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Effect of Seed Treatment with Imidacloprid, Metalaxyl-M and Tebuconazole (Dress Force) on Growth and Performance of Roselle (*Hibbiscus sabdariffa* L.) in Aliero, Kebbi State

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Abstracts

Roselle (*Hibiscus sabdariffa* L.) is one of the most important Traditional Leafy Vegetables (TLVs) in the tropics and sub-tropics belonging to the *Malvaceae* Family. The crop is believed to have originated from Nigeria. An experiment was conducted during the 2023/2024 dry season at the Screen House of the Abdullahi Fodio University of Science and Technology, Aliero, Kebbi State, Nigeria, to evaluate the effects of different levels of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) on the growth and performance of Roselle plants in Aliero, Kebbi State. The treatments consisted of five (5) levels of Imidacloprid, Metalaxyl-M and Tebuconazole applied at 1.0 g, 2.0g, 3.0g, 4.0g, 5.0g, and 0.0 g (control. The treatments were laid out in a Complete Randomized Design (CRD) with six (6) replications. Data were collected on Plant Height, Number of Leaves, and Leaf Length. Data obtained were subjected to the Analysis of Variance (ANOVA), and significant means were separated using the Least Significant Difference (LSD) at a 0.05 probability level. Results revealed that there were significant statistical differences among the treatments except for the number of leaves at 4WAS and leaf length at 2WAS. It can be concluded that treatment 4.0g had the tallest Roselle Plant (18.80) at 2WAS over the 0.0g control (13.800). The research findings recommend the use of a moderate level of Imidacloprid, Metalaxyl-M and Tebuconazole as seed treatment for enhanced growth and performance of Roselle plant in the study area.

Keywords: Imidacloprid, Growth**,** Roselle, Metalaxyl-M and Tebuconazole

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1. Introduction

Roselle (*Hibiscus sabdariffa* L.) belongs to the family *Malvaceae*, it is a shrubby annual plant species of Hibiscus and occurs in many tropical and subtropical countries (Frank *et al.,* 2012). It is cultivated mainly for its calyxes (Luis *et al.,* 2023). The calyx is rich in flavour, a rich source of micronutrients (Vitamin C, B1, and B2) and contains colorants (Anthocyanins), as stated by Alarcón-Alonso *et al.* (2012). Locally, the dried red calyx is processed into a colourful cold beverage; green calyces and bracts are also used to prepare soup/sauce, while in some localities it serves as a medicine for curing human diseases. In many parts of the world, leaves and stalks are consumed as a green vegetable/salad (Mahadevan and Shivali, 2009; Oyewole and Mera, 2010). In Nigeria, Roselle is intercropped with staple foods such as yam, maize, sorghum or oilseed, Beniseed crops, or planted along field margins, preponderantly by women. Roselle is a multi-purpose crop with significant economic, nutritional, and medicinal value, widely cultivated in the tropical and subtropical regions, including Nigeria (Ali *et al.,* 2021). Its calyces are used for beverages, food colouring, and herbal remedies, while its leaves and seeds serve as important sources of nutrients and oils. Despite its importance, Roselle yields are often limited by poor seed germination, soil-borne diseases, and pest infestations, which seed dressers like Apron-Plus may help mitigate (Ogundeji *et al.,* 2023). Different phenological stages of Roselle (seedling, flowering and fruiting stages) are attacked by various insect pests, causing economic losses (Abdel-Moniem *et al.,* 2006; Abdel-Moniem *et al.,* 2011). In the peasantry, the polycultural system of crop production in Nigeria, the inclusion of two or more *malvaceous* crops are prevalent, thus encouraging cross-infection and damage by insects (Adewole, 2010). Despite its economic and nutritional importance, the production of Roselle is often constrained by poor growth and performance due to susceptibility to pests and diseases. Seed dressing with protective chemicals, such as Seed dressers, has been proposed as a potential solution to enhance seedling vigour, reduce pest and disease pressures, and improve overall crop performance (Saeed and Zainol-Abidin, 2024). However, there is limited empirical evidence on the specific effects of seed dressing on the growth and yield of Roselle in improving quality under the Kebbi State environmental conditions. This gap in knowledge hinders farmers and stakeholders from adopting this seed dressing as an effective agronomic practice (Builders, 2013).

The study of the effects of the fungicidal action of seed dressers on the performance of Roselle is both timely and significant, given the increasing interest in optimizing agricultural productivity under sustainable practices. Seed treatment technologies such as seed dressers offer a preventative measure to combat seed- and soil-borne pathogens during the early stages of plant development, leading to better germination, seedling vigour, and overall crop yield. Systemic seed dressers provide fungicidal and insecticidal protection, which has been shown to improve crop establishment and reduce disease pressure in various crops (Abubakar *et al.,* 2022). Evaluating the impact of fungicides on roselle growth and performance in the Sudan savanna is particularly critical because this region is one of Nigeria's key agricultural zones, with unique environmental conditions and soil characteristics that can influence treatment effectiveness. Moreover, as farmers increasingly adopt integrated pest management strategies, understanding the efficacy of dress-force in local conditions could help guide best practices, enhance Roselle productivity and contribute to the broader goal of achieving food security.

Vol. 2, No. 1, 2026 - Kwararafa University Journal of Multidisciplinary Research and Innovation
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2.0 Materials and Methods

2.1 Experimental Site

The experiment was conducted at the premises of the Abdullahi Fodio University of Science and Technology, Aliero (AFUSTA), at the premises of Screen House, situated at Latitude $12^0$16'42''N; Longitude $4^0$27'6''E. The climate of the State is characterized by alternating wet and dry seasons in response to the changes in pressure patterns; the rainy season in the area is associated with a late onset. The challenges of erratic, recurring rainfall variability have adversely affected moisture quality in the area, with agriculture being the most dominant economic activity in the area.

2.3 Treatments and Experimental Design

The treatments consisted of six (6) levels of seed-dressing chemical (Dress Force) applied at 1.0 g, 2.0 g, 3.0 g, 4.0 g, 5.0 g, and 0.0 g (Control), which was laid out in Complete Randomized Design (CRD) with three (3) replications.

2.3 Source of Seeds

Roselle seeds were obtained from the Roselle farmers in Aliero town while Dress-force was purchased from the Jega Central Market; the seeds were visually checked to ensure that they were not infested by insect pests.

2.4 Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) Concentrations

This was measured using sensitive digital weighing balance for an accurate measurement and viable Roselle seeds were thoroughly mixed with Imidacloprid, Metalaxyl-M and Tebuconazole before sowing figure 1.

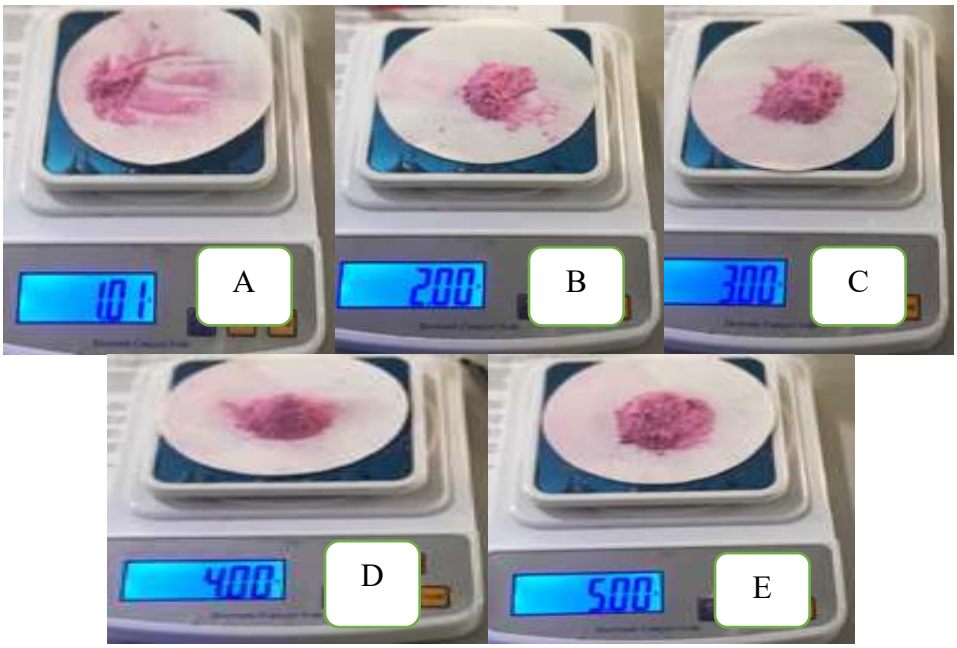

Plate. 1: Different concentrations of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) as treatments: A = 1.0g, B = 2.0g, C = 3.0g, D = 4.0g, E = 5.0g

Vol. 2, No. 1, 2026 - Kwararafa University Journal of Multidisciplinary Research and Innovation
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2.5 Cultural Practices

2.5.1 Soil Preparation

A well-drained sandy-loam soil was thoroughly mixed with manure and sawdust. This was placed into a small plastic container, watered and kept for about one week before sowing.

2.5.2 Seed Sowing

Matured and viable seeds (15 seeds) were sown in six (6) plastic containers, giving a total number of 75 seeds per treatment; the containers were watered at two-day intervals and subsequently for three days for better seed germination.

2.5.3 Fertilizer application

A compound fertilizer (NPK 15-15-15) was judiciously applied at split doses.

2.5.4 Weed control

Weeds were manually controlled at 2 and 4 WAS, and subsequently, when needed.

2.6 Data Collection

2.6.1 Plant Height (cm)

Plant height was obtained by measuring the height of the plant from the base to the last leaf at 2 and 4 WAS, using a meter rule, and the average was recorded.

2.6.2 Number of Leaves per Plant

This was obtained by counting the number of leaves from the tagged plants, and means were recorded.

2.6.3 Leaf Length (cm)

Leaf length was obtained by measuring the leaf length from the tagged plants, and averages were recorded.

2.7 Data Analysis

The data generated were subjected to Analysis of Variance (ANOVA) using SAS Statistical Software (Analytical Software). Differences between significant means were separated using the Least Significant Difference (LSD) at a 0.05 level of probability.

3.0 Results

3.1 Effects of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) on Plant Height and Number of Leaves of Roselle Plant

The effect of Imidacloprid, Metalaxyl-M and Tebuconazole as a treatment shows a significant difference at the 0.05% level of probability in all parameters except for the number of leaves at 4WAS (Table 1). The results on plant height at 2WAS indicated that 4.0g (18.80^{a}) and 1.0g (18.60^{a}) recorded the tallest plants, followed by 2.0g (16.60^{a}) and (16.6^{a}), which were all statistically similar. The shortest plants were recorded by the treatments 0.0g (13.8^{c}) and 3.0g (13.20^{c}) (Table 1). However, the same treatments maintained a similar trend at 4WAS as 1.0g and 4.0g (22.20^{a}), followed by the treatments 5.0g (20.60^{b}) and 2.0g (20.20^{b}), while treatment 3.0g (17.0^{d}) had the

Vol. 2, No. 1, 2026 - Kwararafa University Journal of Multidisciplinary Research and Innovation
Pub. Link: https://aa.unij.co.uk/index.php/kujmri/issue/view/6 - E- ISSN: 3156-5492 | P- ISSN: 3156-5514

shortest plants over the control 0.0g (18.20^{c}). Moreover, treatment 3.0g (4.60^{a}) produced more leaves than 1.0g, 5.0g and the control 0.0g, which recorded the same number of leaves at 2WAS (4.20^{b}), while the same number of leaves was obtained by the treatments 2.0g and 3.0g (3.80^{c}).

Similarly, treatments did not affect the number of leaves at 4WAS, although treatments 3.0g and 0.0g control produced similar results and produced a greater number of leaves (5.20^{a}) than 1.0g, 4.0g and 5.0g, with the least number of leaves recorded on treatment 2.0g (4.80^{a}), Table 1.

Table 1: Effects of Imidacloprid, Metalaxyl-M, and Tebuconazole (Dress-force) on Plant Height and Number of Leaves of Roselle Plant

Treatments	Plant Height at 2WAS (cm)	Plant Height at 4WAS (cm)	No. Leaf at 2WAS	No. Leaf at 4WAS
1.0g	18.60^{a}	22.20^{a}	4.20^{b}	5.00
2.0g	16.60^{a}	20.20^{b}	3.80^{c}	4.80
3.0g	13.20^{c}	17.00^{d}	3.80^{c}	5.20
4.0g	18.80^{a}	22.20^{a}	4.60^{a}	5.00
5.0g	16.60^{a}	20.60^{b}	4.20^{b}	5.00
0.0g Control	13.80^{c}	18.20^{c}	4.20^{b}	5.20
Sig	*	*	*	**NS**
LSD $_{0.05}$	**1.19**	**1.06**	**0.22**	**1.26**

Within a treatment group, means followed by the same letters (S·) are not significantly different at the 0.05% probability level; NS = not significant, $_{0.05}$% level of significance, *= significant difference, WAS: Week After Sowing

3.2 Effects of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) on the leaf length of Roselle Plant

The results showed that only Leaf Length (cm) at 4WAS was significantly influenced by Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) as seed treatment at a 0.05 probability level. Although 1.0g and 2.0g recorded the same and longest leaves (4.30), followed by 4.0g (4.27), which was the second, and 3.0g (4.0) the third, the shortest leaves were recorded in 5 g and 0.0g (control) (3.70), Table 2.

However, at 4 WAS, 1.0g (6.30^{a}) of Imidacloprid, Metalaxyl-M and Tebuconazole had the longest leaves over the 2.0g, 3.0g and 4.0g, which recorded similar leaf length (5.70^{ab}, 5.70^{ab}, 6.00^{ab} respectively), the shortest leaves were obtained in 5.0g (5.30^{b}) and 0.0g (control) (5.27^{b}), Table 2.

Vol. 2, No. 1, 2026 - Kwararafa University Journal of Multidisciplinary Research and Innovation
Pub. Link: https://aa.unij.co.uk/index.php/kujmri/issue/view/6 - E- ISSN: 3156-5492 | P- ISSN: 3156-5514

Table 2: Effects of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) on the leaf length of Roselle Plant

Treatments	Leaf Length (cm) at 2WAS	Leaf Length (cm) at 4WAS
1.0g	4.30	6.30[a]
2.0g	4.30	5.70[ab]
3.0g	4.00	5.70[ab]
4.0g	4.27	6.00[ab]
5.0g	3.70	5.30[b]
0.0g Control	3.70	5.27[b]
Sig	**NS**	*
LSD $_{0.05}$	**0.75**	**0.75**

Within a treatment group, means followed by the same letters (S) are not significantly different at the 0.05 probability level; NS = not significant; $_{0.05}$% level of significance; *= significant difference; WAS: Week After Sowing

4.0 Discussion

4.1 Influence of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-Force) on the Plant Height and Number of Leaves on Roselle Plant

This Research investigates the effects of a combined seed treatment formulation (Dress-Force: Imidacloprid 20% + Metalaxyl-M 20% + Tebuconazole 2%) on early growth parameters of roselle (*Hibiscus sabdariffa* L.). Seed treatment with systemic pesticides has gained prominence as an integrated pest management strategy that protects seedlings during vulnerable early growth stages while potentially enhancing plant vigour through bioactivator effects (Sehrish *et al.,* 2024)

The study revealed the significant effects on plant height at both at 2 and 4 (Weeks After Sowing (WAS) ($p < 0.05$). Notably, the 4.0 g treatment produced the greatest plant height at 4 WAS), statistically comparable to the 1.0 g treatment but significantly superior to the 3.0 g treatment, this could be attributed to its fungicidal effects in controlling soil borne disease which could influences the growth of the roselle plant, but contrary to the findings of (Sehrish *et al.,* 2024) who reported that, neonicotinoid seed treatments, particularly imidacloprid, can function as physiological bio activators that enhance shoot elongation and overall seedling vigor.

However, the number of leaves at 2 WAS showed significant differences at the 0.05% probability level, with the 4.0 g application yielding the highest leaf number, while the number of leaves at 4 WAS were not significantly different among treatments. Moreover, the highest number of leaves could be due to the active ingredients released by the fungicides, which are effective against pathogens affecting the root system of the roselle plant. This temporal pattern reflects the transient nature of seed treatment effects, which are typically most pronounced during early seedling establishment, as reported by (Vyavhare *et al.,* 2020), but also contradicts the findings of Ramos *et al.* (2011), who reported that Roselle plant growth is influenced by growth-promoting factors.

Vol. 2, No. 1, 2026 - Kwararafa University Journal of Multidisciplinary Research and Innovation
Pub. Link: https://aa.unij.co.uk/index.php/kujmri/issue/view/6 - E- ISSN: 3156-5492 | P- ISSN: 3156-5514

This is also contrary to the reports of Wenyonu *et al.* (2011), who reported that wider spacing significantly increases growth due to less competition for light in physiological activities. Similarly, the differences in plant height of the Roselle plant could be assigned to differences in the genetic make-up (Schippers, 2000; Denton, 2004).

However, the number of leaves produced by 4.0 g of Imidacloprid, Metalaxyl-M and Tebuconazole could be attributed to this, which is in line with reports of (Yirzagla, 2023). But in disagreement with the results of Rasheed *et al.* (2018), who stated that the number of leaves of Roselle is determined by varietal differences. This was in line with the findings of (Abubakar *et al.,* 2022), who reported that Imidacloprid, Metalaxyl-M, and Tebuconazole have a positive influence on the growth of Roselle plant (Table 1).

4.2 Effects of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress Force) on the leaf length of Roselle Plant

Leaf length at 4 WAS was significantly influenced by treatment, with the 1.0 g application producing the longest leaves. These morphological responses are consistent with findings that systemic insecticide-fungicide combinations can improve photosynthetic capacity by protecting developing foliage from pest and pathogen pressure (Agronomy, 2024). The longest leaves observed at 4 WAS could be due to the effects of Imidacloprid, Metalaxyl-M and Tebuconazole on the pathogens by targeting RNA, which reduces the early-season damping-off and root rot that commonly limit roselle establishment in tropical soils and by suppressing cell division in fungal pathogens, as reported by (Chemosphere, 2022). Moreover, Imidacloprid, Metalaxyl-M and Tebuconazole could be effective at low doses in promoting leaf length development more than the higher doses, as reported by Okoro (2020). This indicates that lower doses of Imidacloprid, Metalaxyl-M and Tebuconazole are more beneficial for leaf growth during this period Table 2.

5. Conclusion

The study concluded that the application of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) influenced Roselle performance positively at lower doses (1.0g and 2.0g) better than higher doses. These doses enhanced plant height, leaf production, and leaf length, likely due to improved protection against pathogens and pests during early growth stages. Higher doses (3.0g, 4.0g, and 5.0g), however, showed reduced effectiveness, possibly due to phytotoxicity or overstimulation of protective mechanisms. The untreated seeds (control) had poorer performance across most parameters, highlighting the importance of Imidacloprid, Metalaxyl-M and Tebuconazole (Dress-force) in optimizing Roselle growth under the prevailing environmental conditions in Aliero, Kebbi State.

Vol. 2, No. 1, 2026 - Kwararafa University Journal of Multidisciplinary Research and Innovation
Pub. Link: https://aa.unij.co.uk/index.php/kujmri/issue/view/6 - E- ISSN: 3156-5492 | P- ISSN: 3156-5514

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Vol. 2, No. 1, 2026 - Kwararafa University Journal of Multidisciplinary Research and Innovation
Pub. Link: https://aa.unij.co.uk/index.php/kujmri/issue/view/6 - E- ISSN: 3156-5492 | P- ISSN: 3156-5514

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