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Bio-nutritional effects of *Chromolaena odorata* leaf extract and Fungicide (Z-force) on soil and growth parameters of *Telfaira occidentalis*

Chimankpa W Worlu, Chibuzor Njoku, Fortune N C Okogbule
Department of Plant Science and Biotechnology, Faculty of Science, Rivers State University, Nigeria

Abstract
Bio-nutritional effects of *Chromolaena odorata* leaf extracts and fungicide on soil and growth parameters of *Telfaira occidentalis* was carried out at the Department of Plant Science and Biotechnology demonstration site beside the screen house at the Faculty of Science, Rivers State University. Three concentration (5mgl^{-1}, 10 mgl^{-1} and 15 mgl^{-1}) levels of *C. odorata* leaf extract and fungicide, and *C. odorata* extract+fungicide served as the treatments. Soil was treated 3 days before planting and 14 days after planting for 8 weeks. Physicochemical properties of *T. occidentalis* soil were determined before planting and 8 weeks after treatments. Growth parameters of *T. occidentalis* were determined in centimeters by measuring the plant height, leaf length, leaf area where the number of nodes was counted. One-way t-test analysis was used to determine the impact of treatments on the diseases of *T. occidentalis*. Means were separated using Duncan multiple range tests at 5% probability level. *C. odorata*+fungicide had higher impact on potassium (8.475mg/kg) than *C. odorata* (6.300mg/kg) and fungicide (6.350mg/kg). *C. odorata* higher impact on phosphorus (0.851mg/kg) than fungicide (0.844mg/kg) and *C. odorata*+fungicide (0.819mg/kg). Fungicide had higher impact on nitrogen (5.036mg/kg) than *C. odorata*+fungicide (3.035mg/kg) and *C. odorata* (0.367mg/kg) as compared to the control. The treatments generally had significant positive impact on growth parameter of *T. occidentalis* at the various levels of concentration when compared to the control. However, *C. odorata* extract had better bio-nutritional effect on growth parameters (plant height and leaf area) of *T. occidentalis* even at 5ml (49.93±15.72 & 64.00±56.47) than fungicide (29.66±21.12 & 43.66±30.72). *C. odorata* extract possesses bio-nutritional potential and should be used as biofertilizer for cultivation of crops.

Keywords: Bio-nutritional, *Chromolaena odorata,* Fungicide (Z-force), growth parameters, *Telfaira occidentalis*

Introduction
Telfaira occidentalis also known as fluted pumpkin and belonging to the family *Cucurbitaceae* is a perennial, dioecious herb climbing by coiled, often branched tendrils to a height of more than 20m, whose leaves are arranged spirally, pedately compound with 3–5 leaflets; stipules absent; petiole (2–)4–11(–15)cm long; leaflets with petiolules 0.5–3.5cm long, central one largest, up to 15(–19)cm × 10(–12)cm, lateral ones asymmetrical, usually dentate in the upper two-thirds, sometimes scabrid underneath, 3-veined from near the base (Odiaka and Schippers, 2004). Reports have proven that fluted pumpkin is highly nutritious vegetable, containing calcium, potassium, magnesium, iron and folic acid and vitamins such as vitamins A, C and, K (Adegunwa, *et al*. 2011, Akang, *et al*., 2010, Indhumathi, *et al.*, 2013, Udousoro and Etuk. 2012) [1, 3, 15, 27]. Researchers have also shown that the vegetable's seed and leaf prevent cancer, reduce cholesterol levels and improve blood count (Ndor, *et al*., 2013) [22] while others submitted that it maintains the body tissues, rich in antioxidants, lowers blood sugar, promotes fertility, rich in fiber, effective for weight loss and boost immune system (Giami and Sunday 2003) [12].

Despite the reveal of the impact and efficiency of fungicides against fungal pathogens or their residues in crops, several reports have appointed out that some fungicides may enhance plant defenses through phytoalexin synthesis and cell wall lignification or stimulate enzymes involved in the synthesis of phenolic compounds (Maduangu *et al*., 2008) [21]. Others describe the putative protective role of fungicides for crops against various types of stress (Habibi *et al*., 2011) [13]. Triazoles protect *Hordeum vulgare* and *Arachis hypogaea* against ozone exposure or salt stress by stimulating antioxidative enzymes. However, azoxystrobin and epoxiconazole fungicides induced a delay of senescence of *Triticum aestivum* mainly due to an enhancement of the antioxidative potential protecting the plants from harmful active oxygen species. Researchers have proved that there was induction of synthesis of photosynthetic pigments and proteins in fungicide-exposed plants despite its potency to cause harm to the environment and food chain (Pak 2003) [24].

However, fertilizer is a critical factor that is required to enhance soil nutrients, growth, yield and nutritional content of crops that will match the demand of the increasing population (Habibi *et al*. 2011) [13]. NPK fertilizer is normally used but has detrimental effects on plant as it accumulates toxic substances in soil, contaminates ground water, enhances growth of resistant pest which facilitates spread of diseases, inhibition of essential microorganisms needed for nutrient cycling and the immobilization of chemical phosphate fertilizer in the soil, thus, resulting in insufficient availability of phosphate to plant (Kuku, *et al*., 2014) [19]. The application of mineral nutrients such as nitrogen, phosphorus, potassium, calcium, and magnesium, reduced soil bulk density and improved root growth in pepper (Erden and Mois 2006) [11].

The use of plant extract as sources of bio-nutrients for soil amendment has been reported (Balemi and Negisho 2012; Barros *et al*., 2012) [7, 8]. Studies show that organic residues from *Chromolaena* and *Gliricidia* pruning enhanced plant nutrient content in cowpea, cassava and maize and, resulted in higher yield and productivity of sorghum (Akanbi and Ojeniyi 2007; Awodun *et al*., 2007; Al-rawahy 2011) [2, 5, 6].

Isitekhale *et al*. (2014) [16] revealed that materials from plant increased growth and yield of *Talinum fruticosum* (water leaf), and there was no significant different between the compost manure while compost of both additives had significant effects on the plant (Khallil 2001; Kuljarachanan *et al.*, 2009) [18, 20].

Reports have shown that *C. odorata* indicated higher shoot height, leaf area, fresh and dry weights of plants that were treated with aqueous extracts, when compared with those of the control regime, thus showing an indication that aqueous extract of *C. odorata* has the potential of enhancing the growth of some vegetables (Ilori *et al.* 2011) [14]. This went on to show that the leaf of *C. odorata* is viable primers that could enhance germination potential of and protect against selected fungal pathogens. These decoctions are not only organic but are cheap, readily available and friendly to the environment and could lead to greater productivity (Islam and Meah, 2011) [17].

Extensive reports have shown that consistent use of plant residues on nutrient depleted soils has durable positive impacts on the soils texture and improved plant growth (Akpan and Usuah 2014; Derkowska, *et al*., 2015) [4, 10] and enriches the soil by fixing atmospheric nitrogen either freely or symbiotically, solubilizing unavailable phosphate, producing of growth promoting substances and increasing organic matter content of the soil as a result of increased population of microorganisms (Rajasekaran, *et al*., 2015) [25]. Reports indicated that inoculation of pumpkin seed with free-living nitrogen fixing bacteria, phosphate solubilizing bacteria and 50% organic fertilizer led to maximum oil and fruit yield with no significant effects on seeds weight and fruit number per plant, and combination of NPK and poultry manure increased number of leaves per plant, vine length, branches, and pod yield of fluted pumpkin (Habibi *et al*. 2011) [13].

Despite the proven efficacy of these chemical substances (fungicides and NPK) in prevention and control of fungi diseases of plant and relatively positive impact on plant growth, their repeated applications has resulted in the accumulation of chemical residues in food and feed chain, acquisition of microbial resistance to the applied chemicals and unpleasant side effects on human health; because of this concern, efforts have been focused on developing a potentially effective, healthy safer and natural food preservatives and plant extracts are considered as natural sources of bioactive agents that are nutritionally safe and easily degradable (Bialonska *et al.*, 2010) [9]. This research is therefore aimed at comparing the bio-nutritional effect of *C. odorata* extract and fungicide (Z-force) on the soil and growth parameters of *T. occidentalis*.

Materials and Methods

Study Area and Sample Collection

The research was carried out at the Department of Plant Science and Biotechnology demonstrate plot, beside the screen house at the Faculty of Science, Rivers State University, Port Harcourt, Nigeria which lies within Latitudes 4^0 $430^1743^107^{11}$ and 4^054^132 54^132^{11}N and Longitudes $6^056^1045^104$ and $7^03^12003^1$ 20^{11}E. And the mean annual rainfall of the area is 2000mm and mean temperature of 29^0C (Tubonimi and Udonna 2015) [26].

Collection of Soil Sample

The soil was collected randomly from seven different points covering ($12m^2$ x $24m^2$) around the horticultural region of the School Farm, Rivers State University, Port Harcourt, Nigeria. Following Worlu *et al*. (2022) [28], 6kg soil was collected with shovel and put into perforated (17cm x 17cm) experimental bags before moving it to the field beside the green house.

Collection of Seeds of *Telfaria occidentalis*

The seed was collected from the Mile 3 market in Rivers State, Port Harcourt, Nigeria. A total of 30 seeds were used and the seeds were collected immediately the pumpkin was open and it was a mature seed that has already started opening.

Collection of *Chromolaena odorata* and Fungicide

According to Nmom *et al*. (2023), *C. odorata* was collected from the horticultural region of the school farm, Rivers State University, Port Harcourt, Nigeria. The fresh plant was taken to the laboratory and washed with running water and thereafter, the leaves were taken off the stem and washed properly. This leaf was placed in a mortar and were mashed to easily get the extracts from the leaf. This extract was stored and preserved in the refrigerator while the fungicide is been prepared. While, a milky-greenish powdery fungicide (Z-force) was collected from a farm chemical product shop in Mile 3 market, Rivers State, Port Harcourt. But only 25g of fungicide was added into 5 liters of water, stirred and mixed together.

Experimental Design

A completely randomized design method was adopted for the research. The experiment consisted of four treatments (*C. odorata* extract, Fungicide and *C. odorata* extract +Fungicide) at three different concentration levels (5ml, 10ml and 15ml) which were applied into the already prepared soil 3 day before planting and 14 days after planting for 8 weeks. The fourth treatment was the control experiment (Zero application). The treatments were replicated thrice and physical growth parameters were on weekly basis.

Data Collection and analysis

A modified method by (Oyeyinka and Oyeyinka 2016) [23] was adopted for estimation of physicochemical properties (pH, temperature, electrical conductivity, moisture content, and NKP) of soil before planting and 8 WAP while (Worlu *et al*. 2022) [28] was used for measuring of growth parameters (number of leafs, leaf length, leaf height and leaf area) were collected. All growth parameters were subjected to one-way t-test analysis using SPSS to assess treatment effects. Means were separated for comparison using the Ducan Multiple Range Test (DMRT) at 5% probability level.

Results

Effect of *C. odoarta* Extract and Fungicide on Physicochemical Properties of *T. occidentalis* Soil

Table 1 shows the effect treatments on the physicochemical properties of *T. occidentalis* soil. From the table, pH, temperature, electrical conductivity and moisture content of the soil generally decreased across the treatment when compared to the control. Nitrogen also decreased in the treatment when compared to the control whereas, potassium and phosphorous increased in the treatments than the control. The effect of the combined treatment (*C. odorata*+fungicide) was seen to be higher in all the physicochemical properties of *T. occidentalis* soil except the temperature.

Table 1: Effect of Treatments on the Physicochemical Properties *T. occidentalis* Soil

S/N	Parameter/Conc.	Untreated Soil	Treated Soil		
			C. odorata	Fungicide	*C. odorata*+Fungicide
1	pH	7.58	4.66	4.18	4.56
2	Temperature (°C)	28.60	26.00	26.00	26.00
3	Electrical Conductivity (uS/cm)	15.00	5.01	2.09	2.60
4	Moisture content (%)	20.2	9.78	7.17	7.55
5	Potassium (mg/kg)	4.63	6.300	6.350	8.475
6	Phosphorus (mg/kg)	0.53	0.851	0.844	0.819
7	Nitrogen (mg/kg)	4.906	0.367	5.036	3.035

Effect of *C. odorata* and Fungicide on Growth Parameters of *T. occidentalis*

Table 2 shows that there was significant difference in plant height, number of leaf and leaf area between the treatments and when compared to the control. There was no significant difference in leaf length and number of nodes when compared to the control.

Table 2: Mean Comparison of Growth Parameters amongst the Treatment at 5mg/l Concentration

Trt/Parameters	Plant Height (cm)	No. of Leaf	Leaf Length (cm)	Leaf Area (cm^2)	No of Nodes
Fungicide	29.66±21.12a	10.66±2.08^a	7.50±2.78^a	43.66±30.92^a	8.33±3.51^a
C. odorata	49.93±15.72^b	11.33±3.21^a	8.00±2.00^a	64.00±56.47^b	10.00±2.64^a
Fungicide/*C. odorata*	49.50±26.33^b	9.66±2.51^{a-b}	8.43±2.89^a	55.49±48.30^c	9.00±3.00^a
Control	44.66±23.11^b	11.66±3.05^a	8.66±1.15^a	105.00±50.06^d	10.33±3.05^a

Means with the same letter down the column are not significantly different

Table 3 shows there was significant difference in plant height, number of leaf and leaf area between the treatments and the control but in length and number of nodes there is no significant difference when compared to the control.

Table 3: Mean Comparison of Growth Parameters amongst the Treatment at 10mg/l Concentration

Trt/Parameters	Plant Height (cm)	No. of Leaf	Leaf Length (cm)	Leaf Area (cm^2)	No of Nodes
Fungicide	42.00±10.58^a	42.00±10.58 ^{a}	8.46±1.36^a	52.66±13.79^a	10.00±3.60^a
C. odorata	43.33±25.16^a	10.00±3.60^b	7.13±3.55^a	59.66±57.42^a	10.33±3.51^a
Fungicide/*C. odorata*	54.66±15.94^b	10.33±3.5^b	7.76±2.65^a	58.33±45.01^a	9.33±3.51^a
Control	44.66±23.11^{a-b}	11.66±3.05^b	8.66±1.15^a	105.00±50.06^b	10.33±3.05^a

Means with the same letter down the column are not significantly different

Table 4 shows that there is significant difference in plant height, number of leaves, leaf length, leaf area and number of nodes between the treatments even when compared to the control.

Table 4: Mean Comparison of Growth Parameters amongst the Treatment at 15mg/l Concentration

Trt/Parameters	Plant Height (cm)	No. of Leaf (cm)	Leaf Length	Leaf Area (cm^2)	No of Nodes
Fungicide	24.66±23.75^a	9.00±3.60^a	13.00±3.00^a	7.33±1.52^a	8.66±3.51^{a-b}
C. odorata	50.00±25.70^b	11.33±3.50^b	6.33±2.88^b	34.66±26.08^b	10.66±2.51^b
Fungicide/*C. odorata*	44.66±26.68^c	12.33±2.08^b	10.00±1.00^c	66.86±61.41^c	10.00±3.00^b
Control	44.66±23.11^c	11.66±3.05^{a-b}	8.66±1.15^{c-d}	105.00±50.06^d	10.33±3.05^b

Means with the same letter down the column are not significantly different

Discussion

Result from the present study revealed that *C. odorata* extract and fungicide had positive impact on the physicochemical properties of *T. occidentalis* soil. Such good performances over the control were anticipated due to high amount of essential mineral elements contained in the additives (Table 1). The pH, temperature, electrical conductivity and moisture content of the soil generally decreased across the treatment when compared to the control while potassium and phosphorous increased in the treatments excluding Nitrogen than the control. Combination of *C. odorata* extract and fungicide was shown to solubilize more mineral elements to the soil followed by fungicide and then *C. odorata* extract. This agrees with the findings of (Habibi *et al*. 2011; Idem *et al*. 2011) [13] who reported that fertilizer is a critical factor that is required to enhance soil nutrients, growth, yield and nutritional content of crops that will match the demand of the increasing population. Combination of additives such as NPK and poultry manure significantly increased number of leaves per plant, vine length, branches, and pod yield of fluted pumpkin (Idem *et al*. 2011).

This depletion in the nutrients solubilized by *C. odorata* extract is suspected to be the ability of *C. odorata* extract not just to solubilize but make available and accessible the essential mineral nutrients to the plant for increased absorption. This agrees with the findings of Balemi and Negisho (2012) [7] and Barros *et al*. (2012) [8] who reported that the use of plant extract is a good source of bio-nutrients for soil amendment. Studies show that organic residues from *Chromolaena* and *Gliricidia* pruning enhanced plant nutrient content in cowpea, cassava and maize and, resulted in higher yield and productivity of sorghum (Nottidge *et al*., 2005; Akanbi and Ojeniyi, 2007; Awodun *et al*., 2007; Al-rawahy 2011) [2, 5, 6].

The availability but inaccessible of mineral nutrients in the soil treated with fungicide and combination of fungicide and *C. odorata* extract might be as a result of their pungent nature which led to accumulation of toxic residues on rhizosphere thereby inhibiting beneficial microbial activities that would have enhance absorption of mineral elements by *T. occidentalis.* The above observation corroborates to the findings of (Mathabe *et al.*, 2005; Akinyem*i et al*., 2006, Bialonska *et al.*, 2010) [9] that repeated applications of non-degradable inorganic substance has resulted in the accumulation of chemical residues in food and feed chain, acquisition of microbial resistance to the applied chemicals and unpleasant side effects on health of plants and humans. Plant extracts are considered as natural sources of bioactive agents that are nutritionally safe and easily degradable (Cowan, 1999, Duffy and Power, 2001, Berahou *et al.*, 2007, Chika *et al.*, 2007). Extensive reports have shown that consistent use of plant residues on nutrient depleted soils has durable positive impacts on the soils texture and improved plant growth (Adeniyan and Ojeniyi, 2005; Akpan and Usuah 2014; Derkowska, *et al*., 2015) [4, 10] and enriches the soil by fixing atmospheric nitrogen either freely or symbiotically, solubilizing unavailable phosphate, producing of growth promoting substances and increasing organic matter content of the soil as a result of increased population of microorganisms (Rajasekaran, *et al*., 2015) [25].

Furthermore, the treatments had significant ($P < 0.05$) effect on growth parameters of *T. occidentalis* at the various concentration levels (Tables 2, 3 & 4). This improved performance would be attributed to the fact that soil bulk density reduction as a result of solubilized essential mineral elements in the soil. This observation agrees with Erden and Mois (2006) [11] and Ogbodo (2011) who reported that application of mineral nutrients such as nitrogen, phosphorus, potassium, calcium, and magnesium reduced soil bulk density and improved root growth in pepper. The inability of the additives to cause any significant difference ($P < 0.05$) in the number of nodes in the various concentration levels indicates that the additives did have impact on the plant nodes. This finding is corresponding with the reports of Khallil (2001) [18] and Kuljarachanan *et al.* (2009) [20] that there was no significant different between the compost manure while compost of both additives had significant effects on the plant. However, there were significant ($P < 0.05$) improvement in the plant height, number of leaves, leaf length and leaf area of *T. occidentalis*.

The positive impact on the growth parameters may be due the use of mineral nutrients released by the additives to the soil. Isitekhale *et al*. (2014) [16] revealed that materials from plant increased growth and yield of *Talinum fruticosum* (water leaf) as well as organic residues from *Chromolaena* and *Gliricidia* pruning enhanced plant nutrient content in cowpea, cassava and maize and, resulted in higher yield and productivity of sorghum (Nottidge *et al*., 2005; Akanbi and Ojeniyi, 2007; Awodun *et al*., 2007; Al-rawahy 2011) [2, 5, 6]. Fungicide also enhanced the growth of *T. occendantalis* at the various concentrations (Tables 2, 3 & 4). This may be its ability to protect plant against stress by stimulation of antioxidant enzymes which led to increase in photosynthesis thereby inducing senescence in *T. occendantalis*. This observation agrees with the report of Habibi *et al*. (2011) [13] that the putative protective role of fungicides for crops against various types of stress and Triazoles protected *Hordeum vulgare* and *Arachis hypogaea* against ozone exposure or salt stress by stimulating antioxidative enzymes. However, azoxystrobin and epoxiconazole fungicides induced a delay of senescence of *Triticum aestivum* (Habibi *et al*., 2011) [13]. Pak (2003) [24] reported that there was induction of synthesis of photosynthetic pigments and proteins in fungicide-exposed plants despite its potency to cause harm to the environment and food chain.

Conclusion

The study has proven that *C. odorata* extract and fungicide (Z-force) possess bio-nutritional potential in addition to their antimicrobial and antifungal effects, in that the additives impacted positively on the physicochemical properties of soil and growth parameters of *T. occendantalis*. There is therefore need to maximize the additives by farmers especially *C. odorata* extract as a means of controlling the weed and tapping into its easily accessible, low cost eco-friendly bio-nutritional potency.

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