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Growth Response and Gall Formation of *Milicia excelsa* C. C. Berg Seedlings Grown on Organically Amended Soil During *Phytolyma fusca* Walker (Hemiptera: Psyllidae) Attack

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Abstract

Propagation of *Milicia excelsa* is severely threatened by a gall-forming psyllid (*Phytolyma fusca*), which causes stunted growth and could result in plant mortality. This study evaluated the effect of different organic manures on the growth and gall formation of *M. excelsa* seedlings during *P. fusca* attack. Six month-old uniformly growing seedlings were potted in topsoil amended with poultry droppings (T2), cattle dung (T3), and pig faeces (T4), at a mixture ratio of 2:1 (5kg topsoil: 2.5 kg manure), while untreated topsoil served as control (T1). The experiment was conducted using a completely randomised design and each treatment was replicated 60 times. Data were obtained on seedling height, collar diameter, number of leaves and gall formation (number of galls and number of ruptured galls), for 22 weeks. Data were analysed using descriptive statistics and ANOVA at $p<0.05$ level of significance. Seedlings treated with T4 had the highest height (46.21±2.59 cm) while T1 had the least (23.4±0.82 cm). Seedlings in T2 treatment had the highest collar diameter (0.77±0.03 cm), followed by T4 (0.74±0.04 cm) and T3 (0.67±0.02 cm), while T1 had the least (0.46±0.02cm). Cattle dung treated seedlings (T3) had the highest number of leaves (10.48±1.32) while T1 had the least (6.5±0.83). Gall formation was observed after 12 weeks, and T2 seedlings had the highest number of ruptured galls (1.70±1.17) while T1 had the least (1.50±1.94). Soil amendment with organic manure improved seedling growth of *M. excelsa* and could not control *P. fusca* attack.

Keywords: Iroko, Organic manure, Gall-forming psyllid, Soil amendment.

Introduction

Plant nutrition is an important factor in tropical seedling production ensuring high yield and stimulating plant resistance to insect pest and disease attack (Chau and Heong, 2005). Plants grown in soil amended with organic manures such as poultry droppings, cattle dung, horse dung, and pig faeces, have shown increased tolerance or resistance to insect attacks. Moreover, soil nutrient availability influenced insect damage on plants and their ability to recover and withstand such damage. It also influences the physiological susceptibility of plants to insect pests by altering their acceptability to certain herbivores (Magdoff and Van, 2000).

Milicia excelsa C. C. Berg, commonly known as 'Iroko' belongs to the family Moraceae and is an important tropical timber tree species that is endemic to sub-Saharan Africa. The species is highly threatened by *Phytolyma fusca* Walker (Hemiptera: Psyllidae), a psyllid which disrupts its growth and consequently makes its propagation difficult. *Phytolyma fusca* attack leads to gall formation on *M. excelsa.* These galls often rupture and distort the growth of the plant, and in most cases lead to death of young seedlings and saplings (Ofori and Cobbinah, 2007; Ugwu, 2013; Olajuyigbe *et al*., 2015; Ugwu and Omoloye, 2015).

Advocates of organic farming often assert that plants grown on soil amended with manure are more resistant to insect pests. This is because the capacity to resist insect attack is related to the optimal physical, chemical, and biological characteristics of the soils (Sinha *et al.,* 2018). Previous studies have shown that plants that are able to access sufficient nutrients grow strong and healthy. In some situations, they are better able to compensate for pest damage than those grown on poor soils (Teetes, 1980; Listinger, 1993; Sinha *et al.,* 2018).

Efforts by entomologists to determine the effect of soil fertilisation on insect attack of seedlings have not been conclusive. Some evidence support the observation that manures diminish insect populations (Culliney and Pimentel, 1986; Eigenbrode and Pimentel, 1988; Listinger, 1993; Phelan *et al*., 1995; Fallahpour *et al*., 2015), while other reports suggest that manures increase insect populations on plants (Costello, 1994; Costello and Altieri, 1995; Letourneau *et al.*, 1996).

The effect of organic manure on *P. fusca* pest attack and gall formation on *M. excelsa* seedlings has not been clearly elucidated. This study, therefore, evaluated the influence of poultry droppings, cattle dung, and pig faeces on growth of *M. excelsa* seedlings as well as their influence on *Phytolyma fusca* damage on the seedlings.

Materials and Methods

The study was carried out at the Nursery Section of the Evergreen Tree Planters (ETP) Forest Demonstration Centre, Ijari, Ijebu-Ode, Ogun State, Nigeria. The ETP Centre is situated within Latitude 3° 94.850´ - 3° 95.058´N and Longitude 6° 84.681´E - 7° 36.254´E with an altitude of approximately 275 m above sea level. The dry season starts from November to March while the wet season starts from April to October. The annual rainfall is approximately 1300 mm, while temperature ranges from 22°C – 34°C (Oyedepo *et al*., 2011).

Two hundred and forty (240) *Milicia excelsa* seedlings raised in a screen cage (protected from pest attack) were used for this study. Cured manure (2.5 kg each) of poultry droppings (T2), cattle dung (T3), pig faeces (T4) were each mixed with 5 kg topsoil and filled into polythene pots of size 17.5 cm x 20 cm. Then, uniformly growing seedlings were transplanted into the polythene pots filled with the amended soil. The seedlings were watered daily and allowed to stabilise for two weeks, following the method of Ugwu (2013). The untreated topsoil served as control (T1) and the experiment was arranged in a completely randomised design with 60 replicates per treatment. Data were collected fortnightly for 22 weeks.

Data Collection

Seedling height was measured using a metre rule; measurement was taken from the base of the plant to the terminal bud. Collar diameter was measured using vernier mini-caliper and measurement was done at the base of the plant. The number of leaves was determined by counting. The percentage seedling damage was estimated as the total number of seedlings damaged divided by the total number of seedlings in a treatment. The number of galls formed and ruptured galls were also estimated.

Statistical analysis

Data collected were analysed using descriptive statistics and Analysis of Variance (ANOVA) at $p<0.05$ level of significance. Duncan Multiple Range Test (DMRT) was used to separate means of significantly different treatments.

Results

There was steady increase in seedling height across all treatments from week 2 to week 12. However, seedling heights were reduced due to gall formation at week 14 in all treatments (Table 1). At the end of the study, T4 (46.21±2.59 cm) had the highest seedling height, while T1 had the least (23.4±0.82 cm) (Table 1). From week 14, gall formation caused a significant decrease in the height of seedlings in T2 and T3.

There were significant differences in the collar diameter of *M. excelsa* seedlings grown on the amended soils. There was a steady increase in collar diameter among all the treatments from the start to the end of the study, except at week 14 for seedlings in T1 and T4. At the end of the study, seedlings treated with T2 had the highest collar diameter (0.77±0.03 cm) followed by T4 (0.74±0.04 cm) and T3 (0.67±0.02 cm) while T1 had the least (0.46±0.02 cm) (Table 1). Similarly, the number of leaves significantly differed across treatments. After 22 weeks, T3 seedlings had the highest number of leaves (10.48±1.32), while T1 had the least (6.5±0.83).

Gall formation was observed four (4) weeks after transplanting on 90% of the seedlings (Table 2). Seedlings in the control treatment (T1) had the highest survival (80%) followed by T3 (78%) and T4 (70%), while T2 had the least (50%), at the end of the study. There were significant differences in the number of unruptured and ruptured galls in T1 and T2; while T3 and T4 did not significantly differ. Seedlings in T2 had the highest number of un-ruptured galls (3.87±0.32), followed by T1 (1.25±0.09) and T4 (0.97±0.1), while T3 had the least (0.75±0.06) (Table 2). For ruptured galls, T2 had the highest (1.60±0.18), while T4 had the least (0.25±0.04).

Discussion

The application of organic manure stimulated the growth of *Milicia excelsa* seedlings and increased gall formation due to *Phytolyma fusca* attack. This

Table 1: Effect of organic manure on growth characteristics of *Milicia excelsa* seedlings under *Phytolyma fusca* attack

	SEEDLING HEIGHT					COLLAR DIAMETER					NUMBER OF LEAVES				
Weeks/ Treatment	T1	T2	T3	T4	p-value	T1	T2	T3	T4	p-value	T1	T2	T3	T4	P-value
2	10.33±0.46	18.27±1.15	5.67±0.21	15.46±.86	0.00	0.24±0.01	0.35±0.02	0.17±0.01	0.35±0.02	0.00	9.62±0.36	14.42±0.70	8.69±0.23	15.2±0.79	0.00
4	10.37±0.45	18.58±1.13	5.67±0.21	15.46±0.86	0.00	0.24±0.01	0.36±0.02	0.17±0.01	0.35±0.02	0.00	9.62±0.36	14.66±0.67	8.69±0.23	15.2±0.79	0.00
6	15.85±0.68	38.43±2.06	12.34±0.39	29.93±1.56	0.00	0.33±0.01	0.55±0.02	0.29±0.01	0.47±0.02	0.00	11.95±0.32	16.52±0.60	15.02±0.64	16.98±0.68	0.00
8	19.46±0.70	53.00±2.32	23.09±0.73	41.13±1.71	0.00	0.34±0.01	0.65±0.02	0.37±0.01	0.57±0.02	0.00	11.95±0.35	13.92±0.45	14.95±0.68	14.91±0.56	0.00
10	21.89±0.75	60.60±2.45	35.06±1.10	44.64±2.21	0.00	0.40±0.01	0.71±0.02	0.48±0.01	0.65±0.03	0.00	11.45±0.38	14.46±0.39	13.23±0.43	13.2±0.52	0.00
12	24.05±0.79	68.60±2.61	44.79±1.41	51.39±2.21	0.00	0.46±0.01	0.78±0.03	0.55±0.01	0.74±0.03	0.00	11.30±0.40	11.38±0.53	12.3±0.54	12.2±0.53	0.35
14	22.80±1.12	60.79±3.09	41.90±2.08	46.65±2.69	0.00	0.24±0.01	0.78±0.03	0.61±0.03	0.59±0.04	0.00	7.58±0.48	6.27±0.68	6.32±0.44	5.90±0.50	0.13
16	21.63±0.99	54.40±2.79	42.93±1.50	45.97±2.70	0.00	0.46±0.02	0.77±0.03	0.67±0.02	0.74±0.04	0.00	4.88±0.47	5.56±0.81	3.54±0.45	4.73±0.53	0.11
18	19.95±1.23	51.97±3.35	39.03±2.23	42.44±3.01	0.00	0.46±0.03	0.75±0.02	0.64±0.02	0.74±0.03	0.00	5.09±0.55	2.96±0.72	2.96±0.72	4.00±0.57	0.15
20	18.57±1.38	29.75±3.92	42.19±1.57	38.18±3.24	0.00	0.53±0.01	0.82±0.05	0.67±0.02	0.80±0.04	0.00	5.65±0.71	4.48±1.10	9.48±1.24	7.36±1.08	0.01
22	23.40±0.82	30.44±4.08	41.76±1.63	46.21±2.59	0.00	0.53±0.01	0.82±0.05	0.70±0.02	0.85±0.03	0.00	6.50±0.83	7.27±1.25	10.48±1.32	9.98±1.20	0.03

T1= Control, T2=Poultry droppings, T3=Cattle dung, T4=Pig faeces

Table 2: Effect of organic manure on seedling survival and gall formation on *Milicia excelsa* under *Phytolyma fusca* attack

			Number of un-ruptured galls	Number of ruptured galls
Treatments	N	% Survival	Mean	Mean
T1	60	80	1.25±0.09ab	0.28±0.5b
T2	60	50	3.87±0.32c	1.60±0.18b
T3	60	78	0.75±0.06a	0.27±0.04a
T4	60	70	0.97±0.1a	0.25±0.04a

Means with different letters in the same column are significantly different at $p<0.05$
T1= Control, T2=Poultry droppings, T3=Cattle dung, T4=Pig faeces

corroborates the assertion of Jahn (2004) that soil amendment with nutrients, aids the production of broader, succulent and fresh leaves in seedlings. These leaves serve as suitable surfaces for laying of eggs by insect pests. Setamou *et al.* (1993; 1995) also demonstrated that plant damage by insect pest increased with the application of fertilizers.

In this study, organic manure improved the growth of *M. excelsa* seedlings at the early stage. Seedlings treated with poultry droppings showed tremendous growth within 12 weeks. After *P. fusca* attack, seedlings treated with poultry droppings gradually reduced in height and number of leaves. Whereas the effect of this attack on the height and number of leaves of seedlings treated with pig faeces and cattle dung were minimal. *Phytolyma fusca* attack did not have a significant effect on collar diameter growth of *M. excelsa* seedlings in all treatments. The fast growth of seedlings treated with poultry droppings could be adjudged to indicate high nutrient assimilation from the amended soil.

Incidence of gall formation observed on all the seedlings and the number of galls formed varied across treatments with seedling treated with poultry droppings having the highest number of galls. This indicated that *M. excelsa* is a good source of food and nourishment for *P. fusca* and the insect thrived well on healthy and high vigour seedlings. The high number of ruptured galls in seedlings grown on soil amended with poultry droppings indicated a rapid reproductive cycle for *P. fusca*. These would invariable increase their population and the severity of attack on *M. excelsa* seedlings.

Findings from this study showed that application of manure did not cause a reduction in the insect's attack (Godase and Patel, 2001). This contradicts the assertion of Miguel and Clara (2003) that plants grown with organic matter generally exhibit less insect herbivory.

The distortion in the growth pattern of *M. excelsa* plant (seedlings height and number of leaves) could be attributed to *P. fusca* attack. It was observed that the exposed tissues of the ruptured galls began to decay and the region of these attacks started to wilt. The seedlings, thereafter, responded to this attack by producing new branches to continue growth amidst the insect invasion. This could be a strategy for survival, exhibited by the species.

Conclusion

In this study, the application of organic manure enhanced the growth of *Milicia excelsa* seedlings but did not reduce *Phytolyma fusca* attack. Rather, increased gall formation was observed, especially with the application of poultry droppings. Hence, integrated pest management approaches that combine the creation of a physical barrier with chemical control and soil amendment are required to mitigate the impact of the insect's infestation on the plant.

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