Field performance of some selected fungicides in the control of *Cercospora* leaf spot disease of groundnut (*Arachis hypogae* L.) in Ghana

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SUMMARY

Five fungicides, Benomyl, Carbendazim, Metiram, Tridemorph and Triphenyltin hydroxide, were tested over 3 and 4 years in the field as weekly and forthnightly foliar sprays and as seed-dressing chemicals against *Cercospora* leaf spot disease of groundnut. For spraying, concentrations of 0.2 per cent (Benomyl, Carbendazim, Triphenyltin hydroxide) and 0.3 per cent (Metiram and Tridemorph) were used. For seed-dressing, the rates were 3.0 g a.i./kg of seed (Benomyl, Carbendazim and Triphenyltin hydroxide) and 4.8 g a.i/kg of seed (Metiram and Tridemorph). Benomyl and Carbendazim significantly reduced leaf spot incidence more than Triphenyltin hydroxide which, in turn, significantly reduced the disease more than Tridemorph and Metiram when sprayed weekly and fortnightly. Weekly spraying gave significantly higher yields than forthnightly spraying. Foliar spraying with the fungicides was significantly more effective (P=0.01) in controlling the disease and inceasing yield than seed-dressing. It is recommended that fortnightly foliar application of 0.02 per cent Benomyl or Carbendazim should be used to control leaf spot disease of groundnut caused by *Cercospora arachidicola* and *Cercosporidum personatum*.

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RÉSUMÉ

TWUMASI, J. K. : *La performance sur terrain de quelques fongicides sélectionnés pour le contrôle de* Cercospora *la maladie tâche-feuille d'arachide* (Arachis hypogea *L.*) *au Ghana.* Cinq fongicides-Benomyl, Carbendazim, Metiram, Tridemorph et Triphenyltin hydroxyde étaient testés pendant 3 et 4 ans sur le terrain par des pulvérisations foliar hebdomadaire et bimensuel et par le traitement de grain avec des produits chimiques contre *Cercospora*-la maladie tâche-feuille d'arachide. Pour la pulvérisation, les concentrations de 0.2 pour cent (Benomyl, Carbendazim, Triphenyltin hydroxyde) et 0.3 pour cent (Metiram et Tridemorph) étaient utilisées. Pour le traitement de graines, les proportions étaient 3.0 g. a.i./kg de graine (Benomyl, Carbendazim et Triphenyltin hydroxyde) et 4.8 g a.i./kg de graine (Metiram et Tridemorph). Benomyl et Carbendazim ont considérablement réduit la fréquence de tâche-feuille plus que Triphenyltin hydroxyde qui, à son tour, a réduit considérablement la maladie plus que Tridemorph et Metiram lorsque la pulvérisation hebdomadaire et bimensuelle est faite. La pulvérisation hebdomadaire a donné des rendements considérablement élevés que la pulvérisation bimensuelle. La pulvérisation de foliar avec les fongicides était considérablement plus effective (P = 0.01) pour le contrôle de la maladie et la croissance de rendement que le traitement de graine. Il est recommendé que l'application foliar bimensuelle de 0.02 pour cent Benomyl ou carbendazim devrait être utilisé pour contrôler la maladie tâche-feuille d'arachide causée par *Cercospora arachidicola* et *Cercosporidium personatum*.

Introduction

Leaf spot disease of groundnut (*Arachis hypogaea* L.) caused by *Cercospora arachidicola* Hori (*Mycosphaerella arachidis* W.A. Jenkins) and *Cercosporidium personatum* (Berk. and Curt.) Deighton (*M. berklevi* W.A. Jenkins) is the most destructive disease of the crop in Ghana and other countries (*Leather*, 1959; Porter, 1970; Elston, Harkness & Macdonald, 1976; Kannaiyan & Haciwa, 1990). Severe infection greatly reduces the photosynthetic surfaces of the crop and consequently results in reduced potential yield. Further, it has also been observed that the life span of the crop is generally determined by defoliation caused by

Cercospora spp. and not by climatic conditions (Porter, 1970); Elston, Harkness & Macdonald, 1976). Groundnut is cultivated in Ghana both as food and cash crop, hence its importance cannot be over-emphasized. Unfortunately, all the popular varieties grown in the country are very susceptible to the disease (Leather, 1959; Chona, unpublished). With resistant varieties not yet developed, chemical control seems to be the most promising alternative control method.

Several workers (Porter, 1970; Smith & Crosby, 1970; Elston, Harkness & Macdonald, 1976; Kannaiyan & Haciwa, 1990) have reported that the disease can be controlled with certain fungicides. Triphenyltin hydroxide (Duter) as foliar spray and as seed-dressing agent has recorded some success in controlling the disease in Ghana, although it was not compared with any other fungicide (Chona, unpublished). It is possible that under Ghanaian conditions, other fungicides may be more effective than Triphenyltin hydroxide. This paper reports the results of field tests on comparative effectiveness of Triphenlytin hydroxide, Carbendazim, Benomyl, Tridemorph and Metiram in the control of *Cercospora* leaf spot of groundnut.

Materials and methods

Two sets of experiments were performed over 3 and 4 years. In the first set, a trial was conducted at Fumesua, near Kumasi, Ashanti Region, in the rain forest zone, where the annual rainfall ranges between 1500 mm and 2000 mm. This area is known to provide favourable conditions for development of the disease (Chona, unpublished). Plants were sown between 5th and 8th June, 1986, 1987, 1988 and 1989, depending on the onset of rains.

The cultivar *Kumawu*, one of the most popular but very susceptible varieties of the crop, was used throughout the studies. Planting was done on 5 m long plots at two seeds per hole with spacings of 60 cm and 15 cm between and within rows, respectively. After emergence, 14 days after planting, the seedlings wee thinned down to one seedling per hole. Each treatment consisted of four rows, with the two inner rows to be considered for disease intensity assessment and yield records. A randomized complete block design with four replications was employed.

The five fungicides evaluated were Triphenyltin hydroxide (Duter, 19 per cent w.p.), Tridemorph (Calixin in 75 EC, N-tridecycl-2, 6 dimethylmorpholine), Carbendazim (Bavistin, 2-(methoxycarbamoyl)-2 benzimidazole carbamate, 50 per cent w.p.), Benomyl (Benlate, Methyl (1-butyl Carbamoyl-2-benzimidazole carbamate, 50 per cent w.p.), and Metiram (Polyram-combi, a complex of zineb and polythelene thiuram disulphide, 80 per cent w.p.). Benomyl, Triphenyltin hydroxide, and Carbendazim were used at the rate of 0.02 per cent while Metiram and Tridemorph were used at 0.03 per cent. The rates were used according to the manufacturers' recommendations. The control plots were sprayed with water.

Foliar spraying of groundnut seedlings was started 30 days after sowing when the symptoms of the disease had started appearing. One set of plants was sprayed at weekly intervals and another set at fortnightly intervals, using a conventional low pressure (15-CP) knapsack sprayer. Spraying was done until 72 days after sowing. Thus, weekly spraying was done six times while fortnightly spraying was done three times.

Disease severity was assessed 56 days after the first spraying when there was at least 50 per cent defoliation in the control plants. Assessment was based on a 1-5 scale where

1 = none to very low disease level in which up to 10 per cent of the leaf area of leaves on the first branch has up to five spots;
2 = low disease level in which 11-25 per cent of total leaf area on the first branch is covered by 6-10 spots;
3 = intermediate disease level in which the leaves on the first and second branches are all diseased and completely wilted and spots cover 26-40 per cent leaf area of leaves on the third branch, with some defoliation in the first branch;
4 = high level of disease in which spots cover 41-50 per cent of total leaf area of the whole plant,

with increasing defoliation in the first and second branches; and

5 = very high disease level in which over 50 per cent of the leaf area of the whole plant is spotted, wilted and/or more than 50 per cent of the total number of leaves is defoliated.

Disease severity was measured in terms of the mean disease index (MDI), which is represented by

$$\frac{X_1 + X_2 + X_3 ... + X_n}{N}$$

where $X_1 + X_2 + X_3 ... + X_n$ represents the total numerical ratings in a particular treatment, and N represents the number of plants in that particular treatment. The greater the MDI, the more severe the disease. The assessment was done on the two inner rows of each treatment. The two outer rows of each plot were not considered because of possible spray drift of fungicides into adjacent plots, especially control plots, even though the weather was not windy during the times of spraying. Harvesting of the two inner rows was done on the 14th day after disease assessment. The nuts were air-dried, shelled, and weighed. Yield of two inner rows of each treatment was recorded.

In the second set of experiments conducted at another site at Fumesua in 1987, 1988 and 1989, seed-dressing and foliar spraying were compared to determine which of the two methods was more effective than the other in controlling the disease. Randomized complete block design with three replication was employed. The same fungicides and the same groundnut variety were used as in the first set of experiment. In the first half of this set of experiments, seed lots of the same number of seeds were dressed with Benomyl, Carbendazim and Triphenyltin hydroxide at the rate of 3.0 g a.i./kg of seed and with Metiram and Tridemorph at 4.8 g a.i./kg of seed by shaking in polythelene bags for 5 min and then planted immediately in the field. The concentrations of the fungicides were chosen according to the manufacturers recommendations.

In the second part of this experiment, another set of seeds was planted without being seed-dressed. These were later sprayed, after germination, using the same fungicides at the same concentrations as the first experiment at fortnightly intervals. Appropriate controls, using water, were included in the two parts of the second experiment. The plants were observed three times every week for the development of disease symptoms. Disease assessment, harvesting and yield recording were done as in the first set of experiments. All the data were subjected to statistical analyses, using pooled ANOVA.

Results

The results of the first set of experiments on the effect of frequency of foliar application of different fungicides on *Cercospora* leaf spot intensity and yield of groundnut plants from 1986 to 1989 are presented in Tables 1 and 2, respectively, while the results of comparative studies of seed-dressing and foliar spraying obtained from 1987 to 1989 on disease intensity and yield are presented in Tables 3 and 4, respectively.

TABLE 1

Mean Disease Indices of Groundnut Sprayed Weekly and Fortnightly with Different Fungicides against Cercospora *Leaf Spot Disease at Fumesua, Ghana 1986-1989*

	*Time interval of application**	
Fungicides	*Weekly*	*Fortnightly*
Benomyl	1.1*	1.7*
Carbendazim	1.9	2.4
Triphenyltin hydroxide	2.6	3.0
Metiram	3.2	3.5
Tridemorph	2.8	3.6
Control	4.1	4.1

	LSD		
Type of fungicide	(P=0.05)	(P=0.01)	CV (%)
	0.25	0.34	8.86
Time interval of fungicidal application	0.19	11.49	11.49

* Each figure represents mean for four years of four replications each.

All the fungicides significantly controlled the disease (Table 1), compared to the control (P=0.01). Benomyl and Carbendazim significantly reduced disease severity more than Triphenyltin hydroxide (P=0.01), while Tridemorph and Metiram were significantly less effective than Triphenyltin hydroxide in controlling the disease.

The mean percentage reductions of disease intensity when spraying was done weekly were 65.9 per cent for Benomyl, 53.7 per cent for Carbendazim, 36.6 per cent for Triphenyltin hydroxide, 22.0 per cent for Metiram and 31.7 per cent for Tridemorph. For the fortnightly spraying, the percentage reductions were 58.5 for Benomyl, 41.5 per cent for Carbendazim, 26.8 per cent for Triphenyltin hydroxide, 14.6 per cent for Metiram and 12.2 per cent for Tridemorph. The mean per cent reduction of disease intensity for both weekly and fortnightly spraying showed the order of efficiency to be Benomyl > Carbendazim > Triphenyltin hydroxide > Tridemorph > Metiram. However, there were highly significant differences (P=0.01) between the disease intensities of plants sprayed weekly and those sprayed fortnightly. Weekly spraying was more effective than the fortnightly schedules.

All the fungicides sprayed weekly increased yields more than fortnightly spraying (Table 2). In the weekly spraying, Carbendazim, increased yield by 100 per cent, Triphenyltin hydroxide by 96.4 per cent, Benomyl by 92.9 per cent, Tridemorph by 53.6 per cent, and Metiram by 14.3 per cent. With the fortnightly spraying, Benomyl increased yield by 59.4 per cent, Carbendazim by 37.5 per cent, and Triphenyltin hydroxide by 28.1 per cent. Metiram and Tridemorph did not increase yield.

As shown in Table 3, foliar spraying with all the test fungicides was more effective than seed-dressing in controlling the disease because the differences among their mean disease indices were highly significant. There was no significant difference in the mean disease indices when Benomyl and Carbendazim were used as foliar sprays. They equally performed well and better than Triphenyltin

TABLE 2

Yield (shelled weight kg/plot of two rows of Groundnut Sprayed with Various Fungicides to Control Cercospora *Leaf Spot Disease at Fumena, Ghana from 1986 to 1987*

	*Time interval of application**	
Fungicides	*Weekly*	*Fortnightly*
Benomyl	0.54*	0.51*
Carbendazim	0.56	0.44
Triphenyltin hydroxide	0.55	0.41
Metiram	0.32	0.32
Tridemorph	0.43	0.32
Control	0.28	0.32

	LSD		
Type of fungicide	(P=0.05)	(P=0.01)	CV (%)
	0.08	0.11	19.93
Time interval of fungicidal application	0.05	0.07	22.66

* Each figure represents mean for four years of four replications each.

TABLE 3

Effect of Various Fungicidal Treatments on Leaf Spot Disease Severity of Groundnut, Fumesua, Ghana, from 1987 to 1989

Type of fungicide	*Method of fungicidal treatment**	
	Seed-dressing	*Foliar spraying*
Benomyl	4.0*	1.0*
Carbendazim	4.2	1.0
Triphenyltin hydroxide	4.2	2.8
Metiram	4.4	3.0
Tridemorph	4.0	2.8
Control	4.8	4.7

	LSD		
	(P=0.05)	(P=0.01)	CV (%)
Type of fungicidal treatment	0.11	0.15	5.04
Type of fungicide	0.55	0.73	11.44

* Each figure represents mean for four years of four replications each.

hydroxide. The differences between the efficacy of Benomyl and Carbendazim on one hand and Triphenlytin hydroxide and the other fungicides on the other hand were highly significant. When used as foliar sprays, Benomyl and Carbendazim reduced disease severity by 78.7 per cent as compared with 40.4 per cent by Triphenyltin hydroxide. Benomyl reduced disease severity by 16.7 per cent as compared with 14.3 per cent by Triphenyltin hydroxide when the chemicals were used in seed-dressing.

Table 4 shows the effect ofvarious fungicidal treatments on yield/plot of two rows. Although the yields appear to be generally low, foliar spraying increased yields more than seed-dressing method. However, only Benomyl and Carbendazim gave

TABLE 4

Effect of Various Methods of Fungicidal Treatments on the Yield, (shelled weight kg/plot of two rows) of Groundnut, Fumesua, Ghana, from 1987 to 1989

Type of fungicide	*Method of fungicidal treatment**	
	Seed-dressing	*Foliar spraying*
Benomyl	0.11*	0.19*
Carbendazim	0.08	0.12
Triphenyltin hydroxide	0.10	0.12
Metiram	0.10	0.12
Tridemorph	0.08	0.08
Control	0.07	0.12

	LSD		
	(P=0.05)	(P=0.01)	CV (%)
Type of fungicidal treatment	0.04	0.15	59.93
Type of fungicide	0.06	0.73	51.91

* Each figure represents mean for four years of four replications each.

significantly higher yields when used as sprays than used as seed-dressing chemicals. The differences among the yield of Triphenyltin hydroxide, Metiram, and Tridemorph when used as sprays and as seed-dressing chemicals were not significant. With foliar spraying method, Benomyl increased yield by 72.7 per cent over the control while with seed-dressing, the increase was 57.1 per cent. The remaining fungicides did not increase yield appreciably when used as spray, but the yield increases ranged from 14.3 per cent for Carbendazim and Tridemorph to 42.9 per cent for Triphenyltin hydroxide and Metiram when used as seed-dressing.

Discussion and conclusion

Since the mean disease indices in the controls which were treated with water could not all reach the maximum mean disease index of 5.0, even in the very susceptible variety *Kumawu* cv., the natural inoculum level of *Cercospora* spp. at Fumesua was no very efficient.

The superb fungicidal properties of Benomyl and Carbendazim, as compared with Triphenyltin hydroxide as foliar sprays was, however, clearly demonstrated against *Cercospora* leaf spot of groundnut in these studies. At the time when some control plants were almost dead and wilted, the foliage of plants treated weekly with Benomyl and Carbendazim were still fresh and green. When fortnightly applied as foliar sprays, Benomyl and Carbendazim increased yields and reduced disease severity more than Triphenyltin hydroxide, although their effects were not as significant as when the fungicides were applied weekly. This report on the efficacy of Benomyl and Carbendazim on the control of *Cercospora* leaf spot of groundnut agrees with that of Porter (1970) and Sindhan & Jaglar (1988).

The mean yield of weekly foliar applications of all fungicides was 0.48 kg/plot of two rows, and this was significantly higher (P=0.01) than the 0.40 kg per plot obtained from the fortnightly applications. Also, the mean disease severity for weekly application, 2.3, was significantly lower (P=0.05) than that of fortnightly applications which was 2.8. These results showed that the greater the disease intensity, the lower the yield.

While Tridemorph had a stunting effect on treated plants, Carbendazim produced luxuriant growth, suggesting that some growth substances

were involved in the host-fungicide interactions. This observation needs further investigations. The observed stunting effect of Tridemorph was consistent over the years and seemed to indicate that the fungicide would not be stuitable to control diseases in plants grown for fodder production. Carbendazim would rather be preferred.

Sindhan & Jaglar (1988) reported that Benomyl and Carbendazim enhanced plant disease resistance through increases in total phenol and potassium with decreases in sugars, nitrogen and phosphorus contents of treated plants, and this resulted in the control of *Cercospora* leaf spot disease in groundnut. Perhaps, this phenomenon was exhibited in the present studies. Experiments need to be conducted to find our whether Tridemorph, Triphenyltin hydroxide and Metiram behave otherwise. There were no significant differences in the mean yields obtained in 1986, 1987 and 1988, except 1989 in which the yields were lower than the other years. This was probably due to low yields obtained from Tridemorph-treated plants which were extremely stunted in that particular year and also due to serious erratic rains during the season. Rodent damage could also be partly responsible for it.

Data from Table 4 show that although there is increase in yield when Benomyl was used as seed-dresser, it was only 1.2 per cent lower than the yield increase when the same fungicide was used as a foliar spray. This would suggest that with respect to costs, seed-dressing may be better than foliar spraying. However, because of possible high inoculum build-up due to high disease intensity when the fungicide is used as a seed-dresser, foliar spraying would be preferred.

The two benzimidazoles, Benomyl and Carbendazim, showed clear superiority over Metiram in disease control and yield increase in these experiments, although all the three fungicides are systemic. Like Tridemorph, Triphenyltin hydroxide is not systemic but it is more effective in controlling the dissease and increasing yield in groundnut than Metiram.

Benomyl is reported to have mutagenic effect on fungi. This action leads directly to genetic instability, causing fungi to be either resistant to it or causing resistant biotypes to be produced (Erwin, 1973). Being a benximidazole, Carbendazim behaves similarly. Their continuous use over a long time, beyond 4 years, for example, is, therefore, not recommended. They may be used either in combination with other types or used alternately with such other fungicides if efficient fungicide resistance management is to be practised.

In conclusion, therefore, it can be stated that fungicides other than Triphenyltin hydroxide are available which can be used to control *Cercospora* leaf spot disease of groundnut more effectively in Ghana. These are Benomyl and Carbendazim. Weekly foliar applications of these benximidazoles controlled the disease more effectively and gave higher yields than fortnightly spraying.

Foliar spraying was more effective than seed-dressing in controlling *Cercospora* leaf spot disease and in increasing yield. For economic reasons, however, it can be recommended that bi-weekly foliar application of Carbendazim or Benomyl at the rate of 0.02 per cent instead of Triphenyltin hydroxide should be used to control leaf spot disease of groundnut caused by *Cercospora arachidicola* and *Cercosporidium personatum* in Ghana.

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