Scientific Papers. Series A. Agronomy, Vol. LXI, No. 1, 2018
ISSN 2285-5785; ISSN CD-ROM 2285-5793; ISSN Online 2285-5807; ISSN-L 2285-5785

MANAGEMENT OF FUSARIUM WILT (*Fusarium oxysporum* f. sp. *lycopersici)* OF TOMATO WITH ORGANIC AMENDMENTS

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Abstract

Tomato is an important fruit vegetable in Nigeria. Its production is affected by many diseases and Fusarium wilt is one of the most important. The disease is controlled by chemical application especially methyl bromide which is highly hazardous. Alternative methods of control that could be safe, easy and affordable are therefore desirable. Experiment was conducted to evaluate the effects of green manure (cabbage, onion and garlic) in the management of Fusarium wilt of tomato. Results shows significant reduction in the incidence and severity of the disease on plants grown on organic amended soil compared to the control. Similarly, growth parameters and yield of tomato increased significantly with organic amendment compared to the control. Organic amendment could be used in an integrated disease management program for Fusarium wilt of tomato.

Key words*: Fusarium wilt, green manure, incidence, severity, tomato.*

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the major vegetable crops widely cultivated in Nigeria where it has been an important component of the daily diets.

The crop is rich in vitamins, minerals and antioxidant compound lycopene which play a significant role in human health due to its anti-cancer effect (Miller et al., 2002).

Nigeria ranked as the 14th world producer and second leading producer of tomato in Africa with average production of 1.7 metric tonnes (FAO, 2010).

The production of the crop is affected by many pests and diseases. Fusarium wilt caused by *Fusarium oxysporum* f. sp. *lycopersici* is one of the major fungal diseases of tomato. It is a soil-inhabiting fungus that is highly destructive and difficult to control once established (Seremi, Burgess, 2000; Hadian et al*.,* 2011).

The difficulty in the management of the disease was due to the emergence of new pathogenic races (type 2 and 3), indiscriminate use of pesticides leading to the development of resistance and death of antagonistic biocontrol agents (Dewaard et al., 1993; Juliano, Bettiol., 2005). Management of *Fusarium* wilt of tomato under large scale production depends largely on the use of methyl bromide which has been found to have severe environmental hazards and destruction of beneficial microorganisms (Fuchs et al., 1999; Santos et al., 2006). Apart from human and environmental concerns continuous use of chemicals may lead to the development of multi-resistant strains (Njue et al., 2012). This necessitates the search for eco-friendly ways that are effective and affordable in managing the disease.

The objective of this study therefore, was to evaluate the use of organic amendments in the management of *Fusarium* wilt of tomato under field conditions.

MATERIALS AND METHODS

Experimental Site

The experiment was conducted at the teaching and research farm of Federal College of Horticulture, Dadin Kowa, Gombe state, Nigeria. Gombe State is located on latitude 10° 18¹ N and longitude 11° 31¹ E in the Sudan Savannah ecological zone of Nigeria. The area is characterized with a single peak of rainy season starting from May to October and a dry season spanning from November to April.

Isolation and Purification of *Fusarium oxysporum* f sp. *lycopersici*

Fusarium oxysporum f sp. *lycopersici* was isolated from diseased tomato plants that had shown symptoms of wilting and brown discolouration of vascular vessels. The stems of the infected plants were washed in distilled water to remove any foreign materials.

Five-millimetre pieces were cut, dipped in 70% alcohol and then sterilized in 0.5 % sodium hypochlorite solution for 3 minutes. The samples were dried by blotting. Chloramphenicol at 0.5 mg per litre of molten potato dextrose agar (PDA) was added to suppress bacterial growth. The dried sterile infected plant samples were placed in the center of Petri dishes containing amended PDA and incubated at 38°C for seven days.

Colonies showing morphology of *Fusarium* were further sub-cultured for another 7 days on potato dextrose agar (PDA) to obtain pure cultures as described by Booth (1977). Spore suspension of *Fusarium* pathogen was prepared and adjusted to 10^7 spores/ml using haemocytometer.

Experimental set up and procedures

The experimental plot was cleared of remains of crop residues from the previous season, ploughed and harrowed to give a fine tilt. The plot was marked out in to plots measuring $10m^2$. The plots were inoculated with conidial suspension (10^7 conidia/ml) of Fusarium wilt according to the procedures of Misrak et al., 2014. Twenty kilogrammes of cabbage and 5 kg each of garlic and onion bulbs were sliced into 2–3 cm pieces and incorporated separately into the soil in each plot. The amended soil was moistened with tap water to near field capacity, covered with polythene material and left for 14 days for decomposition to take place. An un-amended soil and a synthetic fungicide CAMAZEB® (60% mancozeb and 40% carbendazim WP) were included as control and check respectively.

The treatments were laid in a randomized complete block design with three replications. Three weeks old tomato seedlings were transplanted in each of the treatments 15 days after organic amendment.

Data on number of leaves, branches and plant height was recorded bi-weekly. Disease incidence (%) was recorded at weekly intervals by simply dividing the number of plants showing symptoms by the total number of plants assessed and the product multiplied by 100%. Mathematically, incidence = (number of infected plants/number of plants assessed) x 100%.

Disease severity was recorded weekly using the scale of Sibounnavong et al. (2012): where 1 = no symptoms, 2 = plant showing yellow leaves and wilting (1 - 20%), 3 = plant showing yellow leaves and wilting (21 - 40%), 4 = plant showing yellow leaves and wilting (41 - 60%), 5 = plant showing yellow leaves and wilting (61 - 80%), 6 = plant showing yellow leaves and wilting (81 - 100%) or death.

Disease severity (S) was calculated using the formula: $S = (\sum n) / (N \times 6)$. Where $\sum n$ = summation of individual ratings, 6 = highest score of severity and N = total number of plant assessed. Tomato yield was recorded in $kgplot^{-1}$ at final harvest.

Data was subjected to analysis of variance using GenStat 17th Edition, Release 17.1 (2014). Treatment means were separated using LSD at 1% level of significance.

RESULTS AND DISCUSSIONS

The results show significant reduction in incidence of *Fusarium* wilt on tomato plants grown on soil amended with organic materials than the control (Table 1).

Table 1. Effect of Bio-fumigant crops on incidence of *Fusarium* wilt of tomato

Bio-fumigant crop	Weeks after transplanting						
	7	8	9	10	11	12	13
Cabbage	7.8	36.9	43.0	41.8	40.2	39.9	39.7
Garlic	8.4	37.5	44.4	43.3	41.6	41.0	40.0
Onion	32.6	39.3	45.7	43.9	41.8	41.8	40.8
[a]Cama-zeb	15.6	40.1	46.8	45.4	45.0	44.9	44.8
[b]Control	33.6	41.7	45.0	45.4	45.7	46.8	47.8
LSD P≤0.001	0.33	0.52	0.31	0.20	0.67	0.21	0.29

[a]CAMAZEB® = (60% Mancozeb + 40% Carbendazim WP) as check; [b]Un-amended as control.

Incorporating cabbage, garlic and onion leaves in to the soil infected with *Fusarium* wilt significantly lowered the incidence of the disease on tomato plants than the un-amended soil.

Cabbage leaves significantly reduced number of infected tomato plants than the use of garlic and onion leaves respectively.

The reduction in the incidence of *Fusarium* wilt on tomato grown on amended soils could be attributed to the biocidal volatiles released by the green manure.

Cabbage and garlic are known to contain biologically active compounds that inhibit a wide range of soil borne fungal pathogens (Avato et al., 2000) and some of these compounds are released in form of gases during decomposition that acts as fungi toxic to many soil inhabiting pathogens. This observation agrees with previous findings by Adel et al. (2011), Brown et al. (1999) and Ramsey et al. (2007) who reported reduction in soil borne pathogens on crops grown on soil amended with cabbage and garlic.

Tomato plants grown on soil amended with bio-fumigant crops had lower disease severity than the control (Table 2).

Table 2. Effect of Bio-fumigant crops on severity of *Fusarium* wilt of tomato

Bio-fumigant crop	Weeks after transplanting						
	7	8	9	10	11	12	13
Cabbage	1.1	1.2	1.4	1.7	1.8	2.6	2.7
Garlic	1.2	1.5	1.9	2.2	2.2	2.9	3.0
Onion	1.3	1.7	1.9	2.3	2.3	3.2	3.4
[a]Camazeb	1.2	1.4	1.6	1.7	1.7	3.2	3.5
[b]Control	1.5	2.2	2.3	2.7	2.7	3.6	4.1
LSD (P≤0.001)	0.14	0.36	0.36	0.31	0.36	0.20	0.28

[a]CAMAZEB® = (60% Mancozeb + 40% Carbendazim WP) as check; [b]Un-amended as control.

The effectiveness of cabbage leaves in reducing the severity of the disease was as effective as the synthetic fungicide Camazeb.

Cruciferous plants are known to contain methyl-isothiocynate which is release during decomposition and affects a wide range of soil borne fungi. Research findings have shown reduction in disease severity when crucifers are added to soil due to antagonism, antibiosis and competition (Brown, Morra, 1997; Buskov et al., 2002; Zasada, Ferris, 2003).

Soil amendment with bio-fumigant crops significantly (P≤0.001) increased plant height than the control (Table 3).

Taller tomato plants were obtained when cabbage and garlic leaves were incorporated in the soil than the onion. The use of cabbage was as effective as the synthetic fungicide.

Table 3. Effect of bio-fumigant crops on plant height (cm) of tomato

Bio-fumigant crop	Weeks after transplanting			
	7	9	11	13
Cabbage	19.5	27.2	43.8	55.2
Garlic	18.7	26.3	42.9	51.4
Onion	18.0	25.1	41.7	48.9
[a]Camazeb	18.1	24.4	41.0	49.3
[b]Control	16.7	24.0	40.5	46.7
LSD(P≤0.001)	0.26	0.27	0.33	0.50

[a]CAMAZEB® = (60% Mancozeb + 40% Carbendazim WP) as check; [b]Un-amended as control.

Similarly, tomato leaf production was enhanced by the addition of bio-fumigant crops. Incorporating cabbage, garlic and onion in to soil before transplanting has increased number of tomato leaves than the control (Table 4).

Table 4. Effect of bio-fumigation on number of leaves of tomato

Bio-fumigant crop	Weeks after transplanting			
	7	9	11	13
Cabbage	27.4	45.2	63.9	105.8
Garlic	24.9	43.0	60.2	101.9
Onion	22.3	38.9	54.8	96.5
[a]Camazeb	19.8	32.8	54.8	96.8
[b]Control	20.8	36.3	47.2	88.8
LSD(P≤0.001)	1.41	1.23	1.43	0.99

[a]CAMAZEB® = (60% Mancozeb + 40% Carbendazim WP) as check; [b]Un-amended as control.

Addition of cabbage enhanced tomato leaf production more than garlic which in turn increased leaf production than the onion. Soil amended with cabbage produced tomatoes with the highest yield (16.5 kg plot^{-1}) followed by tomatoes grown on soil amended with garlic (16.2 kg plot^{-1}) and onion bulbs (16.0kg plot^{-1}). Lowest yield was obtained on soil not treated with bio-fumigant crop (13.7 kg plot^{-1}) as presented in Table 5.

Table 5. Effect of bio-fumigant crops on yield of tomato

Bio-fumigant crop	Yield (kg plot^{-1})
Cabbage	16.5
Garlic	16.2
Onion	16.0
Camazeb	15.7
Control	13.7
LSD (P≤0.001)	0.1

Decomposition of green materials enhanced the activities of soil micro-organisms which had adverse effect on *Fusarium* wilt pathogen and improve tomato growth and yield. It also

increase nutrients availability by supplying both macro- and micro-nutrients needed for healthy growth of tomato. Combination of these attributes has contributed in increased growth parameters and consequently in the final yield of tomato. This conforms with the findings of Smolinska (2000) and Pakeerathan et al. (2009) who reported dual effects of combined use of animal manure and plant materials for improvement of diseases control and plant growth.

CONCLUSIONS

Incorporating cabbage and garlic in to soil before transplanting tomato is effective in controlling *Fusarium* wilt and increased tomato yield. These green materials could therefore be used as an alternative to synthetic fungicides in integrated management programme for *Fusarium* wilt during tomato production.

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