stacked bags were sprayed (Table IX).

SUMMARY

The natural wind velocity of 10 - 15 km./hr. was used to cut down time of spraying of paddies; by resorting to drift spraying, using a motorized knapsack sprayer.

The incidence of stem borers, 'break in stem' (internal localized rotting and external injuring to stem caused by rats/long-horned grasshoppers; resulted in erect, empty and white heads of paddy. Relative incidence of stem borers and 'break in stem' in some of the rice varieties is reported.

A technique for detection of bug (Oebalus poecila (Dallas)) damaged grains in paddy has been developed. Paddy is heated at 70°c for 10 - 15 minutes, in 10% sodium hydroxide solution, to reveal bug feeding spots on the grains. Studies on the incidence of the bug indicated that the bug (i) migrated from harvested fields to maturing fields, (ii) incidence was higher in fields with mixed varieties than in those with pure varieties and (iii) infests about 40 and 71% of the areas in autumn and spring crops respectively and thus about 53,000 ha. out of a total of 110,000 ha. require to be treated annually, for its control.

Bug damaged grains show up much less in white rice than in parboiled rice. Further, damaged grains get broken in polishing of white rice and thus by removing brokens, it was possible to get a good quality of white rice from bug damaged paddy. During soaking of paddy in water, for preparation of parboiled rice, immediate removal of light floating grains (bug damaged, unripe and shrivelled grains), resulted in better grade of rice.

Most important storage pest of bagged paddy was Sitotroga cerealella (Olive), followed by Rhizopertha dominica (fab.) and Tribolium castaneum (Herbst.). Studies on duration of toxicity of nine insecticides on jute sacking and time required to knock-down adult S. cerealella indicated that phoxim and pirimiphos methyl were of importance for control of this pest. Application of 0.25% phoxim emulsion at 150 mg a.i./m^2 on exposed surface of stacks of bagged paddy, controlled and prevented the infestation by the moth for six months. Residues on jute of phoxim and pirimiphos methyl were quite toxic to adul R. dominica and of pirimiphos methyl to adult T, castaneum. These insects got killed when crawled out to the treated surface, however they continued inside the bags. The amount of insecticide used to control S, cerealella depended on the stack size. One litre of 50% phoxim E.C. protected about 3,800 tons of bagged paddy.

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Table I. Control of pests by drift spraying, using a motorized knapsack sprayer

Pests	Treatment per ha.	No. of ha. treated per tankful (11 litres) of spray	Width of strip treated in one passing (metres)	Time required to spray one ha. (minutes)
1. Rice caterpilla, Spodopter *frugiperda* S. & A.	Fenitrothion emulsion at 170-250 gm. a.i. in 3.5 litres spray fluid	3	9	21
2. Dipterous stem maggot, Hydrellia sp. n., nr. *spinicornis* Cresson.	Fenitrothion emulsion at 250 gm. a.i. in 3.5 litres spray fluid	3	9	21
3. Long-horned grasshoppers, Neoconocephalus sp. and *Caulopsis cuspidata* Scudder.	Monocrotophos, gamma BHC, malathion and dieldrin emulsions at 270 gm. a.i. in 11 litres spray fluid.	1	6	30
4. Paddy bug, Oebalus *poecila* (Dallas)	(i) Monocrotophos at 120 gm. a.i. in 11 litres of spray fluid.	1	6	30
	(ii) Carbaryl suspension at 1.4 kg a.i. in 44 litres of spray fluid.	0.25	6	60

Table IV. Incidence of stem borer and 'break in stem' in paddy crop of Spring, 1971

Variety	No. of fields sampled	No. of tillers per plant	Percent infested tillers from				Percent white heads* due to	
			all tillers		apparently healthy tillers			
			Stem borer	'B in stem	stem borer	'B in stem'	stem borer	'B in stem'
Star Bonnet	19	3.3	33.5	0.4	29.9	0.0	59.3	23.0
Hybrid R	8	7.5	14.6	1.1	11.7	0.0	37.0	60.0
Hybrid B	7	6.6	9.4	3.0	4.7	0.0	55.8	40.8
Hybrid G	3	7.5	8.0	0.6	4.2	0.0	47.5	50.0
Hybrid S	3	6.3	3.9	0.0	2.6	0.0	45.0	30.0
B.G. 79	5	4.7	6.2	3.7	6.0	0.0	10.0	86.0

*Twenty white heads were uprooted at random from each field and were analyzed.

Table V. Extent of quality loss due to paddy bug.

Classes of bug damaged grains (percent by weight)	Frequency distribution of bug damaged paddy samples (percent)														
	3.G. 79			D 110			Blue Belle			Mixed varieties			Data of all varieties pooled xx		
	A[x]	B[x]	C[x]	A	B	C	A	B	C	A	B	C	A	B	C
0.00	18.7	10.9	3.3	8.5	16.6	7.1	10.5	0.0	0.0	0.0	0.0	0.0	12.4	8.8	2.8
0.001-0.125	15.6	21.8	3.3	22.8	5.6	17.8	36.8	0.0	0.0	0.0	0.0	3.7	22.4	10.3	7.5
0.126-0.250	18.7	14.5	13.3	11.4	13.9	7.1	26.3	25.0	0.0	0.0	0.0	0.0	16.9	14.0	7.5
0.251-0.500	28.1	30.9	26.6	22.8	25.0	28.5	21.1	50.0	0.0	0.0	13.0	0.0	23.6	27.9	18.7
0.501-0.750	12.5	4.5	10.0	20.0	22.2	21.4	5.2	8.3	0.0	33.3	17.4	22.2	14.6	15.4	15.9
0.751-1.000	3.1	3.6	16.6	8.5	11.1	7.1	0.0	16.6	0.0	33.3	26.1	7.4	5.6	12.5	10.3
1.001-1.500	3.1	3.6	16.6	5.7	2.8	7.1	0.0	0.0	25.0	0.0	26.1	40.7	3.4	7.4	22.4
1.501-2.000	0.0	0.0	6.6	0.0	2.8	0.0			25.0	33.3	4.3	18.5	1.1	1.5	8.4
2.001-2.500			0.0	0.0	0.0	3.5			25.0	0.0	8.7	3.7	0.0	1.5	2.8
2.501-3.000			0.0	0.0	0.0	0.0			0.0	0.0	4.3	3.7	0.0	0.7	1.9
3.001-3.500			0.0						25.0	0.0	0.0	0.0	0.0	0.0	0.9
3.501-4.000			0.0										0.0	0.0	0.0
4.001-4.500			0.0										0.0	0.0	0.0
4.501-5.000			3.3										0.0	0.0	0.9
No. of samples analyzed	32	55	30	35	36	28	19	12	4	3	23	27	89	136	107

x A,B and C represent the paddy received from 10th Oct. to 19th Oct.; 20th Oct. to 5th Nov. and 22nd Nov. to 1st Dec..

xx It also includes 21 and 7 samples of varieties D-52 and 6047 respectively.