MARDI Res. J. 19(2) 1991: 251–258

Maize as a barrier crop in reducing aphids, the virus vector of chilli

(Tanaman jagung sebagai tanaman perintang untuk mengurangkan serangan afid, vektor virus cili).

M. N. Mohamad Roff* and B. L. Ho*

Key words: chilli, maize, pest management, alate aphid population, virus diseases

Abstrak

Kesan dua corak susunan pokok jagung sebagai tanaman perintang telah dikaji. Selingan antara cili dan jagung dan cili dikelilingi oleh jagung telah dibandingkan dengan petak kawalan (cili sahaja). Populasi afid yang berkepak dapat dikurangkan melalui penanaman selingan cili dan jagung. Pengurangan afid dalam percubaan yang pertama dan yang kedua masing-masing ialah 65.1% dan 59.6%. Berat buah dan bilangan buah cili yang dicatat menunjukkan bahawa selingan cili dan jagung nyata memberi hasil yang lebih tinggi ($p < 0.05$). Sistem ini juga mengurangkan penyakit virus. Keadaan ini mungkin disebabkan oleh pengurangan populasi afid yang berkepak.

Abstract

The effects of two patterns of arranging maize plant as a barrier crop were studied. Intercropping chilli with maize and surrounding chilli with maize were compared with the control plot (chilli monocrop). The alate aphids were markedly reduced by intercropping chilli with maize. Reduction of alate aphid in the first and second trial was 65.1% and 59.6% respectively. Fruit weight and fruit number recorded, indicated that intercropping chilli with maize gave a significantly ($p < 0.05$) greater yield. This system also significantly reduced the incidence of viral diseases, probably due to the reduction of alate aphids vector.

Introduction

Chilli (*Capsicum annuum* L.) is one of the most important vegetable crops grown in Malaysia. The rampant occurrence of viral diseases poses a major constraint in its production (Shukor et al. 1988).

In Malaysia, chilli plants are severely affected by two aphid-borne viruses that are transmitted non-persistently. They are chilli veinal mottle potyvirus (CVMV) and cucumber mosaic cucumovirus (CMV) (Mohamad Roff et al. 1989). When young plants are infected, hardly any marketable fruit is produced. Partial control can be achieved by using effective insecticides to decrease vector populations (Thresh 1983).

To date, various barrier crops have been reported to be effective in reducing viral disease incidences on a number of crops. Simons (1957) reported the use of maize to impede the aphid population from spreading pepper vein banding mosaic virus. Alfalfa and maize have been used around tomato against leafhopper and beet curly top virus (Broadbent 1964). Work in Costa Rica indicated that tall maize plants among beans and squash can interfere with the flight behaviour of certain beetles including virus

*Division of Horticulture, MARDI Jalan Kebun, P.O.Box 186, 41720 Klang, Malaysia
Authors' full names : Mohamad Roff Mohd. Noor and Ho Ban Lee

vectors (Risch 1978). This study was therefore conducted to evaluate the effectiveness of the various planting arrangements of maize plants as a barrier crop in reducing aphids.

Materials and methods

Field experiments were conducted for two seasons, from August 1987 to February 1988 and from July 1988 to January 1989 on peat soil (pH of ca. 5.3) at the MARDI Research Station Jalan Kebun, Klang. Two types of barrier arrangements and unprotected controls were tested viz. intercropping chilli and maize, surrounding chilli with maize and chilli alone.

All treatments in the first trial consisted of 68 chilli plants each in different plot sizes. In the second trial, all plots were of equal size and the total number of chilli plants per plot varied. In the control plots of chilli alone, each contained 70 chilli plants, while plots of chilli surrounded with maize and intercropping chilli with maize consisted of 50 and 30 plants, respectively (*Figure 1*).

The plots were arranged in a completely randomised block design with three replications. Seedlings of chilli MC 4 variety were planted at a spacing of 60 cm in single-row beds. Spacing between treatment plots was 3 m apart. This spacing was selected to reduce interference between treatments. Maize seeds were sown 2 weeks before chilli seedlings were transplanted on a separate single-row bed.

Chilli plants were fertilized four times with 30 g NPK Blue Special^R per plot at monthly intervals. *Mancozeb* was sprayed twice a month to control anthracnose fruit rot from the onset of fruit set. No insecticide was used in the study so that the effect of various planting arrangements of the maize plants could be assessed.

Two circular yellow water troughs (diameter 30 cm, depth 10 cm) were placed on the chilli bed in the centre row of each plot to trap alate aphids. The number of alate aphids in the troughs was counted weekly and the water changed. The incidences of virus infected plants were also recorded at regular intervals and calculated as a percentage of the total stand per plot.

Total fruit weight per plot, average fruit weight per plant, number of fruit per plot and average number of fruit per plant were recorded for each treatment. The data were analysed using the analyses of variance and Duncan's multiple range test.

Results

First trial

In the first trial, the mean total number of alate aphids trapped per plot where chilli and maize were intercropped, and in plots

Table 1. Effects of maize planting arrangements on alate aphid populations and viral disease incidences on chilli (1st trial: Aug. 1987-Feb. 1988)

	Mean no. aphid caught per trap	Mean aphid reduction %	Overall mean viral disease incidence (%)
Intercropping chilli with maize	41.0a	65.1a	32.4a
Chilli surrounded by maize	67.3a	42.6b	34.9a
Chilli only	117.3b	–	53.5b
F-test	**	*	**
SE$\bar{x}$	7.6	3.6	1.9
C.V. (%)	17.6	11.4	30.2

NB: Values are means of 3 replicates
Means with the same letter are not significantly different from one another at 5% level
**: Significant at 1% probability level
*: Significant at 5% probability level

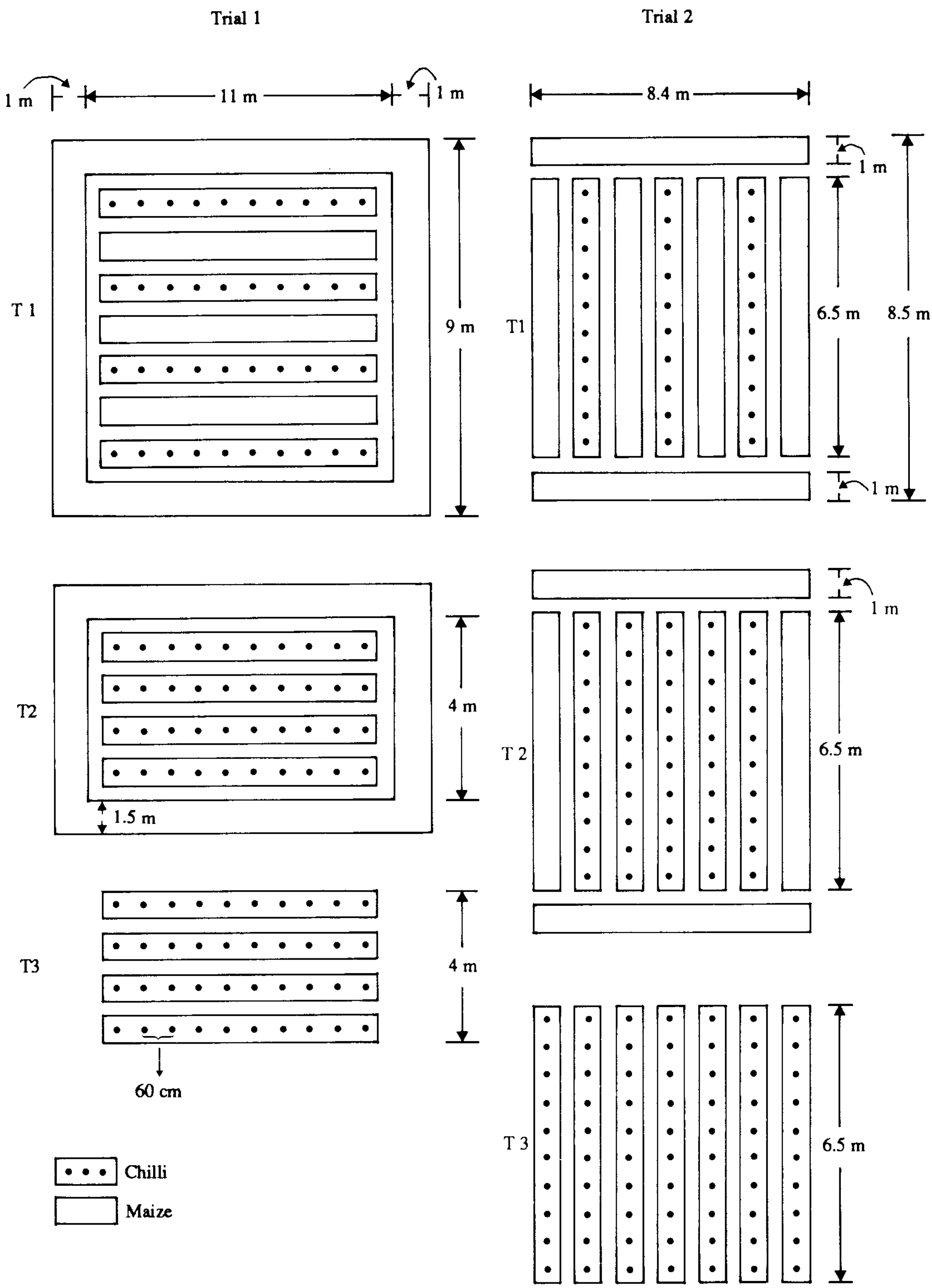

Figure 1. Experimental layout and design of trial 1 and 2 with three treatments (T1 = intercropping chilli and maize, T2 = surrounding chilli with maize, T3 = chilli only)

where the chilli was surrounded with maize, were not significantly different ($p > 0.05$) from each other (*Table 1*). Both these treatments gave significantly ($p < 0.05$) lower total numbers of alate aphids when compared with the chilli monocrop (*Table 1*). However, percentage of reduction of the alate aphid caught in the intercropped plots was significantly ($p < 0.05$) higher than that surrounded by maize (*Table 1*).

In all the three treatments, the cumulative number of aphids caught increased progressively (*Figure 2*). However, the trend showed that maize had definitely contributed to lower alate aphid populations on the chilli plants. Between the two treatments with maize as a barrier, the intercropping pattern performed much better than the plot surrounded with maize in terms of lower alate aphid populations and its slower rate of increase.

Similar results were obtained from analyses of variance based on the overall mean percentage of viral disease incidence (*Table 1*) where maize had also contributed to significantly lower ($p < 0.05$) viral disease incidences (*Figure 3*) compared with planting chilli alone.

The yield data also showed the superiority of intercropping chilli with maize. The number and weight of fruit/plot and the number and weight of fruit/plant of the intercropping treatment gave values which were greater than planting chilli surrounded with maize or the control (*Table 2*).

Second trial

In the second trial, the effects of maize as a physical barrier to alate aphids were again apparent. Both the intercropping and the chilli plot surrounded with maize treatments gave significantly ($p < 0.05$) fewer alate aphid populations, compared with the plot planted with only chilli (*Table 3*). The second trial further revealed the superiority of the intercropping treatment over the 'chilli surrounded by maize' treatment. The mean percentage of alate aphid reduction of the former was significantly ($p < 0.05$) higher (59.6% as compared with 45.0%). This was because the total number of alate aphids caught in the former was significantly ($p < 0.05$) lower at 89.3 compared with 121.7 in the latter.

The increasing trend with time in the cumulative numbers of aphids caught was

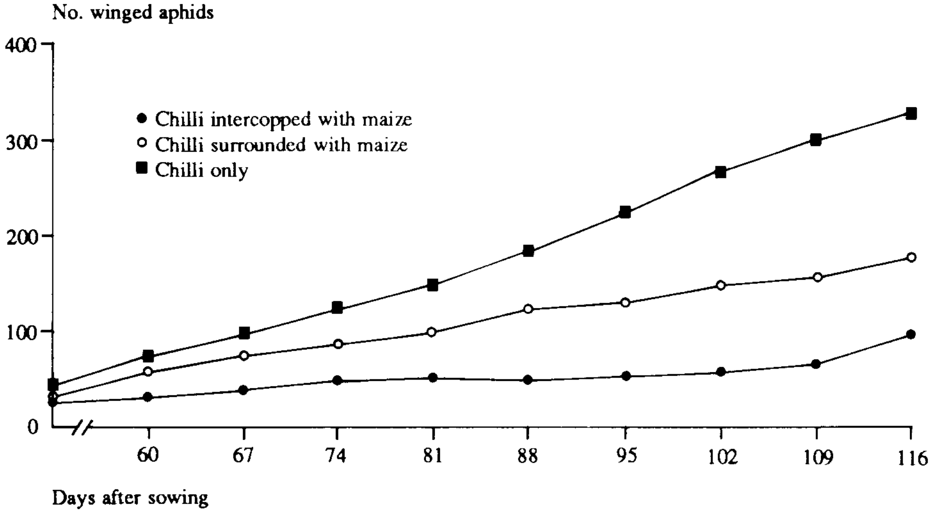

Figure 2. Cumulative numbers of alate aphids caught in plots with and without maize as barrier crop in the first trial (Aug. 1987 – Feb. 1988)

similar to the first trial (*Figure 3*). The graphs also showed positive depressive effects of maize on alate aphid populations. The rate of increase in alate aphid populations was also much slower. The intercropping pattern gave a much lower alate aphid population and even slower rate of increase, compared with the 'chilli surrounded by maize' plot (*Figure 4*).

Similar results were clearly seen in the overall mean viral disease incidences (*Table 3*). The treatments with maize showed significantly lower viral disease incidences than that of the control. However, between the two different patterns, the intercropping pattern gave a significantly lower viral disease incidence (*Figure 5*).

The yield data from the second season experiment confirmed the beneficial effects of maize on chilli (*Table 4*). Both the treatments with maize gave significantly higher fruit number and weight per plant than the control. However, between the two treatments with maize, the intercropping pattern gave a significantly higher yield per

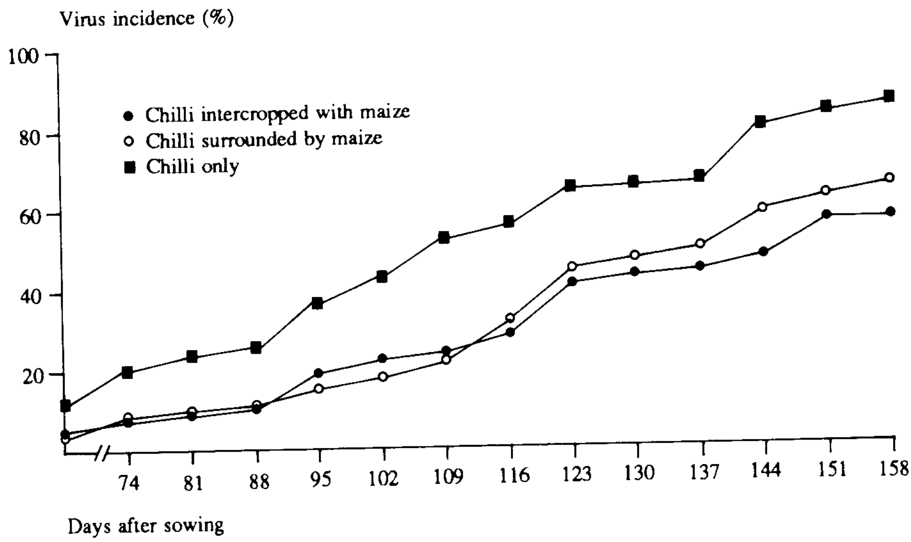

Figure 3. Chilli virus incidence in plots with and without maize as barrier crop in the first trial (Aug. 1987 – Feb. 1988)

Table 2. Effects of maize planting arrangements on the yields of chilli (1st trial: Aug. 1987 – Feb. 1988)

	Yield/plot		Yield/plant	
	Fruit no.	Fruit wt. (g)	Fruit no.	Fruit wt.(g)
Intercropping chilli with maize	4 565.0a	40 738.7a	67.1a	599.1a
Chilli surrounded by maize	3 365.3ab	31 521.7ab	49.5ab	463.6ab
Chilli only	2 788.3b	22 528.3b	41.0b	331.2b
F-test`	*	*	*	*
SE$\bar{x}$	351.1	2 707.6	5.2	39.8
C.V.(%)	17.0	14.8	17.0	14.8

NB: Values are means of 3 replicates
Means with the same letter are not significantly different from one another at 5% level
* : Significant at 5% probability level

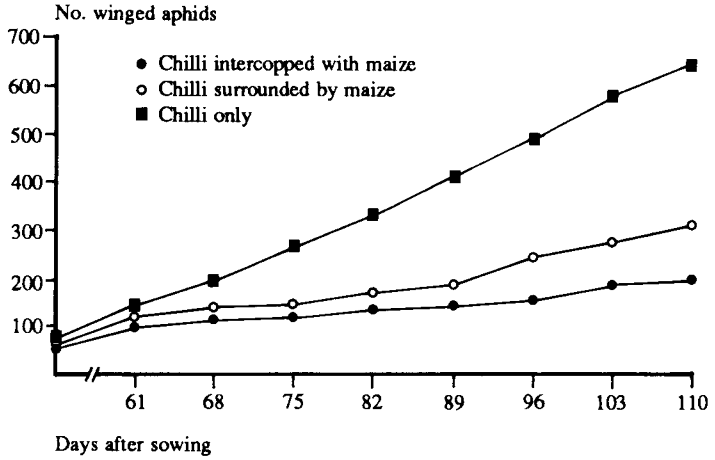

Figure 4. Cumulative numbers of alate aphids caught in plots with and without maize as barrier crop in the second trial (July 1988 – Jan. 1989)

Table 3. Effects of maize planting arrangements on winged aphid populations and viral disease incidences on chilli (2nd trial: July 1988–Jan. 1989)

	No. aphids caught	Mean aphid reduction %	Overall mean viral disease incidence
Intercropping chilli with maize	89.3a	59.6a	49.4a
Chilli surrounded by maize	121.7b	45.0b	64.7b
Chilli only	221.3c		71.4c
F-test	**	*	**
SE$\bar{x}$	4.8	2.3	0.9
C. V. (%)	5.8	7.6	7.9

NB: Values are means of 3 replicates
Means with the same letter are not significantly different one another at 5% level
**: Significant at 1% probability level
* : Significant at 5% probability level

Table 4. Effects of maize planting arrangements on the yields of chilli (2nd trial: July 1988–Jan 1989)

	Yield/plot		Yield/plant	
	Fruit no.	Fruit wt. (g)	Fruit no.	Fruit wt. (g)
Intercropping chilli with maize	2 102.7a	22 461.7a	70.0a	748.7a
Chilli surrounded by maize	2 240.3ab	24 396.7a	44.8b	487.9b
Chilli only	2 473.3b	25 940.7a	35.3c	370.6c
F-test	*	ns	**	**
SE$\bar{x}$	61.7	1 014.3	2.1	20.4
C. V. (%)	4.7	7.2	7.3	6.6

NB: Values are means of 3 replicates
Means with the same letter are not significantly different one another at 5% level
**: Significant at 1% probability level
*: Significant at 5% probability level

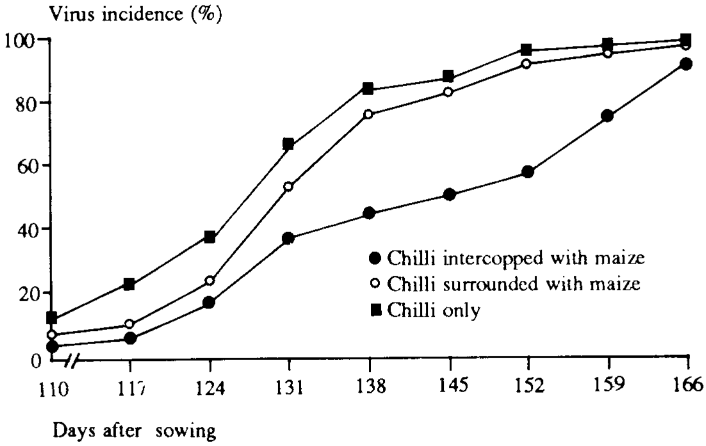

Figure 5. Virus incidence in plots with and without maize as barrier crop in the second trial (July 1988 – Jan. 1989)

plant. This confirms the results of the first experiment.

Discussion

Generally, the effectiveness of intercropping maize and chilli to control virus diseases, could be due to visual effects and physical barrier against vector.

The change in ground cover due to the maize plant has affected the alighting behaviour of alate aphids. This is because of the camouflaging effect of the maize plants. Similarly, work done by various researches had shown that such cultural practice can reduce the flying insect population. Smith (1976) has found that the background effect of weeds in Brussels sprouts planting has minimized aphid *(Brevicoryne brassicae)* captured in pan traps and on the plants. Work in Costa Rica by Risch (1978) has shown that tall maize plants among beans and squash interfered the flight behaviour of beetles.

With the reduction in vector population, virus disease incidence was also reduced. This confirms the results of previous work done in other countries. Simons (1960) reported that virus incidence was reduced by 50% in pepper plots surrounded at three sides with one row of sunflowers. About 70% reduction was obtained by planting a 17 m swath of beans outside the strips of sunflower. Van Rheenan et al. (1981) found that intercropping french bean and maize reduced incidence of bean common mosaic virus. Similarly in Jordan, tomato yellow leaf curl virus was also reduced by interplanting cucumber and tomato (Al-Musa 1982).

Gamez and Moreno (1983) also found that economic loss could be reduced through the intercropping system in Central America where cassava was interplanted with cowpea, and beans with maize to minimize incidence of severe cowpea mosaic virus.

Another factor which might also contribute to the reduction of vector through intercropping is the effect of olfactory inhibition. Feeny (1976) suggested that interplanting two or more crops will confuse the colonization of pests by the mixed odours of different types of plants.

Intercropping chilli with maize can be easily adopted by farmers. A recent survey in Peninsular Malaysia (Hussein 1987) showed that Malaysian farmers are capable and willing to receive and implement technologies which do not impose additional costs or burdens on their limited resources. Hussein and Noraini (1987) reported that chilli intercropped with maize could reduce pesticide application by 50%. Moreover, intercropping is a practice which is already familiar to many farmers.

The adoption of such practices would definitely open the avenue to the adoption of more discriminate chemical and non-chemical practices which could be superimposed on existing ones to enhance the effectiveness of Integrated Pest Management (IPM) programmes.

Acknowledgements

The authors wish to express their sincere appreciation to Dr J. M. Thresh of the Overseas Development Natural Resources Institute, Kent, England for reviewing this paper prior to publication. Thanks are also due to Mr Azam Jamhuri for assistance, Ms Salbiah Husin for statistical analyses of the data, Ms Anita Abbas and Ms Noraini Ibrahim for typing this manuscript.

References

Al-Musa, A. (1982). Incidence, economic importance and control of tomato yellow leaf curl in Jordan. *Plant Dis. 66:* 561–3

Broadbent, L. (1964). Control of plant virus diseases. In *Plant virology* (Corbett, M.K. and Sister, H.D. ed.) p. 330–364. Gainesville: University of Fla. Press.

Feeny, P. P. (1976). Plant apparency and chemical defense. *Recent Adv. in phytochem 10:* 1

Gamez, R. and Moreno, R. A. (1983). The epidemiology of beetle-borne viruses in Central America. In *Plant virus* epidemiology (Plumber, R. T. and Thresh, J.M. ed.) p. 103–13. Oxford: Blackwell.

Hussein, M. Y. (1987). Perception and management of pests and pesticides by Malaysian traditional small farmers - A case study. In *Management of pest and pesticides: Farmer's perceptions and practices* (Tait, J. and Napompeth, B. ed.) p.142–9. West View Press.

Hussein, M. Y. and Noraini, A. S. (1987). Appropriate technology for chilli pest management under small farm conditions. *UPM Research News. 1 (4)*: 8–9

Risch, S. (1978). Effects of resource diversity on the population dynamics of several pests in a tropical agroecosystem: monocultures and polycultures of corn, beans and squash in Costa Rica (abstract). *Bull. Ecol. Soc. Am. 59:* 53

Mohamad Roff, M. N., Saharan, H. A. and Ong, C. A. (1989). Research on chilli viruses in Malaysia. Paper presented at the AVRDC Planning Meeting for Germplasm Improvement Sub-network of ADB project, 31 May-2 June 1989, AVRDC, Taiwan

Shukor, M. N., Chew, B. H., Noraini, S. and Mohamad Roff, M. N. (1988). Tomato and chilli pepper growing in Malaysia : A country report. *Proc. of the int. symp. on integrated management practices.* (Theme: Tomato and pepper growing in the tropics.) 21–26 March 1988, p. 508–520. Shanhua, Tainan: AVRDC

Simons, J. N. (1957). Effects of insecticides and physical barriers on field spread of pepper vein banding mosaic virus. *Phytopathology 47*: 139–45

Smith, J. G. (1976). Influence of crop background on natural enemies of aphids on Brussels sprouts. *Ann. Appl. Biol. 83:* 15

Thresh, J. M. (1983). Progress curves in plant virus disease. *Adv. Appl. Biol. 8:* 1–85

Van Rheenan, H. A., Hasselbach, O. E. and Mulgai, S. G. S. (1981). The effect of growing beans together with maize on the incidence of bean diseases and pests. *Neth. J. Plant Path. 87:* 193–9

Accepted for publication on 16 January 1991