FOLIAR SPRAY EFFECT OF THREE ASTERACEOUS LEAF EXTRACTS ON TUBER YIELD OF SWEET POTATO VARIETIES INFECTED BY LEAFSPOT DISEASE

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Abstract

Ten varieties of sweet potato (*Ipomoea batatas* (L.) Lam) namely: TIS 86/0356, TIS 2532.OP.1.13, TIS 8441, CIP.K.134, Ex-Igbariam, CIP.400004, TIS 87/0087, TIS 8164, CIP Tanzania and Sapele local infected by leafspot disease were screened during 2008 and 2009 cropping seasons to evaluate the foliar spray effect of Asteraceous leaf extract on the tuber yield. The leaf extracts of *Synedrella nodiflora*, *Tithonia diversifolia* and *Vernonia amygdalina* were used and the trials were conducted at the Teaching and Research Farm of Department of Agricultural Education, Delta State University, Abraka. Sweet potato leaves were inoculated using spore suspensions of three fungi (*Cochliobolus lunatus, Fusarium lateritium* and *Fusarium solani*) at $85x10^5$cfu/ml 28 days after planting and sprayed at weekly intervals using the extracts and the synthetic fungicide (Dithane M_{45}) in three regimes (once, twice and thrice). Results showed that 5% extract sprays of *T. diversifolia, S. nodiflora* and *V. amygdalina* gave a significant ($P<0.05$) increase in tuber yield compared to the control and dithane M_{45} across the varieties tested. Tuber yields were higher in Sapele local (24.33 t/ha), TIS 87/0087 (21.67 t/ha), Ex-Igbariam (16.33 t/ha) and TIS 8164 (15.67 t/ha) respectively. For Sapele local and TIS 87/0087, tuber yields were significantly higher $P<0.05$ than CIP.K.134 (9.00 t/ha) and CIP Tanzania (10.00 t/ha) varieties respectively. Increase in tuber yield due to extract application of *T. diversifolia* was 6.00 % in CIP Tanzania and 52.85 % in Sapele local. This study therefore recommends: (i) 2 sprays at 7-days interval of 5% extracts of Asteraceae especially that of *T. diversifolia* be used for field application. (ii) Cultivation of Sapele local, TIS 87/0087, Ex-Igbariam and TIS 8164 varieties is quite promising in this agro-ecological region.

Keywords: Asteraceous leaf extracts, sweet potato varieties, leaf spot fungi, tuber yield

Introduction

Sweet potato (*Ipomoea batatas* (L.) Lam) a member of the family Convolvulaceae is one of the tuber crops grown extensively in Nigeria by subsistence farmers dating back to the 17th century (Onwueme, 1978). It is commonly grown throughout the tropics and in some countries they were replacing yams and taros as a source of energy food (Bailey, 1992). Nigeria produces about 0.2% of the world's sweet potato; with an estimated production of about 2-6 million tonnes per year hence is one of the ten most important sweet potato producing countries in Africa (Amienyo and Ataga, 2008; Ilondu *et al.,* 2014). Sweet potato production is influenced by many factors such as variety, spacing, pests and diseases and propagation methods. Farm-gate yields range

from 3-8 t/ha whereas potential yields of 20 tonnes and above are attainable (Namo and Ifenkwe, 2005).

In the world over, conventional potato production is not possible without fungicides. However, these increase production cost, environmental and human health hazards (Lebato *et al.,* 2010; Ilondu *et al.,* 2014). The leaves of sweet potato are the main source of assimilate for dry matter production and increase (Hahn and Hozyo, 1984). Severe leafspot infections sometimes result in total defoliation and hence crop failure (Alabi and Waliyar, 2004). The use of extracts of some Asteraceae in the management of leafspot diseases of sweet potatoes have been reported by Ilondu *et al.* (2014).

There is paucity of information on the use of botanicals in the control of fungal leaf infection of sweet potato and the effect on tuber yield in the study area. Considering the role of leaves in photosynthesis with its direct effect on tuber yield, this experiment was conducted to evaluate the effect of some Asteraceous leaf extracts on the control of leafspot fungi of sweet potato varieties and the impact on tuber yield in Abraka agroecological zone of Delta State. It is hoped that this study will lead to increased food production, alleviate hunger and poverty among the resource-limited people in the study area.

Materials and Methods

Experimental Materials

Ten varieties of sweet potato (9 exotic and 1 local) were screened in the study. These were: TIS 86/0356, TIS 2532.OP.1.13, TIS 8441, CIP.K.134, Ex-Igbariam, CIP.400004, TIS 87/0087, TIS 8164, CIP Tanzania and Sapele local

The exotic varieties were obtained from National Root Crops Research Institute (NRCRI), Umudike, Abia State, while the local variety was obtained from Ogorode, Sapele, Delta State. The vines were cultivated at the Department of Agricultural Education Teaching and Research Farm Delta State University, Abraka. Dithane M_{45} (Mancozeb: Zinc manganese ethylene bis dithiocarbamate) procured from Delta State Agricultural Procurement Agency (DAPA) Ibusa, near Asaba was used as a synthetic check.

Source of Fungi

The fungi used in this study included *Cochliobolus lunatus* R.R Nelson & F.A. Haasis. Anamorph: *Curvularia lunata* (Wakker) Boedgin (1M1394871); *Fusarium lateritium* Nees. Teleomorph: *Gibberella baccata* (Wallr.) Sacc. (1M1394869) and *Fusarium solani* (Mart.) Sacc. (1M1 394872) previously isolated from leafspot disease of sweet potato (Ilondu, 2013). The isolates were revived twice on PDA before use.

Preparation and extraction of the plant samples

The leaves of the plant samples (*Synedrella nodiflora* Gaertn, *Tithonia diversifolia* (Hemsl.) A. Gray and *Vernonia amygdalina* Del. were separately plucked and washed in flowing tap water to remove debris. The leaves were shade dried (Rai *et al.,* 2002) on the bench in a ventilated area of the herbarium at room temperature of 30 ± 2^0C for two weeks. The dried leaves were separately ground into fine powder using an electric blender (Philips Comfort HR 1727) before extraction. The extraction was done in the Department of Chemistry Laboratory, Delta State University, Abraka following the method reported by Ilondu *et al* (2014). The extracts were evaporated on a rotary evaporator at 40^oC to remove excess alcohol (Amadioha and Obi, 1998; Oyewale and Audu, 2007) and separately sterilized by passing it through 0.2µm membrane filter.

Land preparation, experimental design and planting

Land clearing and preparation were done using plough and followed manually using cutlasses and hoes. The field experiment was conducted on a plot of land measuring 21m x 16m which was moulded into ridges 4m long and 1m apart. Three-node vine cuttings from the nursery were planted at the crest of the ridges, two nodes inside and one node out at an angle of 45. Each ridge had 10 stands of the vine at 40cm spacing (Nwokocha *et al*., 1999; Okwuowulu and Asiegbu, 2000). This was replicated three times. The experimental design was a factorial experiment arranged in a randomized complete block design. The factors were:

1. Leafspot fungi (*C. lunatus, F. lateritium* and *F. solani*).
2. Spraying regime (Once, twice and thrice).
3. Five treatments which included
   T_1 = control (inoculated and sprayed with sterile distilled water).

   T_2 = inoculated + *Synedrella nodiflora* extract.

   T_3 = inoculated + *Tithonia diversifolia* extract.

   T_4 = inoculated + *Vernonia amygdalina* extract.

   T_5 = inoculated + Dithane M_{45} solution.
4. Sweet potato varieties as listed above.

Treatment application

At 28 days after planting (DAP), spore suspension from pure cultures of the test fungi were artificially inoculated on the sweet potato leaves, using a hand spraying can in assessing the protection potentials of the extracts. The leaves were sprayed at weekly intervals with water suspension (1L per ridge) of the extracts/dithane M_{45} in three regimes: once at day-7 after inoculation, twice at day-7 and day-14 after inoculation and thrice at days-7, 14 and 21 after inoculation, as adopted from Anaso *et al*. (1990). There were five treatments (T_1-T_5) as listed above and the field was kept free from weeds by regular hand-weeding.

Data collection

Tuber yield at harvest was weighed and recorded. Increase in tuber yield at harvest following modified Awoderu (1990) formula:

$$\% \text{ increase in yield} = \{(Y_t - Y_0)/Y_t\} \quad X \quad \{(100)/1\};$$

Where: Y_t = yield of tubers in extract sprayed plants (protected), and Y_0 = yield of tubers in the control (H_2O) plants (unprotected).

Data Analysis

All the data collected from all the experiments were subjected to analysis of variance (ANOVA) using SAS (2000) and means were separated with the Duncan's Multiple Range Test (DMRT).

Results

The data on yield of sweet potato from the various application of plant extracts and Dithane M_{45} as well as yield obtained from different spray regimes assessed are presented in Table 1 and 2. Difference in the yield performance of the sweet potato varieties was observed in the field. In all cases, the yield of the varieties followed the same trend. The best yield was

obtained in Sapele local, followed by TIS87/0087, Ex-Igbriam, TIS 8441 and TIS 8164 while the least in CIP.K.134, CIP Tanzania and CIP400004 (Tables 1 and 2).

Table 1. Tuber yield from ten varieties of sweet potato sprayed with different plant extracts

Variety	Control (H_2O)	Dithane M_{45}	*Synedrella nodiflora*	*Tithonia diversifolia*	*Vernonia amygdalina*
TIS 86/0356	6.33^{b}	8.33^{c} (24.01^{a})	9.33^{c}(32.15^{b})	12.00^{c}(47.25^{a})	9.67^{d}(34.54^{ab})
TIS 2532.OP.1.13	7.67^{b}	10.00^{c}(23.30^{a})	10.33^{c}(25.75^{bc})	13.00^{c}(41.00^{ab})	9.00^{d}(14.78^{c})
TIS 8441	8.67^{b}	14.00^{bc}(38.07^{a})	10.00^{c}(13.30^{c})	14.33^{b}(39.50^{ab})	14.67^{b}(40.90^{a})
CIP.K134	5.33^{b}	5.67^{d}(6.00^{b})	6.00^{d}(11.17^{c})	6.00^{d}(11.17^{d})	5.33^{e}(0.00^{e})
Ex-Igbariam	10.67^{b}	15.67^{b}(31.91^{a})	16.00^{b}(33.31^{b})	14.00^{b}(23.79^{b})	16.00^{b}(33.31^{ab})
CIP.400004	6.00^{b}	6.00^{d}(0.00^{c})	8.00^{c}(25.00^{bc})	7.67^{cd}(21.77^{b})	7.00^{e}(14.29^{c})
TIS 87/0087	12.67^{b}	16.67^{b}(24.00^{a})	19.33^{b}(34.45^{b})	15.67^{b}(19.14^{c})	18.00^{ab}(29.61^{b})
TIS 8164	8.67^{b}	11.67^{c}(25.71^{a})	13.00^{b}(33.31^{b})	14.00^{b}(38.07^{ab})	13.33^{c}(34.96^{ab})
CIP Tanzania	5.33^{b}	5.67^{d}(6.00^{b})	6.33^{d}(15.80^{c})	5.67^{d}(6.00^{e})	6.67^{e}(20.09^{bc})
Sapele Local	19.33^{a}	26.00^{a}(25.65^{a})	36.33^{a}(46.79^{a})	41.00^{a}(52.85^{a})	21.67^{a}(10.80^{d})

Values with the same superscript(s) in the same column are not significantly different at P>0.05 by DMRT. Values in parenthesis indicate percentage increase in tuber yield over the control

In both first and third regimes, sweet potato plants sprayed with *S. nodiflora* and *T. diversifolia* gave the best tuber yield with no significant difference between them. There was no significant difference in the yield obtained from the plants sprayed with Dithane M_{45} and *V. amygdalina* in both regimes. However, plants sprayed with *T. diversifolia* gave the best yield in the second regime (Table 3).

Table 2. Field evaluation of spraying regimes across all the extracts on tuber yield (t/ha) of ten varieties of sweet potato

		Spraying regime		
Variety	Control	Once	Twice	Thrice
TIS 86/0356	6.33^{ab}	7.67^{cd}(17.47^{c})	12.00^{d}(47.25^{ab})	7.67^{c}(17.47^{c})
TIS 2532.OP.1.13	7.00^{ab}	9.67^{c}(27.61^{ab})	13.33^{c}(47.49^{ab})	9.00^{c}(22.22^{b})
TIS 8441	8.33^{ab}	10.67^{bc}(21.93^{b})	14.00^{c}(40.50^{b})	10.67^{b}(21.93^{b})
CIP.K134	3.33^{b}	4.33^{d}(23.09^{b})	9.00^{e}(63.00^{a})	3.33^{e}(0.00^{d})
Ex-Igbariam	8.33^{ab}	13.33^{b}(37.51^{a})	16.33^{c}(48.99^{ab})	13.33^{b}(37.51^{a})
CIP.400004	5.33^{ab}	6.67^{cd}(20.09^{b})	12.33^{d}(56.77^{a})	7.00^{c}(23.86^{b})
TIS 87/0087	12.33^{a}	19.00^{a}(35.11^{a})	21.67^{b}(43.10^{b})	19.00^{a}(35.11^{a})
TIS 8164	8.00^{ab}	12.67^{b}(36.86^{a})	15.67^{c}(48.95^{ab})	12.67^{b}(36.86^{a})
CIP Tanzania	4.33^{b}	4.67^{d}(7.28^{a})	10.00^{d}(56.70^{a})	5.00^{d}(13.40^{c})
Sapele Local	14.33^{a}	22.33^{a}(35.83^{a})	24.33^{a}(41.10^{b})	22.33^{a}(35.83^{a})

Values with the same superscript(s) in the same column are not significantly different at P>0.05 by DMRT. Values in parenthesis indicate percentage increase in tuber yield over the control

As shown in Table 4, there was no significant difference in the yield performance of the plants infected by *C. lunatus* that were sprayed with *S. nodiflora, T. diversifolia* and *F. lateritium*. With respect to *F. solani,* plants sprayed with *S. nodiflora* gave the best tuber yield.

Table 3. Effects of the spraying regimes at 7-day intervals and the plant extracts on the tuber yield (t/ha) across the sweet potato varieties in the field

Tuber yield (t/ha)			
	Spraying regime		
Treatments	Once	Twice	Thrice
Control (H_2O)	9.67^{b}	9.67^{b}	9.67^{b}
Dithane M_{45}(check)	10.67^{ab} (9.37^{b})	13.67^{ab} (29.26^{b})	10.67^{ab}(9.37^{b})
Synedrella nodiflora	12.33^{a}(21.57^{a})	15.67^{ab}(38.29^{ab})	13.00^{a}(25.62^{a})
Tithonia diversifolia	13.00^{a} (25.62^{a})	17.33^{a}(44.20^{a})	13.00^{a}(25.62^{a})
Vernonia amygdalina	11.33^{ab}(14.65^{b})	14.67^{ab}(34.08^{b})	11.33^{ab}(14.65^{b})

Values with the same superscript(s) in the same column are not significantly different at P>0.05 by DMRT. Values in parenthesis indicate percentage increase in tuber yield over the control

An increase in tuber yield of sweet potato plants was observed in all varieties over the control (Tables 1). The percentage increase in yield ranged from 6.00 to 52.85% in all varieties. Among all the varieties, Sapele local, TIS 86/0356, TIS 2532.0P.1.13 and TIS 8164 performed best when sprayed with *T. diversifolia* extract. TIS 87/0087 preferred *S. nodiflora* extract while Ex-Igbariam performed best with *T. diversifolia* and *V. amygdalina* extracts respectively.

Table 4. Effects of extract sprays on the tuber yield (t/ha) across all varieties of sweet potato inoculated with the three leafspot fungi in the field

Tuber yield (t/ha)			
	Leafspot fungi		
Treatments	*C. lunatus*	*F. lateritium*	*F. solani*
Control (H_2O)	7.33^{c}	9.00^{c}	6.33^{c}
Dithane M_{45} (Check)	13.33^{b}(45.01^{b})	15.00^{a}(40.00^{a})	8.00^{bc}(20.88^{b})
Tithonia diversifolia	18.00^{a}(59.28^{a})	14.33^{ab}(37.19^{ab})	11.00^{b}(42.45^{ab})
Synedrella nodiflora	18.00^{a}(59.28^{a})	13.67^{ab}(34.16^{ab})	14.00^{a}(54.79^{a})
Vernonia amygdalina	14.00^{b}(47.64^{b})	11.33^{bc}(20.59^{b})	10.67^{b}(40.63^{ab})

Values with the same superscript(s) in the same column are not significantly different (P>0.05).Values in parenthesis indicate percentage increase in tuber yield over the control

As shown in Tables 2 and 3, increase in tuber yield among all the varieties was obtained in the second regime. There was no significant difference in the yield increase from plants infected with *C. lunatus* and sprayed with *T. diversifolia, S. nodiflora* and *F. lateritium*. As regards *F. solani*, plants sprayed with *S. nodiflora* gave the best increase in tuber yield (Table 4).

The Analysis of Variance (ANOVA) results of factorial experiment for tuber yields of sweet potato is shown in Table 5. There were significant effects (P<0.05) for regime, fungi, varieties and extracts for tuber yields (t/ha) at final harvest. The interaction

effects for fungi x variety, fungi x extract, variety x extract, and fungi x extract x variety were significant.

Table 5. Analysis of Variance (ANOVA) table showing the interactions among the factors on tuber yields of ten varieties of sweet potato

Source	Df	Anova SS	Mean Square	F-Value	Pr>F
Regime (A)	2	2.65402222	1.32701111	15.72	<.0001*
Fungi (B)	2	2.38482222	1.19241111	14.13	<.0001*
Variety (C)	9	23.50054444	2.61117160	30.93	<.0001*
Extracts (D)	4	2.02382222	0.50595556	5.99	<.0001*
A X B	4	0.56004444	0.14001111	1.66	0.1585^{ns}
A X C	18	0.28842222	0.01602346	0.19	0.9999^{ns}
A X D	8	0.12164444	0.101520556	0.18	0.9935^{ns}
B X C	18	6.49895556	0.36105309	4.28	<.0001*
B X D	8	5.16884444	0.64610556	7.65	<.0001*
C X D	36	19.01595556	0.52822099	6.26	<.0001*
A X B X C	36	0.51617778	0.01433827	0.17	1.0000^{ns}
A X B X D	16	0.13228889	0.00826806	0.10	1.0000^{ns}
B X C X D	72	36.32737778	0.50454691	5.98	<.0001*
A X C X D	72	0.92924444	0.01290617	0.15	1.0000^{ns}
A X B X C X D	144	1.67482222	0.01163071	0.14	1.0000^{ns}

Legends: * = significant at 0.05 level of probability ns = Not significant

Discussion

Significant yield variation obtained with the different varieties confirms the report of Okwuowulu and Asiegbu (2000). Sapele local recorded highest tuber yield among the ten sweet potato varieties studied while TIS 87/0087 produced the highest yield from the exotics. Asumugha (1999) reported no significant difference between the yield of TIS 8164 and TIS 87/0087. Moreover, Okwuowulu and Asiegbu (2000) reported that TIS 87/0087 was the highest yielding variety in National Root Crop Research Institute (NRCRI), Umudike. Similarly, Namo and Ifenkwe (2005) reported that TIS 87/0087 varieties among others produced high tuber yield in the Jos Plateau environment. Other reports have been given by Hahn and Hozyo (1984); Messiaen (1992), Okwuowulu and Asiegbu (2000).

The CIP.K.134, CIP Tanzania and CIP 400004 varieties performed poorly when compared with other exotic varieties despite their luxuriant vegetative (Vine + herbage) growth. The poor performance may be attributed to variations in soil characteristics and climate change which could not have been conducive for tuber formation and yield in the new location. They may be regarded as non-food tubers (Okwuowulu and Asiegbu, 2000) especially CIP.K.134 which could serve as fodder for animals, such as swine's, rabbits and guinea pigs, while TIS 87/0087, TIS 8441, TIS 8164, Ex-Igbariam and Sapele Local have been acclimatized as staple food tubers. The yield potentials of CIP Tanzania and CIP 400004 could be improved by the application of appropriate K-fertilizer. This has been reported crucial for tuber bulking (Hahn and Hozyo 1984; Okwuowulu and Asiegbu 2000).

Irrespective of the plant extract used or the spraying regime, the yield performance of the potato varieties followed the same trend. The yields in the plants sprayed with the plant extracts compared favourably with those sprayed with Dithane M_{45} The corresponding increase in tuber yield due to low disease severity in the potato plants

showed that *T diversifolia*, *S. nodiflora* and *V. amygdalina* extracts were effective in reducing the spread of leafspot disease of sweet potato under field conditions (Ilondu *et al.*, 2014).

A significant variation in tuber yield increase of sweet potato varieties as result a of extract sprays of *T. diversifolia*, *S. nodiflora* and *V. amygdalina* was observed in this study. The findings of this study corroborates with that of Ogwulumba (2007), who reported that reduction in the fungal foliar diseases of groundnut (*Arachis hypogaea L.)* with extracts of pawpaw (*Carica papaya)* and bitterleaf (*V. amygdalina)* resulted in yield increase. Kabir *et al.,* (2007) reported that treatment of wheat seeds with vitavax-200 reduced the incidence of leafspot caused by *Bipolaris sorokiniana* and increased grain yield which varied among cultivars.

Earlier, Nnodu and Okwuowulu (1990) reported that control of ginger leafspot with Thiazolybenzimidazole resulted in corresponding increase in yield due to low disease severity which also varied in both yellow and black ginger cultivars. Irrespective of the sweet potato variety used or the plant extract, the yield increase was greatest in the second regime.

The lower yields in some varieties may not solely be due to the effect of the disease but could partly be due to the inability of the varieties to utilize assimilates for bulking. Nnodu and Okwuowulu (1990) made a similar report on the yield of ginger rhizome due to leafspot disease.

Analysis of variance of the fresh tuber yield of sweet potato showed significance for some of the interactions. This implies that each of these factors responded differently to the variation of the other factors. Similar results were reported by Akparobi *et al.* (2003, 2008) who reported varied interaction effects for tuber yield of cassava genotypes.

Conclusion

Tuber yields were significantly higher in Sapele local, TIS87/0087, Ex-Igbariam, TIS 8441 and TIS 8164 than CIP.K.134 and CIP Tanzania varieties. The yield performance of the sweet potato varieties was high for the plants that received the second spraying regime especially those sprayed with *T. diversifolia* extracts. Percentage increase in tuber yield due to extract application ranged from 6.00 – 52.85% in all sweet potato varieties studied.

This study therefore recommends: Attempting the formulation of 5% concentration of the Asteraceous extracts especially the oily extract of *Tithonia diversifolia* for field application. The cultivation of Sapele local, TIS 87/0087, Ex-Igbariam and TIS 8164 sweet potato varieties by farmers in the Abraka agro-ecological zone of Delta State.

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