RESULTS AND DISCUSSION

I. Greenhouse Tests

Data presented in Table 1 clearly indicate that all treatments with various concentrations of milcurb and morestan used as foliar sprays or soil drench significantly controlled the disease compared to the nontreated control. Milcurb applied as soil drench gave significantly higher disease control than that obtained by foliar sprays.

Morestan sprays were more effective than milcurb sprays in decreasing the number of powdery mildew lesions per individual and the total number of infected leaves. However, spraying with Morestan was equally effective in controlling the disease compared with Milcurb soil treatments.

Foliar and soil application of Milcurb has resulted in the complete disappearance of powdery mildew lesions previously observed at random prior to fungicidal treatments. This supports the previous finding (1,2,3,6) of the chemotherapeutic action of this compound.

Phytotoxicity resulting from treatments with milcurb has been observed. In preliminary greenhouse tests application of miscalculated dosages of 12,500 and 2,500 ppm (a,i) used as foliar spray and soil drench respectively, induced severe marginal necrosis, wilting, and total collapse of plants in less than 48 hours following treatments. Although

A B

Fig. 1. (A) right: Phytotoxicity induced by milcurb soil application at the rate of 1,000 ppm (a,i). Compare to control at left.
(B) right: The same reaction induced at 2,000 ppm (a,i)
Note: wilting of control plants is due to extended exposure to sunlight.

phytotoxicity to cucumber has been reported (1), the nature of such a reaction was not revealed.

Succeeding experiments have shown two types of phytotoxicity of Milcurb. The first is epinastic in nature and characterized by marginal downward curling of leaves typically resembling the appearance of an umbrella (Fig. 1). The second is characterized by the appearance of a water-soaked lesion followed by interveinal chlorosis and terminating in marginal necrosis. Both reactions were mild in intensity and occured upon foliar spray or soil treatments with Milcurb at the rates of 1,000 and 2,000 ppm (a,i) respectively. No phytotoxicity was observed when Milcurb sprays or soil drench were applied at the rate of 500 ppm (a,i).

Both phytotoxic reactions were more pronounced with soil treatment and with higher dosages than with foliar spray or lower dosages of the fungicide. Since Milcurb tend to accumulate around leaf margins (1,3,10) and has a restricted systemic movement when applied as foliar spray (1), it is suggested that its phytotoxicity can be partly attributed to its accumulation in higher dosages around leaf margins. It is also postulated that the intensity of these phytotoxic reactions upon soil application is in part due to the efficient translocation of Milcurb through the absorptive root system. No phytotoxicity was observed with Morestan treatments.

Results of these tests have confirmed the protective and curative effect of Milcurb against the disease. In particular, one single soil application of this fungicide at 500 ppm (a,i) has resulted in complete freedom from the disease for at least one month following treatment. Despite the mild phytotoxic reactions observed, this fungicide offers a promising prolonged protective and curative action in controlling the disease. This is of utmost importance when the nature of fast growing crops such as cucumber which often necessitate the cumbersome repeated application of nonsystemic protective fungicides, is taken into economic considerations.

II. Field Experiment

Results are summarized in Table 2, 3, and 4, and illustrated in (Fig. 2, 3 and 4). Disease index (I) reflects the effect of the two fungicides on the disease severity irres-

Table 1 Mean number of lesions of powdery mildew, and number of dead infected leaves of cucumber treated with Milcurb and Morestan

Treatment and rate in ppm (a,i)	Method of applocation	Number of lesions[1]		
		Per individual infected leaf	Per total number of infected leaves	Number of dead[1] infected leaves
Control	—	43.6 **a**[2]	17.15 **a**[2]	12.16 **a**[2]
Morestan (500)	Spray	00.0 **d**	00.00 **d**	00.00 **b**
Morestan (1,000)	Spray	00.0 **d**	00.00 **d**	00.00 **b**
Milcurb (500)	Soil	00.0 **d**	00.00 **d**	00.00 **b**
Milcurb (1,000)	Soil	00.0 **d**	00.00 **d**	00.00 **b**
Milcurb (2,000)	Soil	00.0 **d**	00.00 **d**	00.00 **b**
Milcurb (250)	Spray	9.3 **b**	2.12 **b**	00.00 **b**
Milcurb (500)	Spray	4.0 **c**	0.53 **c**	00.00 **b**

[1] Values represent means of six replications, each consisting of 3 plants.

[2] According to Duncan's Multiple Range Test, means followed by the same letter do not differ significantly at the 5% level.

Table 2 Disease index (II) of powdery mildew, irrespective of, and within each of two cucumber varieties treated with Milcurb and Morestan

Treatment and rate in ppm (a,i)		Method of application	Disease Index		
			Irrespective of[1] host variety	Within host varieties[2] Alpha green	Ashly
Control		—	76.25**a**[3]	77.75**a**[3]	74.75**a**[3]
Milcurb	(2,000)	Soil	4.50**c**	9.00**d**	00.00**c**
Milcurb	(500)	Spray	11.00**c**	22.00**c**	00.00**c**
Morestan	(1,000)	Soil	73.00**a**	77.00**a**	72.25**a**
Morestan	(500)	Spray	46.00**b**	66.75**b**	27.00**b**

[1] Values represent means of eight replications, each consisting of 16 plants.
[2] Values represent means of four replications each consisting of 16 plants.
[3] According to Duncan's Multiple Range Test, means followed by the same letter do not differ significantly at the 5% level.

Table 3 Disease Index (I) of powdery mildew and fruit yield irrespective of host varieties treated with Milcurb and Morestan

Treatment and rate in ppm (a,i)		method of application	Disease[1] Index	Fruit Yield[2] in Kg.
Control		—	147.50**a**[3]	29.48**b**[3]
Milcurb	(2,000)	Soil	7.00**d**	43.95**ab**
Milcurb	(500)	Spray	28.25**c**	54.92**a**
Morestan	(1,000)	Soil	142.50**a**	29.35**b**
Morestan	(500)	Spray	96.00**b**	51.44**a**

[1,2] Values represent means of 8 replication, each consisting of 32 plants.
[3] According to Duncan's Multiple Range Test, means followed by the same letter do not differ significantly at the 5% level.

Table 4 Disease index (I) of powdery mildew, and fruit yield of two cucumber host varieties treated with Milcurb and Morestan.

Treatment and rate in ppm (a,i)		Method of application	Disease Index[1]		Fruit Yield in Kg[2]	
			Variety Alpha Green	Variety Ashly	Variety Alpha Green	Variety Ashly
Control		—	152.50**a**[3]	142.50**a**[3]	36.70**b**[3]	22.25**b**[3]
Milcurb	(2,000)	Soil	14.00**d**	00.00**c**	56.60**ab**	23.30**ab**
Milcurb	(500)	Spray	53.50**c**	3.00**c**	76.72**a**	33.10**ab**
Morestan	(1,000)	Soil	154.00**a**	136.50**a**	37.70**b**	21.02**b**
Morestan	(500)	Spray	129.50**b**	62.50**b**	56.57**ab**	46.37**a**

[1,2] Values represent means of 4 replications, each consisting of 32 plants.
[3] According to Duncan's Multiple Range Test, means followed by the same letter do not differ significantly at the 5% level.

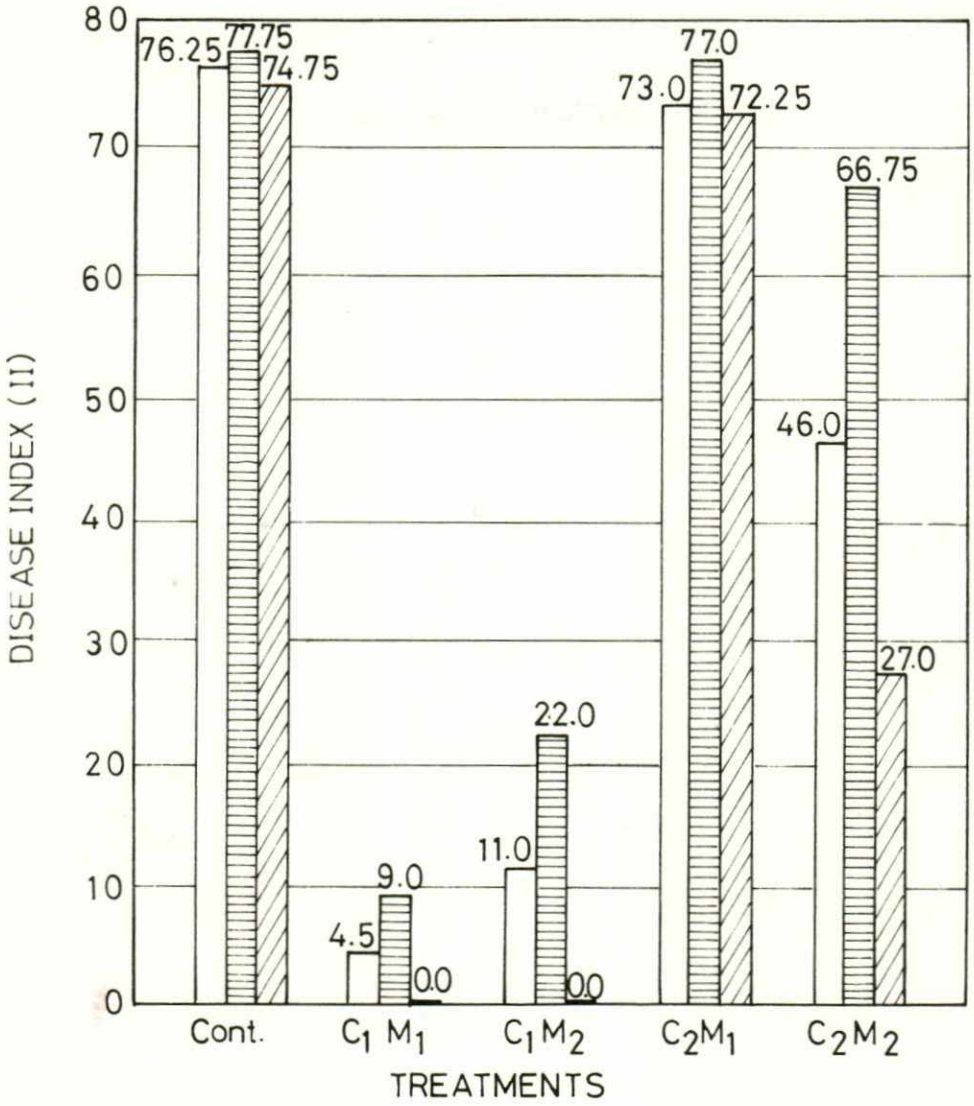

Fig. 2. Disease index (II), irrespective of, and within each of two cucumber varieties treated with milcurb and moreston.

Legend

□ irrespective of host var. ▤ alpha green
▨ ashly cont:non treated

C_1M_1: milcurb soil application C_1M_2: milcurb spray
C_2M_1: morestan soil application C_2M_2: morestan spray

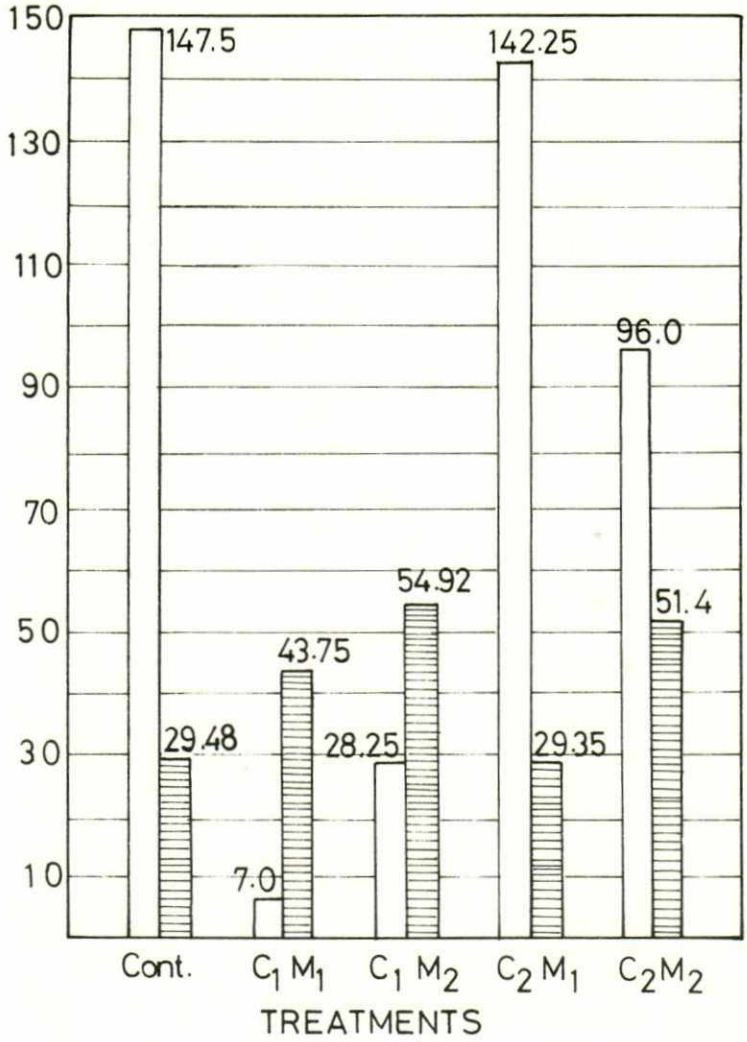

Fig. 3. Disease index (I) and fruit yield irrespective of host varieties treated with milcurb and morestan.

Legend

□ disease index(I)

▤ fruit yield in kg.

Cont : non treated C_1M_1 : milcurb soil application

C_1M_2 : milcurb spray C_2M_1 : morestan soil application

C_2M_2 : morestan spray

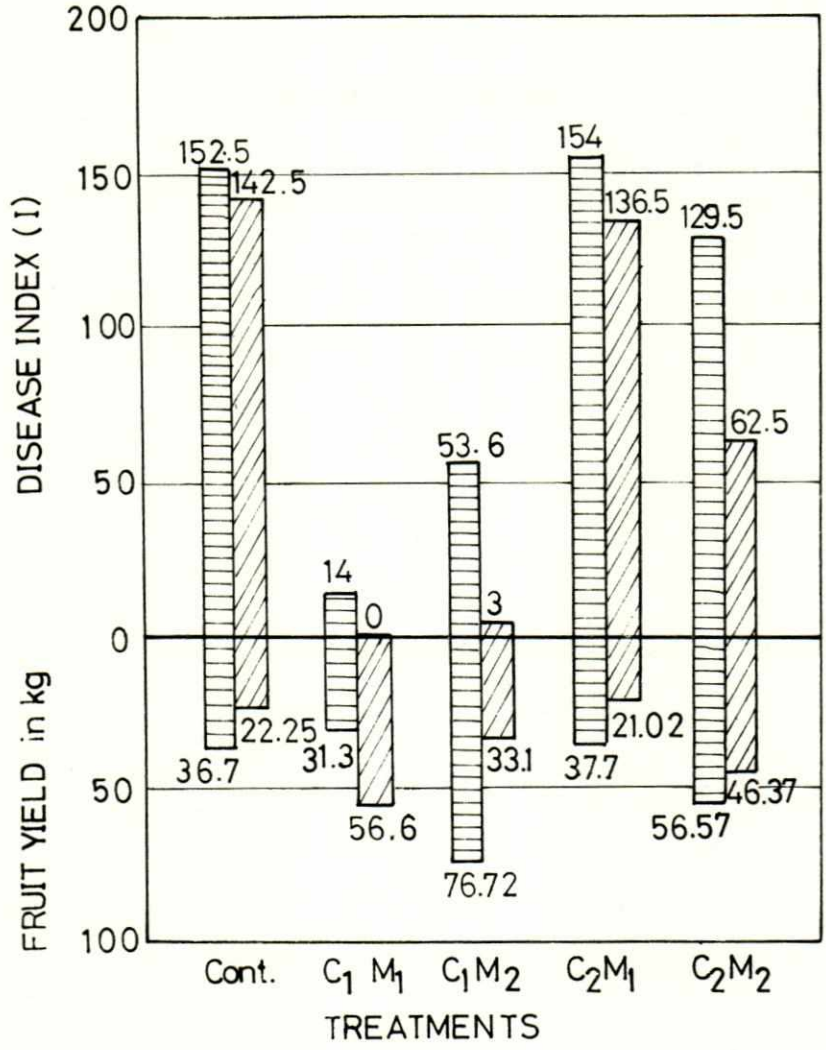

Fig. 4. Disease index (I) and fruit yield of two cucumber host varieties treated with milcurb and morestan.

Legend

Alpha green

Ashly

Cont : non treated

C_1M_1 : milcurb soil application

C_1M_2 : milcurb spray

C_2M_1 : morestan soil applicn.

C_2M_2 : morestan spray

pective of the host variety (Table 3, Fig. 3). Disease index II represents the comparable effect of the two fungicides on the disease severity within each of the two host varieties (Table 2, Fig. 2). Data expressed by disease index (I) and disease index (II) irrespective of, and within each host variety are essentially similar. These results strongly indicate uniformity of infection, and the absence of any possible interference due to border effect among neighbouring variously treated plots.

Table 2 reveals the changes in disease index (II) associated with various treatments with Milcurb and Morestan. Soil application of morestan completely failed to control the disease. Morestan foliar spray, however, gave significant reduction in disease severity. Milcurb used as soil drench or foliar spray proved to be the most outstanding in controlling the disease. Within the variety Ashly, this fungicide completely prevented infection and within the variety Alpha green, infection was significantly reduced to the lowest level. In all comparisons, Milcurb produced significantly higher reduction in disease indices than did Morestan (Table 2, Fig. 2). Foliar spray or soil treatment with Milcurb gave significantly comparable disease control irrespective of host varieties and also within the variety Ashly. However, soil treatment with Milcurb in the variety Alpha green gave significantly higher reduction in disease indices than did milcurb foliar spray.

Both host varieties appear to be similarly susceptible to the disease. This is evident by the severity of infection in the nontreated controls of both varieties (Table 2 and 4). It is noticed, however, with the exception of Morestan soil treatment, that application of both fungicides gave a greater reduction in disease severity in the variety Alpha green. (Table 2, and 4, Fig. 2 and 4). This observation indicates the presence of a differential chemical/host variety response favouring disease control in the variety Ashly. This suggested differential response was not, however, reflected on fruit yield (Table 4).

Data presented in Table 3 (Fig. 3) show the changes in disease index (I), irrespective of host varieties, in relation to fruit yield influenced by various treatments. Again, soil application of Morestan failed to control the disease and increase the yield compared to the control. Morestan and Milcurb foliar spray significantly lowered disease severity and increased fruit yield. Milcurb soil application gave the highest significant reduction of disease severity and substantially increased fruit yield, although the latter was not significantly different from that of the control or the Milcurb foliar treated plots.

Table 4 and (Fig. 4) reveals the relation of disease index (I) to fruit yield within each host variety subjected to various treatments, within each host variety Morestan soil application as before failed to show any significant reduction in disease severity or improvement in fruit yield as compared to the nontreated control. All other treatments significantly controlled the disease in both host varieties. Milcurb soil application offered the best control of the disease in both varieties and gave significantly lower disease indices than did Milcurb or Morestan foliar treatments.

Within the variety Alpha green, although foliar spray with both fungicides greatly increased fruit yield, only Milcurb foliar treatment gave significantly higher fruit yield compared to the control. Regarding the variety Ashly only Morestan foliar spray gave any significant increase in fruit yield compared to other treatments (Table 4, Fig. 4).

The failure of some treatments, notably Milcurb soil application to give a significant increase in fruit yield despite the striking level of disease control cannot be fully explained. Unknown physiological factors irrespective of stress due to disease severity, such as host response to nutrition or other soil factors invariably affecting yield might be involved. Also the delay in the appearance of increasing disease severity, in addition to the fact that only yield data following fungicidal treatments were assessed, thereby

neglecting the part of fruit yield taken prior to treatments might be, in part, contributing factors to the failure in increasing the fruit yield. Nevertheless, the increase in fruit yield within the variety Alpha green is considered economical and warrants further investigation.

Phytotoxicity resulting from treatment with milcurb has been observed in the field. Marginal necrosis and intervenal chlorosis of affected leaves were the predominant features. Phytotoxicity appeared only upon soil treatment at the rate of 2,000 ppm (a,i) and was more pronounced in the variety Alpha green.

Regardless of the host variety used, results of this work confirmed the superiority of Milcurb soil treatment as an effective method of controlling powdery mildew of cucumber and substantially increased fruit yield in the variety Alpha green.

Further experiments with Milcurb are needed to determine: (1) the minimum non-phytotoxic dosages required for maximum disease control, (2) the best timing of application in relation to developmental stages of the host growth, (3) frequency of application, (4) any possible interaction between host variety and method of application.

SUMMARY

Greenhouse and field experiments were conducted to control powdery mildew of cucumber with Morestan and Milcurb. In greenhouse experiments, Morestan was used as foliar spray at weekly intervals for 5 weeks at the rate of 250 and 500 ppm; whereas, Milcurb was used as foliar spray for 3 times at two week intervals at the rate of 200 and 500 ppm, and as soil drench applied twice at a one month interval at the rates of 500, 1,000, 2,000 ppm.

In field experiments, Milcurb and Morestan were used as foliar sprays once every two weeks for 3 sprays at the rate of 500 ppm. Soil application with Milcurb and Moreswas done twice at one month interval at the rates of 2,000 and 1,000 ppm, respectively.

In greenhouse experiments, Milcurb applied as soil drench gave significantly higher disease control than that obtained by foliar sprays in decreasing number of powdery mildew lesions per individual and total number of infected leaves. However, spraying with Morestan was equally effective in controlling the disease compared with Milcurb soil treatments. Phytotoxicity was observed upon foliar spray or soil treatments with Milcurb at the rates of 1,000 and 2,000 ppm, respectively.

In field experiments, soil application of Morestan completely failed to control the disease. Morestan foliar spray, gave significant reduction in disease severity. Milcurb used as soil drench or foliar spray proved to be the most outstanding in controlling the disease. Phytotoxicity resulting from soil treatment with Milcurb at the rate of 2,000 ppm was observed.

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