EFFICACY OF FUNGICIDES TO CONTROL *PHYLLOSTICTA* LEAF SPOT OF GINGER, YIELD LOSS AND IT'S ECONOMIC ANALYSIS UNDER MID HILLS CONDITIONS

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ABSTRACT

Phyllosticta leaf spot caused by Phyllosticta zingiberi Ramkr is one of the widely spread diseases of ginger (Zingiber officinale Rosc.) occurring through the ginger growing areas of the country. An experiment was conducted during three consecutive years 1997-1999 to estimate the yield losses and select cost effective fungicide against the disease under south faced hills located at 1450 m a s l at Kapurkot, Salyan. Five fungicides i.e. Mancozeb, Copperoxychloride, Carbendazim, Chlorothallonil and Bordeaux mixture were tested against leaf spot and compared with non-treated water sprayed plot. Highest efficacy was observed in Chlorothallonil with disease control 54 percent. No significant yield losses had been observed in control plot, during the experimental period. Results also showed that spraying of any fungicide up to the leaf spot severity of 47 % was not found to be economical for a released ginger variety Kapurkot Aduwa-1 (ZI-9721) under mid hill conditions of Nepal.

Key words: Ginger, *Phyllosticta* leaf spot, fungicides and yield loss

INTRODUCTION

Ginger (*Zingiber officinale* Rosc.) is one of the commercial horticultural export commodities of Nepal being grown basically in the mid hills in a wider area from Mechi to Mahakali. Area under ginger in Nepal is estimated to be 9189 hectares and production 87909 Mt with the national average productivity of 9.57 t/ha (APSD 2002). Lack of high yielding varieties, poor soil fertility and poor knowledge of plant protection measures have been considered as bottlenecks for higher yield.

Regarding with the economically important diseases concern *Phyllosticta* leaf spot (*Phyllosticta zingiberi* Ramakr.) is the second important disease after rhizome rot. It is wide spread through out the ginger growing areas of the country but the severity of the disease was found to be quite variable 5 to 40 % depending on the cultivars grown, size of the rhizome bits planted, cropping pattern and inter cropping and light intensity due to sloping direction of the land (Sharma 2001)

Since this disease is epidemic, ginger farmers of many locations have been found to be worried on this disease with the assumptions of high yield loss. Leaf spot and rhizome rot commonly occur on the same plant under such conditions farmers get confused for identifying primary causal factor for yield loss.

Phyllosticta leaf spot is observed on leaves especially when the crop is grown under exposed conditions. The disease starts as water soaked, oval to elongated spots and later turns as whitish spot surrounded by dark brown margin with a yellowish halo. Pycnidia appear on

mature lesions and remain viable for about 14 months in leaf debris. Spores ooze out into water drops on the leaves and get dispersed through rain splashes (Brahma and Nambiar1982 and 1984).

The pathogen is both seed and soil borne. *Phyllosticta* leaf spot is noticed at any stage of crop growth, but more often when the crop is around 3 months old specially during July September which coincides with onset of monsoon. The disease spread is slow or absent when ginger is grown in shaded area.

Regarding with the resistant varieties to leaf spot Dohroo et al. (1986) reported that none of the ginger types screened was found resistant to P. zingiberi. However, cultivars Maran, Karakkal were reported to be field tolerant to P. zingiberi by Premnathan *et al.*, 1982). The disease can be managed by one or two spray of 1 % Bordeaux mixture (Sharma and Brahma 1973).

However majority of the farmers realized the extent of yield loss is lower than the rhizome rot estimated the yield loss caused by leaf spot ranging 5 to 10 % under Kerala and Himachal Pradesh hill conditions (Dake 1995). Under Nepalese mid hills conditions detail investigation on yield loss was not done in the past. However, Sharma *et al.*, (1998) reported that leaf spot severity ranged up to 40 % and yield loss roughly estimated 10 percent. Farmers are intended to spray fungicides to control leaf spot without knowing its economic threshold levels.

On the other hand, European and American Countries, which are the major consumers of ginger, have their own trade Associations i.e. European Spice Association (ESA) and American Spice Trade Association (ASTA). These Associations strictly follow their minimum quality standard (George 2000). When farmers are exposed to International quality standards and cleanliness specifications, farmers of Palpa have started growing "Organic ginger". Now they need to have disease resistant ginger varieties and economic threshold levels of frequently occurring diseases like rhizome rot and *Phyllosticta* leaf spot.

Keeping these points in view, an experiment was conducted with the objectives of measuring extent of damage due to *Phyllosticta* leaf spot and yield loss on promising ginger variety, selection of cost effective fungicides to manage the disease and reduce the cost of production.

MATERIALS AND METHODS

A field experiment was conducted under natural epiphytotic condition at Kapurkot, Salyan in the consecutive years 1997-1999 to evaluate the efficacy of fungicides and estimate the yield losses due to *Phyllosticta* leaf spot of ginger. There were six treatments including check with three replications arranged in a Randomized Complete Block Design. Fungicides were Mancozeb (Indofil M-45 @ 0.25 %), Copperoxychloride (Blitox- 50 @ 0.25 %), Carbendazim (Bavistin @ 0.1%), Chlorothallonil (Kavach @0.15 %), Bordeaux Mixture (4:4:50) and Check (Water spray). Plot size was 4.5 m^2 providing spacing between plot to plot and block to block, 0.5 m 1.0 m respectively. Experiment was planted on Second week of April in all the three years.

Planting was done at 30 X 30 cm spacing with the seed rhizome bits of around 50g weight having strong healthy sprout. Farmyard manure @ 30 t/ha was applied 5 days prior to planting during final land preparation. Chemical fertilizers were also applied @ 100:50:50 Kg N P K/ ha. Half dose of N, K_2O and full of P_2O_5 were used as basal during planting where as remaining half of N and K_2O were applied as top dressed during first and second intercultural

operations. Dry leaves mulch @ 10 t/ha was applied just after planting to suppress the weeds and conserve the soil moisture since ginger was grown under rain fed conditions. *Phyllosticta* leaf spot disease usually occurs every year in all most all the ginger growing areas of the country but the severity of disease was found always higher on sole crops grown on field facing towards south. Even then, to build up the strong disease pressure spores collected from the naturally infected leaves were incubated for 24 hours at 25° C under humid chamber to initiate the Pycniospore production. After incubation, infected leaves were macerated with the help of mortar and pestle, filtered and sprayed over the experimental plots at 90 days after planting (after first disease scoring) at 4-5 pm. This practice was followed in the first experimental years. Disease severity was recorded based on the leaf area damaged by leaf spot. Randomly thirty leaves were selected from three leaf positions lower, middle and top considering the similar leaf size from each plot. Depending on the level of disease severity, leaves were divided into 5 groups necrotic area on leaf surface was estimated on individual leaf and computed as-

$$\text{Leaf area damage \%} = \frac{\text{Sum of all area damaged (\%) on leaves}}{\text{Total no of sample leaves}}$$

Cost of disease control was analyzed based on price of 1999. Fresh rhizome yield was also recorded at harvest after removing dirt, roots and pseudo stems. Spraying of fungicides was done at intervals of 15 days. Water was sprayed in each spraying on check plot instead of fungicide.

RESULTS AND DISCUSSION

Etiology of Fungus

Microscopic studies conducted at laboratory showed that, infected leaves with mature lesions when incubated into a humid chamber for 24 hours were found to be ready for Pycniospore release from pycnidium as volcanic explosion. Pinpoint brown or black dot like pycnidia could be seen on older lesions with the help of hand lens. Pycniospore get released from ostiole when pycnidium was submersed into water droplets. Pycniospores were hyaline, round or oblong.

Incidence and Severity

During the early crop growth, some dwarf plants developed from shriveled rhizome bits were found to be more prone to *Phyllosticta* leaf spot infection as compared to tall plants of normal growth. In other hand, when secondary infection starts from onset of monsoon top tender leaves get severely infected than the lower and centrally located leaves. Disease incidence was 100 % in all the plots irrespective of treatment but the severity was found to be variable between the treatments. Mean leaf spot severity of three years in the check plot was 47 % and lowest on Chlorothallonil sprayed plot (21%). Disease severity was highest in 1997 (52.5 %) followed by 1998 (49.7 %) and 1999 (38.8 %). Data are presented in Table 1. The reason behind it could be the amount of primary inoculum density of pathogen, rainfall and size of rhizome planted. Rainfall data of three years showed that in 1997 there was 14 rainy days prior to 85 days of crop whereas in 2nd and 3rd year rainy days were 7 and 12 respectively (Fig 6).

Table 1. Efficacy of fungicides to control *Phyllosticta* leaf spot under field conditions at Kapurkot, during 1997 to 1999.

SN	Treatments	LEAF SPOT SEVERITY				DISEASE CONTROL %			
		1997	1998	1999	Mean	1997	1998	1999	Mean
1	Mancozeb (Indofil M-45)	48.60	43.47	33.30	41.79	15.1	20.6	14.1	16.6
2	Copperoxychloride (Blitox- 50)	35.10	25.80	28.07	29.66	33.1	58.2	48.2	46.5
3	Carbendazim (Bavistin)	38.00	28.02	23.77	29.93	27.6	43.6	38.7	36.6
4	Chlorthallonil (Kavach)	29.40	17.20	16.33	20.98	44.0	65.4	52.7	54.0
5	Bordeaux Mixture (4:4:50)	36.80	26.32	24.70	29.27	35.6	55.1	36.3	42.3
6	Check (Water spray)	52.50	49.72	38.77	47.00	0.0	0.0	0	0.0
	F Test	**	**	**					
	CV %	7.37	13.78	12.43					
	LSD (P=0.05)	4.9	7.2	5.7					

Efficacy of Fungicides

Among the fungicides tested, Chlorothallonil 0.15 % was found to be significantly superior to control leaf spot (54%) than Mancozeb (16.6 %). However, Chlorothallonil, Blitox- 50, Bavistin and Bordeaux mixture were found comparable (Fig. 1). Among them cheapest one could be used for leaf spot control, if necessary.

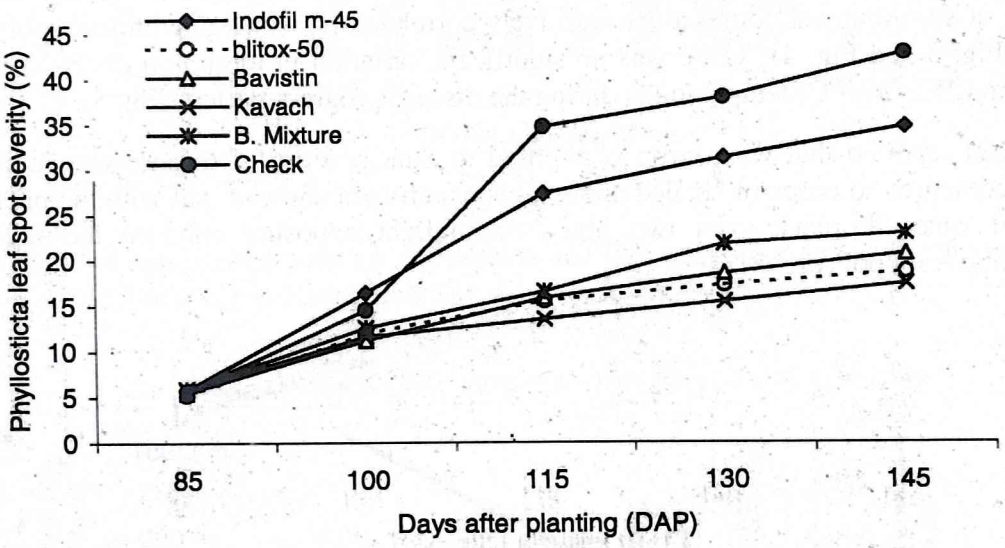

Fig. 1. *Phyllosticta* leaf spot development after fungicides spray in different time intervals, mean of three years (1997-1999) at Kapurkot Salyan.

Effects on Rhizome Yield

There were no significant yield differences between the treatments in all the experimental years. Number of tillers per clump is one of the yield attributing characters of ginger was also found to be non significant (Table 2). There was no correlation observed between disease severity and rhizome yield.

Table 2. Effects of fungicides to control *Phyllosticta* leaf spot and its effect on tillers and rhizome yield under field condition at Kapurkot, during 1997 to 1999.

SN	Treatments	Tillers /clump				Yield t/ha				Yield
		1997	1998	1999	Mean	1997	1998	1999	Mean	Loss%
1	Mancozeb (Indofil M-45 @ 0.25 %)	8.20	7.90	6.40	7.5	42.38	43.23	54.33	46.65	4.42
2	Copperoxychloride (Blitox- 50 @ 0.25 %)	7.70	6.00	5.90	6.5	41.57	49.52	54.03	48.37	0.88
3	Carbendazim (Bavistin @ 0.1%)	8.30	7.30	5.70	7.1	40.53	41.80	57.20	46.51	4.69
4	Chlorthallonil (Kavach @0.15 %)	6.75	7.70	6.80	7.1	42.43	45.20	58.77	48.80	0.00
5	Bordeaux Mixture (4:4:50)	9.50	8.10	6.20	7.9	37.63	47.13	54.33	46.36	5.00
6	Check (Water spray)	7.90	6.80	6.10	6.9	37.13	41.20	51.13	43.15	**11.57**
	F Test	NS	NS	NS		NS	NS	NS		
	CV %	15.8	16.7	29.3		7.60	10.24	6.98		
	LSD (P=0.05)	-	-	-		-	-	-		

Conducive Environment

Micro weather conditions favour for leaf spot disease development. At 70 days after planting infection was just started on tender leaves of dwarf plants. With the onset of monsoon due to secondary infections disease progressed rapidly from 80 to 145 DAP (Fig. 1). Precipitation and sunshine hours were found to be responsible for disease development. Amount of precipitation and leaf spot severity was found positively correlated (r= 0.95) where as, duration of sunshine was found to be negatively correlated (r = - 0.98) with leaf spot severity (Fig. 2, Fig. 3 and Fig. 4). There was no significant variation in minimum (19.8-20.6°C) and maximum (25.2-26.3°C) temperatures during the disease progress period (Fig. 5).

It has been reported that when crop is exposed to Sun, severity of disease was found to be high as compared to crops of shaded areas. This experiment showed that with the presence of sufficient water droplets, even two hours of sunlight exposure enhance the severity of *Phyllosticta* leaf spot (Fig. 3).

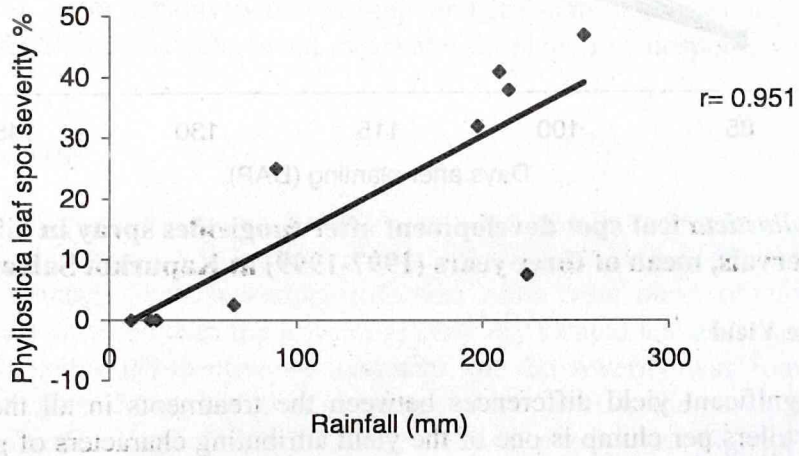

Fig. 2. Correlation between amount of rainfall and *Phyllosticta* leaf spot disease severity at Kapurkot Salyan 1500 m a s l during1998-99.

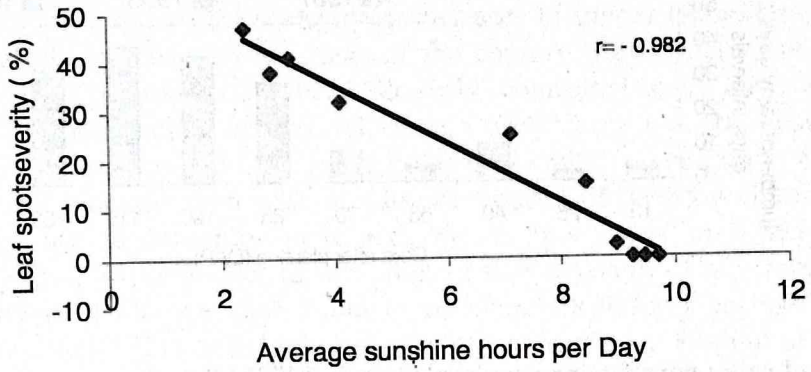

Fig. 3. Correlation of Sunshine hours and leaf spot severity during the observational period at Kapurkot, Salyan during 1997-1999.

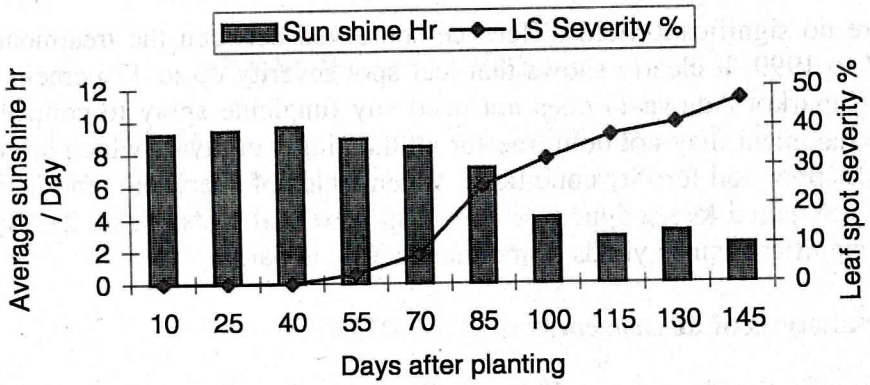

Fig. 4. Effects of sun shine hours on *Phyllosticta* leaf spot severity under south faced mid hills (1450 m a s l) at Kapurkot, Salyan.

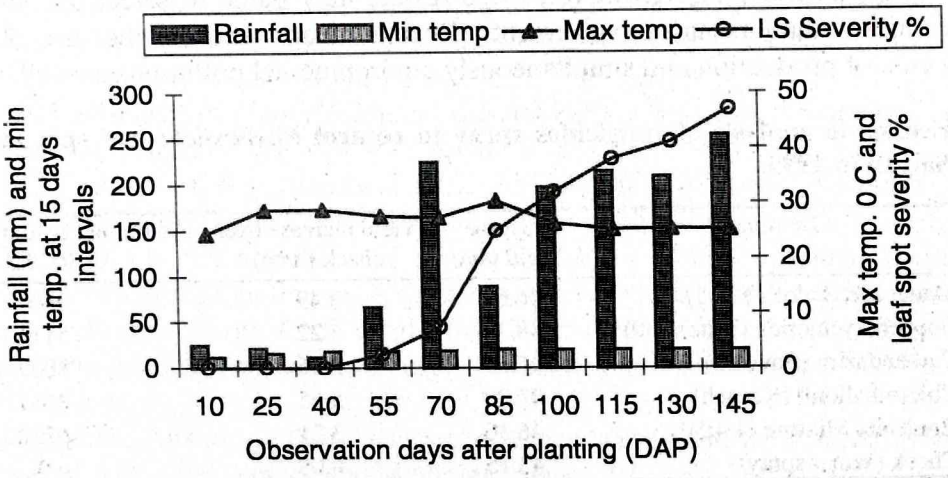

Fig. 5. Effects of Rainfall and temperatures on *Phyllosticta* Leaf spot severity.

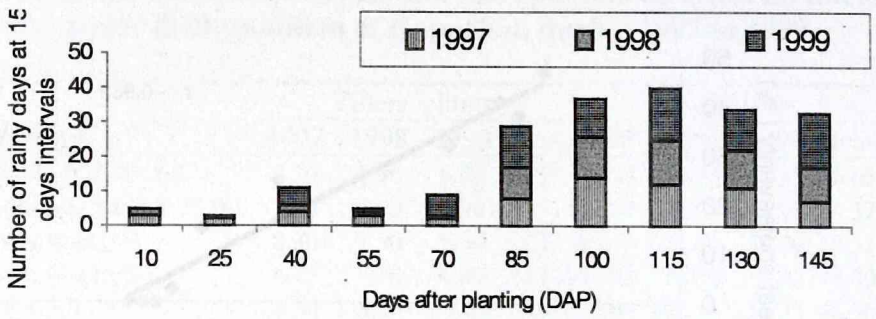

Fig. 6. Number of rainy days during crop period up to 145 DAP in three consecutive years 1997-1999 at Kapurkot, Salyan.

Yield Loss Assessment

There were no significant yield differences observed between the treatments in all the three years1997 to 1999. It clearly shows that leaf spot severity up to 47 percent on ginger variety ZI-9721 (Kapurkot Aduwa-1) does not need any fungicide spray to control *Phyllosticta* leaf spot. This statement may not hold true for all the ginger cultivars which are of short plant and grown under poor soil fertility conditions. When yields of check plot and 54 % disease control plots were compared losses appears 11.57 % in untreated plots (Table 2). This difference was not found significant since yields of treatments were at par.

Economic analysis of disease control

Out of four effective fungicides, Chlorothallonil was found costlier (Rs 8631/ha) followed by Carbendazim (Rs 8069/ha) and Bordeaux mixture (Rs 8631/ha) and Copperoxychloride (Rs 6250/ha) as shown in Table 3. Bordeaux mixture preparation should be cheaper but due to high price of Copper Sulphate in the local market it became expensive than the Blitox-50. Fungicide application to control *Phyllosticta* leaf spot on Kapurkot Aduwa-1 variety does not need any fungicide treatment. However, these results may guide to select the fungicides for other susceptible cultivars and environments. Results clearly showed that use of fungicides increasing cost of production and simultaneously environmental pollutions as well.

Table 3. Economic analysis of fungicides spray to control *Phyllosticta* leaf spot at Kapurkot, Salyan in 1999.

SN	Treatment	Rhizome Yield t/ha	Yield increase over check (t/ha)	Additional cost of treatment Rs./ha
1	Mancozeb (Indofil M-45)	46.65	3.49	4694
2	Copperoxychloride (Blitox- 50)	48.37	5.22	5116
3	Carbendazim (Bavistin)	46.51	3.36	8069
4	Chlorothallonil (Kavach)	48.80	5.65	8631
5	Bordeaux Mixture (4:4:50)	46.36	3.21	6250
6	Check (Water spray)	43.15	0.00	0

Price rate of spray inputs: Indofil M-45@Rs 165/500g; Blitox-50@Rs. 175/500g; Copper sulphate @Rs. 130 /kg; lime (CaO)@Rs. 25/kg; Bavistin @Rs. 115/100 g; Kavach @Rs. 125 /100g; Labour @Rs. 80/labour/ day

CONCLUSION

Phyllosticta leaf spot is one of the wide spread diseases of ginger (*Zingiber officinale* Rosc.) occurring through the ginger growing areas of the country. *Phyllosticta* leaf spot caused by *Phyllosticta zingiberi* Ramkr could be effectively controlled with any one of the four fungicides i.e. Chlorothallonil, Copperoxychloride, Carbendazim, and Bordeaux mixture. The mean severity of disease over the three years in the check plot reached up to 47 %. There was no significant yield increase even with the disease control of 54% by chlorothallonil spray. Since yield was not significantly increased, means there was no yield losses due to *Phyllosticta* leaf spot. Experimental results showed that spraying of any fungicide up to the leaf spot severity of 47 % was not found to be economical for a released ginger variety Kapurkot Aduwa-1 (ZI-9721) under mid hill conditions. Sufficient amount of precipitation (> 1000 mm) and minimum sunshine (2 hrs) during mid growth period enhance the disease development. Bold rhizome bits with strong sprout of "Kapurkot Aduwa-1" variety when planted in a fertile soil preferably in humus soil do not need fungicide spray to control *Phyllosticta* leaf spot under mid hill conditions.

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