

Research Article

Effect of Fungicides and Application Methods for the Management of Pepper Wilt Complex Diseases in Ethiopia

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Abstract

Pepper Wilt complex disease is one of the devastating soil-borne diseases, due to which 68-70% yield loss is recorded. Effects of different fungicides and application methods on wilt incidence and yield of pepper (*Capsicum annum* L.) were tested for two years at Fogera and for one year at Dera districts of South Gondar zone Ethiopia. Effects of fungicides viz. copper oxychloride (Isacope 50WP), mancozeb + metalaxyl (Omaxim), thiamethoxam + metalaxyl + difenoconazole (Apron Star 42WS), copper hydroxide (Sinoko) and application methods viz. seed +seedling treatment, seed + seedling treatment followed by spraying at crown region of the plant on wilt disease incidence and pepper yield were studied at Fogera and Dera districts of South Gondar zone Ethiopia. The fungicides were applied at the rates of 3 kg/ha, 2 kg/ha, 20 g/ha and 2.5 kg/ha for Isacope 50WP, Omaxim, Apron Star 42WS and Sinoko, respectively. The seeds of pepper treated with fungicides and untreated were sown in seedling bed. The 45-day old seedlings were uprooted from the seed bed and subjected to the seedling treatment in different fungicides for 30 minutes and were planted in field. The spraying of the fungicides at crown region of the plant was done at 15 days interval after the initiation of wilt disease. The data on wilt incidence and yield were recorded in each treatment. The price of pepper was assessed from the local market and the total price of the yield obtained from each treatment was computed on hectare basis. Input costs like fungicide and labor were converted into hectare basis according to their frequencies used. Based on the obtained data from the above-mentioned parameters economic analysis was performed. The result of the experiment indicates that, during 2020 year, the highest disease reduction (61.11% and 51.39%) over check and maximum dry pod yield (21.95 q/ha and 48.46 q/ha) was observed with T6 (seed treatment+ seedling treatment +foliar spraying with fungicide Omaxim (mancozeb + metalaxyl) at Fogera and Dera, respectively. Similarly, highest disease reduction (26.66%) and maximum green pod yield was observed in T6 at Fogera during 2021 year. Moreover, economic analysis revealed that T6 (application of seed treatment+ seedling treatment + foliar spraying of fungicide Omaxim within 15 days interval) is effective treatment.

Keywords

Pepper Wilt, Economic Analysis, Fungicide, Seedling Treatment

1. Introduction

Pepper (*Capsicum annum* L.) is the most important vegetable crop in different parts of the world [1]. It is important source of income to smallholder farmers and contributes to export earnings in Ethiopia [2]. But its

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production is declining due to several factors including diseases [3]. Among the known pepper diseases, wilt is major problem causing losses up to 70% [4]. The disease has been observed to be caused by *Fusarium spp.*, *Phytophthora capsici*, *Rhizoctonia solani*, *Sclerotium rolfsii*, and *Verticillium spp.* [5-8]. Now days, crop failure due to wilt diseases has been common in Fogera plane and farmers are forced to abandon their production.

To minimize the problem, number of fungicides has been evaluated by different researchers. Among the fungicides that controlled wilt pathogens: carbendazim, and Ridomil against *F. oxysporum*, Ridomil against *P. capsici*, Carboxin and carbendazim against *R. solani* have been reported [7, 9-10]. Moreover, different methods of fungicide application have been evaluated for management of pepper wilt complex. Among them: seed and seedling treatment in combinations with foliar spraying was found to be more effective than seed and seedling treatment alone [7]. However, there is a lack of information regarding the effectiveness of fungicides and application methods for wilt complex disease in Fogera plains. Therefore, the objective of the study was to evaluate fungicides and application methods for the management of pepper wilt complex.

2. Materials and Methods

The experiments were conducted at Fogera and Dera districts of South Gondar zone Ethiopia during 2020 and 2021 cropping seasons at Fogera and in 2020 at Dera district. Effects of fungicides viz. copper oxychloride (Isacope 50WP), mancozeb + metalaxyl (Omaxim), thiamethoxam + metalaxyl + difenoconazole (Apron Star 42WS), copper hydroxide (Sinoko) and application methods viz. seed + seedling treatment, seed + seedling treatment followed by spraying at crown region of the plant against wilt complex disease were studied. The fungicides were applied at the rates of 3 kg/ha, 2 kg/ha, 20 g/ha and 2.5 kg/ha for Isacope 50WP, Omaxim, Apron Star 42WS and Sinoko, respectively.

The seeds of pepper treated with fungicides and untreated were sown in seedling bed. The 45 day old seedlings were uprooted from the seed bed and subjected to the seedling treatment in different fungicides for 30 minutes and were planted in field. The spraying of the fungicides at crown region of the plant was done at 15 days interval after the initiation of wilt disease. The data on wilt incidence and yield were recorded in each treatment.

The price of dry and green pepper fruit yield was assessed from the local market and the total price of the yield obtained from each treatment was computed on hectare basis. Input costs like fungicide and labor were converted into hectare basis according to their frequencies used. Fungicides cost was estimated based on the price of the local market. Cost of the labor was in Birr per man-days; cost of spray and spray equipment to spray per hectare were also calculated.

Based on the obtained data from the above-mentioned

parameters economic analysis was performed according to the procedure [11]. The dominance analysis procedure as detailed was used to select potentially profitable treatments from the range that was tested and serve to eliminate some of the treatments from further consideration and thereby simplify the analysis. The dominant or dominated treatments were ranked from lowest to highest costs that vary (Tables 2 and 3). A dominated treatment is any treatment that has net benefits that are less than those of a treatment with lower costs that vary [12].

3. Result and Discussion

3.1. Effect of Fungicides and Application Methods on Pepper Wilt Incidence

Result revealed that some the fungicides and application methods significantly reduced wilt incidence and increased yield as compared to check (Table 1). The highest disease reduction (66.66%) over check was observed with T7 followed by T6 and T11 (each 61.11%) at Fogera during 2020 year. At Dera, highest disease reduction (each 51.39%) over check was observed with T6 and 11 followed by T9 (11.95%) and T10 (12.5%) during 2020 year. However, the highest plant wilt, greater than check, was observed in all T5, T8 and T12 which are seedling treated with Apron star at both locations during 2020 year. It might be due to toxicity of seed treatment recommended dose fungicide Apron star for seedling treatment. The fungicide had recommendation rate for seed treatment, but not had seedling treatment recommendation. The highest disease reduction over check was observed with T6 (21.1%), T7 (26.66%), T8 (38.88%), T9 (28.88%) and T12 (37.77%) at Fogera in 2021.

Superiority of T6 (Seed treatment + Seedling treatment + foliar spraying of fungicide omaxim) was confirmed as maximum dry pod yield of 48.46 q/ha and 21.95 q /ha at Dera and Fogera, respectively, in 2020 (Tables 1 and 2). Similarly, highest green pod yield of 107.22 q/ha was recorded on this treatment at Fogera in 2021 (Table 1). The present findings are supported by earlier works where in Seed treatment and seedling treatment when fungicides were sprayed at crown region of the plant, wilt incidence was significantly reduced. Seed treatment+ seedling treatment + spraying of Carbendazim + Metalaxyl proved most effective and recorded 59.8% disease reduction over check under field conditions [7]. Seed treatment with either mefenoxam or metalaxyl is a viable alternative for effective control of *P. capsici* during seed germination, seedling emergence, and early growth stages [9]. Other four fungicides tegula (tebuconazole), thiophanate methyl, ridomil gold (metalaxyl+mancozeb) and mancozeb significantly inhibits the radial growth of *S. rolfsii* under in vitro condition. Besides it, two fungicides thiophanate methyl and mancozeb substantially control the growth of *S. rolfsii* under in vivo condition responsible for causing collar rot disease in Chickpea [13].

Table 1. Effect of fungicides and application methods on wilt incidence and yield in pepper at Fogera during 2020 and 2021.

		2020			2021		
Tr. No.	Treatments	WI (%)	DR (%)	DPY (q/ha)	WI (%)	DR (%)	GPY (q/ha)
Seed Treatment + Seedling treatment							
T1	Check	94.44	-	1.45	58.88	0	63.89
T2	Sinoko (CH)	61.11	33.33	7.38	47.78	11.1	63.61
T3	Omaxim (O)	55.56	38.88	8.16	62.22	-3.34	33.057
T4	Copper oxychloride (CO)	52.78	41.66	9.38	70	-11.12	28.61
T5	Apron star (A)	100	-5.56	0	50.55	8.33	72.5
Seed treatment + Seedling treatment + Foliar spraying							
T6	O	33.33	61.11	21.95	37.78	21.1	107.22
T7	A+O+O	27.78	66.66	17.2	32.22	26.66	75.557
T8	T5+O	97.22	-2.78	0.13	20	38.88	90.557
T9	CH	69.44	25	7.96	30	28.88	86.943
T10	CO	55.56	38.88	8.99	63.33	-4.45	34.443
T11	A+CO+CO	33.33	61.11	12.18	75.56	-16.68	38.33
T12	T5+CO	100	-5.56	0	21.11	37.77	93.89
	CV (%)	27.34		34.44	21.64		20.4

3.2. Economic Analysis of Fungicides and Application Methods Effects on Pepper Wilt

Economic analysis results showed that highest marginal rate of return was obtained from treatment three in 2020 at both Fogera and Dera and treatment four in 2021 at Fogera (Table 2 and 3). According to the manual for economic analysis, the recommendation is not necessarily based on the treatment with the highest marginal rate of return, the treatment with the highest net benefit, and nor the treatment with the highest yield.

The identification of a recommendation is based on the minimum acceptable marginal rate of return, and the treatment with the highest net benefit together with an acceptable MRR becomes the tentative recommendation [11]. In this study, 100% was considered as minimum acceptable rate of return for farmers' recommendation. It is important to note that the acceptable minimum rate of return for farmers' recommendation is 50 to 100% [11]. Accordingly, the study revealed that T6 (application of seed treatment+ seedling treatment + foliar spraying of fungicide Omaxim within 15 days interval) is effective treatment.

Table 2. Economic analysis of fungicides and application methods effects on pepper wilt in 2020 and 2021 at Fogera.

		2020		2021		
Tr. No.	Treatments	TVC	NB	MRR	NB	MRR
Seed Treatment + Seedling treatment						
T1	check	0	26100		230004	
T2	Sinoko (CH)	780	132060	13584.6	228216D	
T3	Omaxim (O)	800	146080	70100	118205D	

Tr. No.	Treatments	2020		2021		
		TVC	NB	MRR	NB	MRR
T4	Copper oxychloride (CO)	850	167990	43820	102146D	
T5	Apron star (A)	900	-900D		260100	3344
Seed treatment + Seedling treatment +Foliar Spraying						
T6	O	12800	382300	3199.16	373192	950.35
T7	A+O+O	12800	296800D		259205D	
T8	T5+O	12900	-10560D		313105D	
T9	CH	14280	129000D		298715D	
T10	CO	17100	144720D		106895D	
T11	A+CO+CO	17100	202140D		120888D	
T12	T5+CO	17150	-17150D		320854D	

4. Conclusion and Recommendation

On the basis of present investigation it may be concluded that seed treatment followed by seedling treatment and foliar spraying of fungicide Omaxim (mancozeb + metalaxyl) can be applied to manage the devastating pepper wilt disease.

Nevertheless, it is currently unclear whether the fungicides suppress which type of wilt pathogen, because the disease has been observed to be caused by more than four fungal pathogens. Therefore, identification of specific causal pathogen and designing integrated management options need to be done for management of pepper wilt complex diseases in the study area.

Table 3. Effect of fungicides and application methods on wilt incidence, yield and economic analysis of pepper at Dera (On farm).

Tr. No.	Treatments	WI (%)	DR (%)	DPY (q/ha)	TVC (ETB/ha)	NB (ETB/ha)	MRR (%)
Seed Treatment + Seedling treatment							
T1	Check	62.5	-	1.69	0	30420	
T2	Sinoko (CH)	25	37.5	20.48	780	367860	43261.5
T3	Omaxim (O)	20.28	42.22	26.36	800	473680	529100
T4	Copper oxychloride (CO)	15.28	47.22	41.66	850	749030	550700
T5	Apron star (A)	57.94	4.56	0	900	-900D	
Seed treatment + Seedling treatment +Foliar Spraying							
T6	Omaxim	11.11	51.39	48.46	12800	859480	928.15
T7	A+O+O	25	37.5	40.07	12800	708460D	
T8	T5+ Omaxim	65.28	-2.78	16.8	12900	289500D	
T9	Sinoko	11.95	50.55	35.1	14280	617520D	
T10	CO	12.5	50	36.22	17100	634860D	
T11	A+CO+CO	11.11	51.39	40.95	17100	720000D	
T12	T5+ CO	93.05	-30.55	0.76	17150	-3470D	

Tr. No.	Treatments	WI (%)	DR (%)	DPY (q/ha)	TVC (ETB/ha)	NB (ETB/ha)	MRR (%)
	CV (%)	26.26	-	39.14			
	LSD (%)	15.157	-	17.15			

Abbreviations

TVC	Total Variable Cost
NB	Net Benefit
MRR	Marginal Rate of Return
D	Dominated Treatment
LSD	Least Significant Difference
CV	Coefficient of Variation
WI	Wilt Incidence
DR	Disease Reduction
DPY	Dray Pod Yield
TVC	Total Variable Cost
GPY	Green Pod Yield

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Conflicts of Interest

The authors declare no conflicts of interest.

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