*Indian Journal of Agricultural Sciences* 71 (7) : 460–2, July 2001

# Economic evaluation of fungicides for leaf blight (*Alternaria alternata*) control in the transplanted crop of 'Shivalik' menthol mint (*Mentha arvensis*)

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Received: 23 October 2000

ABSTRACT

A study was conducted during rainy (*kharif*) season of 1997,1998 and 1999 to evaluate the different fungicides for control of leaf blight of menthol mint (*Mentha arvensis* L.) caused by *Alternaria alternata* (Fr.) Keissler and to determine most economical optimal application schedule. Chlorothalonil provided maximum disease control, though the other fungicides mancozeb, thiophanate-methyl and copper oxychloride were also effective. The chlorothalonil-sprayed plots gave 45% greater yield of essential oil compared with the unsprayed plots. Three applications of chlorothalonil at 15-day intervals provided economically acceptable disease control with maximum increase (40%) in essential oil yields and total net returns (Rs 7 700).

**Key words:** Fungicides, Evaluation, *Alternaria alternata, Mentha arvensis*, Chlorothalonil

The oil of menthol mint (*Mentha arvensis* L.) is a natural source of l- menthol widely used in food, pharmaceutical and perfumery industries. India produces more than 12 000 tonnes (>50% of total world's production) of menthol mint oil valued at about Rs 4 200 million (Singh *et al.* 1999). Of late, there had been an increased interest of growers towards cultivation of menthol mint as transplanted crop so as to have another food crop like potato, mustard, gram or even wheat before *M. arvensis* (Kumar *et al.*, 1999).

Leaf blight, caused by *Alternaria alternata* (Fr.) Keissler, is one of the most serious diseases of menthol mint (Shukla *et al.* 1999) when cultivated as transplanted crop and is particularly damaging when there are few showers or high humidity during the later stages of crop growth. No information is so far available on the management of this disease through fungicides and in the absence of which growers have to incur heavy yield losses. The objective of this study was to compare the efficacy of different fungicides and to determine the most economical optimal spray schedule of the most effective fungicide for the leaf blight control.

## MATERIALS AND METHODS

The experiment was conducted at the Field Station, Central Institute of Medicinal and Aromatic Plants, Pantnagar. Soil was clay loam with *p*H 7.5 and the plots were fertilized with 100, 40 and 40 kg N, P and K respectively. The nursery of 'Shivalik' *M. arvensis* (susceptible to leaf blight) was raised in the nursery beds 3 m × 3 m through suckers (Kumar *et al.* 1997). Well-grown plants were transplanted 40 cm apart in the field during first week of April in 1997 and 1998 in randomized block design with 5 replications.

Four fungicides, viz. thiophanate methyl 0.28 kg ai/ha (Roko 70 WP), copper oxychloride 0.60 kg ai/ha (Blitox 50 WP), chlorothalonil 0.90 kg a i/ha (Kavach 75 WP) and mancozeb 0.90 kg a i/ha (Dithane M-45 75 WP), selected on the basis of their *in-vitro* toxicity against *A. alternata*, were included in the study. All the fungicides were sprayed 3 times (50,65 and 80 days after transplanting) at the required concentrations suspended in 400 litres/ha with the help of a foot -powered sprayer.

Another trial was conducted to determine the most economically optimal schedule of chlorthalonil, found superior among the tested fungicides. The plants raised in the nursery were transplanted in April 1998 and 1999 in 8 $m^2$ plots, 40 cm apart in randomized block design with 6 replications. There were 4 treatments (3,2 and 1 sprays of chlorothalonil and a no-fungicide control).

Ten plants were randomly selected from each replication and rated for leaf damage on a modified 1–9 scale where 1 represented no symptoms and 9 represented >80% leaf area damaged (Subramaniam *et al.* 1980). At least 10 random plants were also sampled from each replication and number

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Table 1 Effect of different fungicides on severity of leaf blight and yield of 'Shivalik' *Mentha arvensis* cultivated as transplanted crop (mean data of 1997 and 1998)

| Fungicide | Disease severity# | Defoliation* | Herb yield (tonnes/ha) | Oil content (%) | Oil yield (kg/ha) |
|---|---|---|---|---|---|
| Thiophnate -methyl | 2.6 | 4.0 | 14.1 | 0.80 | 100.3 |
| Copper oxychloride | 3.4 | 6.0 | 13.6 | 0.79 | 96.1 |
| Chlorothalonil | 2.4 | 3.0 | 16.0 | 0.86 | 122.0 |
| Mancozeb | 3.0 | 4.0 | 14.9 | 0.83 | 110.8 |
| Control | 5.1 | 7.0 | 12.4 | 0.76 | 84.1 |
| LSD ($P$=0.05) | 0.87 | 2.1 | 0.8 | 0.04 | 10.5 |

* Average number of paired leaves defoliated from the main stem; #severity measured on 1–9 scale where 1, no symptom; 2, up to 10%; 3, 11 to 20%; 4, 21 to 30%; 5, 31 to 40% 6, 41 to 50%; 7, 51 to 65%; 8, 66 to 80%; 9, > 80% of leaf area damaged

Table 2 Influence of number of chlorothalonil applications on leaf blight and yield of 'Shivalik' *Mentha arvensis* when cultivated as transplanted crop (mean data of 1998 and 1999)

| Number of sprays | Disease severity | Defoliation* | Leaf : stem ratio | Herb yield (tonnes/ha) | Oil content (%) | Oil yield (kg/ha) |
|---|---|---|---|---|---|---|
| 3 | 2.2 | 2.0 | 0.85 | 16.5 | 0.77 | 118 |
| 2 | 3.1 | 3.0 | 0.80 | 15.2 | 0.75 | 101 |
| 1 | 3.9 | 5.0 | 0.78 | 14.3 | 0.73 | 92 |
| 0 | 5.2 | 7.0 | 0.66 | 13.6 | 0.69 | 84 |
| LSD ($P$=0.05) | 0.76 | 1.9 | 0.06 | 0.9 | 0.04 | 12.7 |

* Average number of paired leaves defoliated from the main stem

of leaves defoliated and the leaf : stem ratio were recorded.

The essential oil content was determined by hydro-distillation of herbage for 2 hr (Langenau 1948) in the Clevenger-type apparatus. The menthol content in the essential oil was determined by gas chromatography using Varian 3400CX with multiple temperature programme and FID detector having capillary column (Supelcowax 10) 30 m × 0.25 mm.

## RESULTS AND DISCUSSION

Blight developed slowly during May end or June beginning when precipitation was low during both the years. However, it developed rapidly after a few showers and with the increase in relative humidity during June end and July. The development of disease was slow in-fungicide treated plots but it increased rapidly in non-sprayed plots.

Of the fungicides tested, chlorothalonil was the most effective. Leaf-blight development was the least and disease severity at the end of season was the lowest in chlorthalonil-sprayed plots; though all the other fungicides were also effective in suppressing the disease (Table 1). Application of fungicide lead to a significant improvement in herb and oil yields; the maximum being with chlorothalonil, followed by mancozeb, thiophnate-M and copper oxychloride. The content of essential oil was also observed to be higher in the fungicide treated plots (Table 1). However, spray of fungicides did not affect the content of menthol, which varied from 71 to 74%.

Three sprays of chlorothalonil were most effective in reducing the severity of disease and defoliation. The total essential oil yield was reduced to 71% when no fungicide was applied compared to plots sprayed with chlorothalonil thrice (Table 2). Three applications of chlorothalonil resulted in a crop value in excess of Rs 11,900/ha based on returns from essential oil. The net returns were more than Rs 7 700/ha higher in chlorothalonil sprayed (3 times) plots and this schedule was the most economically optimal (Table 3).

The study showed that under commercial growing conditions fungicide sprays contributed substantially to the productivity and economic viability of transplanted mint crop under *tarai* conditions; a prime area for mint cultivation where *Alternaria* leaf blight is a major limiting factor for the successful cultivation of the transplanted crop of menthol mint. The major effect of leaf blight seems to be leaf damage and defoliation of lower leaves that contribute significantly for the content of essential oil.

No information exists on the management aspect of *Alternaria* disease in the transplanted crop of *M. arvensis* and in the absence of which growers suffer serious economic losses. The present study showed that applications of chlorothalonil in *M. arvensis* can prevent the development of blight and reduce the overall severity of disease, resulting

Table 3 Economic responses in relation to untreated control for the number of chlorothalonil applications for the control of leaf blight in the transplanted crop of *Mentha arvensis*

| No. of applications | Increase in oil yield (kg) | Value of additional yield (Rs) | Cost of fungicide applications | Mean net returns (Rs) |
|---|---|---|---|---|
| 3 | 34 | 11 900 | 4 200 | 7 700 |
| 2 | 17 | 5 950 | 2 800 | 3 150 |
| 1 | 08 | 2 800 | 1 400 | 1 400 |

Net return = Total returns—total cost; Cost per fungicide application = Rs 1 400 includes cost of fungicide and use of labour; total return is the value of the yield increase with oil valued at Rs 350/kg

in significant increase in essential oil yields. Vakalounakis and Malathrakis (1988), Brignai *et al.* (1990); and Davis *et al.* (1997) reported effective control of plant diseases caused by *Alternaria* by chlorothalonil on several other crops.

Plants sprayed with chlorothalonil thrice at fortnightly intervals gave the highest herbage and oil (Table 1). It was concluded that chlorothalonil is superior to other fungicides for leaf blight control in menthol mint and its application at 15-day intervals provides maximum return and this schedule is most economically optimal.

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