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Field Efficacy of Several Selected Insecticides Against the Diamondback moth, Plutella xylostella (L)[1], on Cabbage, *Brassica oleracea* var. capitata (L), in the Lowland of Malaysia

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RINGKASAN

Keupayaan beberapa pilihan racun serangga yang didapati dipasaran telah diuji keatas ulat plutella, Plutella xylostella *(L), pada kobis,* Brassica oleracea *var. capitata (L), di kawasan tanah rendah (Ladang Universiti Pertanian Malaysia). Pada keseluruhannya, keputusan ujian ini menunjukkan acephate, methamidophos, dan bendiocarb semuanya pada 0.1% b.a.,* Bacillus thuringiensis *pada 1g/l., diflubenzuron pada 0.007 b.a., tiap-tiap satunya didalam 450 l. air/ha. mengakibatkan pengurangan yang bererti ($P \leqslant 0.05$) keatas populasi larva. Racun-racun ini juga memberikan perlindungan yang sama pada daun-daun kobis, terutama daun-daun muda. Bersamaan dengan keputusan-keputusan awal, petak-petak kawal didapati memberi hasil pasaran yang agak rendah, lebih bererti ($P \leqslant 0.05$) jika dibanding dengan petak-petak yang mendapat rawatan racun-racun serangga.*

SUMMARY

Efficacy of several selected insecticides available in the market were tested against the Diamondback moth, Plutella xylostella *(L), on cabbage,* Brassica oleracea *var. capitata (L), in the lowland (University of Agriculture Malaysia farm). In general, the results showed that acephate, methamidophos, and bendiocarb all at 0.1% a.i.,* Bacillus thuringiensis *at 1g./l., diflubenzuron at 0.007% a.i., each in 450 l. of water/ha. caused significant reduction ($P \leqslant 0.05$) in larval population. These insecticides also provided equal protection against larval damage on young hearting leaves of cabbage. Consistently, the control plots gave significantly lower yield ($P \leqslant 0.05$) of marketable heads as compared to the insecticide treated plots.*

INTRODUCTION

The diamondback moth, *Plutella xylostella* (L), is a serious pest of cruciferous crops (Ankersmit, 1953; Asano *et al,* 1973; Beri, 1958; Calora *et al,* 1968; Hardcourt, 1955; and Lee, 1969). The status of this pest in Malaysia has been studied since 1957 by Henderson, followed by Ho (1965), Ho and Ng (1969), Wan (1970), and Ho and Tan (1971).

In this country more than twenty generations of the pest have been recorded in a year (Chuo, 1973) with an average duration of 10.8 day life cycle (Ho, 1965). The larvae of the insect feed on the abaxial surface of the leaf, and in extreme cases skeletonised the plant.

Currently, insecticide spraying is the most popular control method adopted by vegetable growers in Malaysia. A wide range of insecticides have been used, particularly in Cameron Highlands; however, the general view of the farmers indicates that the intensive use of these insecticides has resulted in several of them becoming no longer effective. This situation further confirms the reports by Henderson (1957) that certain strains of this insect have developed resistance to DDT and BHC. Works in other countries have also showed that strains of *Plutella* had developed resistance to several other insecticides (Ankersmit, 1951; Tjoa, 1959; and Lee, 1969). There are also reports of field effectiveness of insecticides and microbial agents against the larvae of this moth (Ho, 1965; Chuo, 1973; Creighton and McFadden, 1975; Asano *et al,* 1973; Ho and Ng, 1969; and Ho and Tan, 1971). These studies were, however, either conducted in the vegetable areas of Malaysian Highlands (Cameron Highlands), or in other countries. In

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view of the increase in acreage, and the consequent higher production of lowland cabbage in Malaysia, a study on the efficacy of some of the latest insecticides available in the market against *P. xylostella* (L) on this crop is imperative. It is hoped that the results from this study will throw some light on the choice of insecticides for the control of the pest.

MATERIALS AND METHODS

The experiment was conducted at the farm of the University of Agriculture Malaysia, Serdang. A randomized complete block design with four replicates was employed. *Brassica oleracea* var. capitata (L) (K-K cross) was used as test plants.

Cabbage seedlings were initially grown in an insect proof glass house for five weeks, after which they were transplanted in the field on raised beds (1m × 23m) at 0.75m apart. The beds were enriched with chicken manure at the rate of 15 tonnes/ha., two weeks before transplanting. There were 13 plants per experimental unit, separated by two guard rows, planted on a triangular pattern and spaced at 0.5m between plants. Top dressings of compound fertilizer (NPK 15:15:15) were applied at one week and four weeks after transplanting at a rate of 12g/plant at each application. Chicken manure was again applied at the rate of 100g/plant two weeks after transplanting.

Five insecticidal treatments and a control at the rate of 450 l. of water/ha. were carried out for each replicate. The insecticides applied were: acephate (Orthene 75SP®) at 0.1% a.i.; *Bacillus thuringiensis* Berliner var. *Kurstaki* (Thuricide HP 3.2%®) at 1g/l.; bendiocarb (Garvox®) at 0.1% a.i.; diflubenzuron (Dimilin 25WP®) at 0.007% a.i.; and methamidophos (Monitor 600®) at 0.1% a.i.. Water was used for the control. A total of six spray applications were made at weekly intervals, starting two weeks after transplanting, with Killaspray-air flow sprayer fitted with a hollow cone nozzle.

Assessment was done by pre-spray (one day before each subsequent spray) counting of the larvae on every third plant of each treatment sampled systematically, totalling five plants per plot. Occurrence of leaf damage as a measure of effectiveness of the treatments was assessed weekly commencing at seven-week old plants. At this stage each cabbage plant had more than ten leaves. The formula by Chuo (1973) was used to compute the severity index for each treatment.

RESULTS AND DISCUSSION

Larval Count. Table 1 presents the total number of living larvae for samples recorded, at 1 week intervals before each spray was conducted. Significantly higher number of larvae was recorded in the control as compared to all the insecticidal treatments. No difference was, however, detected among the insecticides tested. Chuo (1973) and Kouskolekas and Harper (1973) also reported satisfactory control of the insect with methamidophos, acephate, and *B. thuringiensis.*

Although a highly significant result was obtained between control and insecticidal treatments, this was perhaps not a true reflection of the effectiveness of the insecticide. This method of assessment (larval count) may only be applicable up to a certain stage of crop growth. Generally, there was a decline in the larval count after the fourth spray except for *B. thuringiensis* treatment where the number began to decline only after the fifth spray (Table 2). It was noted that control plots registered a lower larval count than the treated plots from the third spray onwards. This decline in the number of larvae could be explained by the fact that the plants in the control plots were severely damaged by then, and as such lacking in fresh leaf surfaces for oviposition. This result, therefore, revealed that prespray larval count is a poor indicator of insecticide efficacy since reduction of leaf surface due to larval feeding will also reduce oviposition activity and thus reduce the number of larvae. The general decline from the fourth count onwards was a phenomenon also discussed by Henderson (1957), Ho (1965) and Chuo (1973), that population of *Plutella* was known to decline when the cabbage reaches maturity.

Table 2 also showed a general trend of increase in the number of larvae in acephate, bendiocarb and methamidophos treatments on the fourth sampling date. This could perhaps be due to the inception of a new generation. However, the increase was not high enough to give an overall significant result among the insecticidal treatments.

Foliage Protection. Results obtained from the calculation of foliage protection index indicate that all insecticidal treatments gave significant foliage protection against larval damage in comparison to the control (Table 3). Chuo (1973), and Kuoskolekas and Harper (1973) reported similar findings from field trials with methamidophos, acephate, and *B. thuringiensis.* Field tests have also indicated that bendiocarb was

TABLE 1

Total number of living larvae *P. xylostella* recorded after 6 samples. UPM, 1977

Treatments	Number of living larvae				Mean
	I	II	III	IV	
Control	68	64	54	59	61.31 a
Acephate	62	33	27	25	36.81 b
Bendiocarb	53	19	51	23	36.51 b
B. thuringiensis	43	38	25	34	35.01 b
Diflubenzuron	49	31	38	12	32. 5 b
Methamidophos	38	38	24	24	31. 0 b

Means followed by the same letter are not significantly different at 5% level of probability (DMRT).

TABLE 2

Weekly prespray count of living *P. xylostella* larvae. UPM, 1977

Treatments	Total number of living larvae at each count						
	August			September			
	13th	20th	27th	3rd	10th	17th	Total
Control	5	151	89	44	23	8	370
Acephate	3	110	34	61	27	22	257
Bendiocarb	6	109	31	49	18	29	242
B. thuringiensis	4	61	75	36	48	16	240
Diflubenzuron	4	63	63	87	62	21	300
Methamidophos	8	70	70	85	76	50	335

TABLE 3

Foliage protection index and percent marketable heads after insecticidal treatments against *P. xylostella*. UPM, 1977.

Treatments	Foliage Protection Index		Marketable Heads	
	Mean (%)[1]	% increase above control	Mean (%)[1]	% increase above control
Bendiocarb	78.7a	46.3	93.0a	126.3
Acephate	82.9a	54.1	91.5a	122.6
Methamidophos	81.7a	51.9	92.3a	124.6
B. thuringiensis	75.2a	39.8	81.0a	97.1
Diflubenzuron	77.5a	44.1	78.4a	90.8
Control	53.8b	0	41.1b	0

[1]Means in the same column followed by the same letter are not significantly different at 5% level of probability (Duncan's Multiple Range Test).

effective against numerous species of Lepidopterans that feed on foliage (Lemon, 1971). Diflubenzuron was reported by Granett and Dunbar (1975) to be very effective in protecting the foliage of apple trees against gypsy moths. In this study no significant difference was obtained among the different insecticidal treatments. Evidently, these insecticides gave an overall protection of cabbage leaves against the *P. xylostella* larvae.

Marketable Heads. The percent marketable cabbage heads in all the insecticide treated plots was significantly higher than that of the control plots (Table 3). There was however no significant difference among the insecticidal treatments. This showed that the insecticides employed were equally effective in preventing damage to the head, but the fact that bendiocarb, methamidophos, and acephate produced considerably more plants with no holes on the heads suggest that they killed the larvae more rapidly than did *B. thuringiensis* or diflubenzuron. Chuo (1973) and Creighton and McFadden (1975) also obtained satisfactory heading with methamidophos, acephate and *B. thuringiensis*. Apparently, all the insecticides tested provided considerable protection against *P. xylostella* damage to the young hearting leaves.

Yield Assessment. Table 4 indicates that there were significant differences in yield between the insecticide treated plots and the control. No significant difference in yield was detected among the insecticidal treatments, even though acephate, methamidophos, and *B. thuringiensis* registered considerablly higher yield. These results confirmed the reports that acephate, methamidophos, and *B. thuringiensis* were effective in protecting the cabbage from yield loss thus promoting higher yields (Ho and Ng, 1969; Chuo, 1973; Creighton and McFadden, 1975).

TABLE 4

Yield of marketable cabbage at harvest. UPM, 1977

Treatments	Mean weight per cabbage head (g)[1]	Expected yield (kg/ha.)[2]
Acephate	733a	18363.8
Methamidophos	722a	18106.0
B. thuringiensis	712a	17833.3
Bendiocarb	626a	15666.8
Diflubenzuron	594a	14878.8
Control	300b	7530.3

[1]Means followed by the same letter are not significantly different at 5% level of probability (Duncan's Multiple Range Test).

[2]The expected yield is based on experimental results estimated from 25,000 cabbage heads/ha.

CONCLUSION

The various assessments indicated that the efficacy of the insecticides for the control of *P. xylostella* was quite consistent. The cabbage heads for market appearance, in treated plots were visually larger and almost free from damage compared to those of the control plots. The plants in the control plots were so badly damaged that only limited marketable heads could be salvaged at harvest. It was observed that early protection of the cabbage plants against the diamondback moth was essential, especially during the hearting stage. Plants badly damaged at this stage recovered by producing multiple heads which were of no economic value. It is thus imperative to use effective insecticides with quick knockdown action during this period in order to ensure a good harvest of the crop.

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