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ORIGINALE ARTICLE

EVALUATION OF THE EFFECTIVENESS OF RABBIT URINE ON CORN (*Zea mays*) YIELD

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ABSTRACT

Context: This study was conducted at the Nkoemvone Agricultural Research Station in southern Cameroon, focusing on maize cultivation from September to November 2022. The objective of this study was to assess the effectiveness of rabbit urine in comparison to a standard chemical pesticide on maize yield. **Objective**: The aim was to provide guidance to farmers on the use of biopesticides instead of chemical pesticides to ensure food security. **Objective**: The specific objectives of this study were to determine the appropriate dosage of rabbit urine, reduce pest attacks, and quantify the resulting maize yield. **Method**: The experimental area covered a total of 750 m², with individual plot sizes of 250 m². Each plot was further divided into four units, representing different treatments. The treatments were randomly assigned to the three primary plots as follows: T0 = absolute untreated control, T1 = urine concentration of 1.5 liters in 10 liters of water, T2 = urine concentration of 2.5 liters in 10 liters of water, and T3 = application of GREMEC 50 WG at a rate of 10g per 16 liters of water using a backpack sprayer. The evaluation of these treatments was based on four parameters: the number of diseased plants, the number of pest-infested plants, and the number and weight of maize ears. The data analysis employed ANOVA to conduct the statistical analyses. The experimental design employed a completely randomized design to assess the effect of rabbit urine. **Results**: The results showed no significant differences among the treatments regarding the number of diseased plants. However, there was a significant effect observed for T0 (79) and T3 (34) compared to T1 (52) and T2 (48) in terms of the number of pest-infested plants on average. Similarly, there was a significant difference in yield, particularly the number of maize ears, among the treatments: T0 (101), T1 (202), T2 (178), and T3 (186) ears. No treatment exhibited a significant effect on the weight of maize ears. **Conclusion**: These findings suggest that rabbit urine could serve as a viable alternative to chemical pesticides. However, it is crucial to pay attention to the dosage used, as excessively high doses may harm the plants, while excessively low doses may not yield the desired effects.

Keywords: biopesticide, phytotoxicity, urine, attacks.

1. INTRODUCTION

Maize (Zea mays), a member of the botanical family Poaceae, is believed to have originated in the highlands of Mexico, Peru, Ecuador, and/or Bolivia [9]. It was introduced to Africa, specifically Egypt, by Turkey and Syria around 1540 and later spread to the Gulf of Guinea region around 1550 [6]. Maize is an annual herbaceous plant [3] with varying heights, typically ranging from one to three meters for commonly grown varieties. The plant features a single sturdy stalk with a large diameter, composed of several internodes. Leaves are inserted alternately on both sides of the stem, each having a sheath enclosing the stem and a blade [2]. The root system consists of numerous adventitious roots originating at the base nodes of the stem [5].

The flowers of maize are unisexual and grouped in male and female inflorescences composed of spikelets [20]. This separation of flowers leads to cross-pollination in maize, as the grain is a caryopsis formed by three parts of different origins [5]. Maize is the most significant cereal crop in Africa and a crucial staple food for over 1.2 billion people on the continent [8]. All parts of the maize plant can be utilized for food and non-food purposes. However, in Cameroon, maize production falls short of the demand. Heavy reliance on maize in the diet can contribute to malnutrition and deficiencies in essential vitamins, such as kwashiorkor [14]. Rainfed agriculture accounts for the majority of maize production in Africa [17]. Maize is processed and prepared in various forms across different regions, including porridge, frying, and cooking [7].

Maize faces multiple challenges, including climate change, diseases, and pests, with the most destructive being the armyworm, leading to significant yield reduction [13]. Enhancing maize production can be achieved through the adoption of good agricultural practices. For instance, farmers should focus on selecting seeds from healthy cobs, renewing hybrid seeds each season, and providing necessary agricultural inputs to achieve optimal yields. However, the intensification of agricultural production brings about environmental and social concerns, driven by the heavy reliance on purchased inputs and specialization of activities [4]. One of the problems associated with this intensification is the scarcity of chemical inputs, leading to the exploration of natural pesticides and fertilizers as alternatives to chemicals. Biofertilizers, commonly known as natural products, are used as organic fertilizers for sustainable agriculture, promoting ecological and health benefits while preserving biodiversity [1]. They fulfill the nutritional requirements of plants by providing all the necessary nutrients for healthy growth [15].

In the region of Nkoemvone, located in the southern part of Cameroon, a tropical zone characterized by high rainfall, major agricultural challenges include increased pest presence, diseases, misdirected fertilization due to climate change, and poor farming practices. In this study, we focus on rabbit urine, which exhibits both fertilizing and repellent properties. A preliminary analysis reveals that rabbit urine contains nitrogen-rich components such as ammonia and urea, which are vital for plant development. The application of fermented rabbit urine as a spray to control insects and harmful pests, including aphids, moths, leaf miners, caterpillars, and mites, has enabled farmers to optimize their yields. However, the use of pesticides and natural fertilizers raises concerns about proper dosage. It is essential to apply the appropriate quantity that maintains organic matter status and vegetative balance, avoiding excessive amounts that result in luxury consumption and considering the remanence time (the interval between two applications in the field to ensure an effective response). In Kenya, a farmer describes a practice where collected urine is mixed with maize starch and molasses and left to ferment for approximately three weeks. The resulting mixture is then diluted, with one liter of the fermented mixture diluted in 20 liters of water. This practice highlights the significance of the present study, which aims to provide farmers with a cost-effective alternative to conventional pesticides. Implementing this approach can potentially save farmers five times the cost typically incurred with traditional pesticides.

The primary objective of this study is to comprehensively monitor the entire maize crop cycle and investigate the impact of different doses of rabbit urine on the quality and quantity of both vegetative and floral components obtained at the end of the cycle. Specifically, three parameters were assessed: the toxicity of the product on individuals, the number of individuals affected by insect and pest attacks, and the yield of maize ears.

2. MATERIALS ET METHODS

2.1. Study zone

The trial was conducted in the Nkoemvone locality, near the town of Ebolawa in Cameroon. This particular locality falls within Zone V, characterized as a humid forest zone with bimodal rainfall patterns. Maize cultivation in this region typically occurs in two seasons: the first season spans from March 15 to April 15, while the second season extends from August 15 to 25. However, considering climatic disturbances, maize planting for this study was carried out when the rainfall was adequately established.

2.2 Plants materials

The corn seeds used in this study were sourced from IRAD, an institute known for its strong production of corn varieties. The specific variety employed in this experiment is CMS 8704, which is a composite variety well-suited for the study zone. CMS 8704 is recognized for its yellow-colored, starchy, sweet kernels, highly regarded and preferred by farmers. It is typically cultivated at lower altitudes and has a longer development cycle, ranging from 110 to 115 days after sowing. The expected yield of CMS 8704 is approximately 5 to 7 tons per hectare (refer to Figure 1).

Figure 1: The experimental design with the plant material.

2.3 Non-biological materials

The urine used in the study was collected in 5-liter drums. To ensure the integrity of the urine and prevent contamination with feces, careful collection techniques were employed. One of the simplest methods involved placing a plastic sheet on the floor in a designated corner of the rabbit hutch where they typically urinate. This allowed for easy collection as rabbits tend to use the same spot for urination. The plastic sheet was sloped towards a pipe that directed the urine flow into a canister located beneath the hutch. To prevent bacterial utilization of nitrogen during fermentation, the urine was mixed with cornmeal. The fermentation process typically took a few weeks.

GREMEC 50 WG, a non-systemic insecticide available in local markets, was used in the study. This insecticide acts both through contact and ingestion on targeted pests. For data analysis, the RStudio software was employed to perform the analysis of variance (ANOVA) to assess statistical significance.

2.4. Experimental design

The trial area was carefully selected to ensure a distance of 300 to 400 meters between the experimental plots and neighboring fields, thus maintaining isolation. The soil was prepared by tilling specifically at the pit locations, maintaining a spacing of 75 cm between rows and 50 cm between pits. Three maize grains were sown per pit, and after emergence, the seedlings were thinned to two plants per pit.

The total area of the trial was 750 m², and each elementary plot consisted of 250 m². These elementary plots were arranged as completely randomized experimental units, including an untreated absolute control. In total, there were 12 experimental units, with the four treatments repeated three times, alongside the untreated control. The treatments were defined as follows: T0 = untreated absolute control, T1 = urine concentration of 1.5 liters in 10 liters of water, T2 = urine concentration of 2.5 liters in 10 liters of water, and T3 = GREMEC 50 WG at a dosage of 10 grams per 16-liter backpack sprayer, diluted only in water. The treatments were applied three weeks after sowing and continued at weekly intervals until the end of the maize plant's life cycle. The purpose of the study was to compare the effects of urine and a chemical pesticide, specifically assessing the differences in their impacts on the maize plants.

2.5. Effects of treatments on diseases (phytotoxicity)

The evaluation of phytotoxicity was conducted by applying precise and standardized doses of each treatment. This approach enabled the counting of affected plants exhibiting any disease symptoms within each experimental unit throughout the entire crop cycle. Furthermore, a visual assessment was conducted to estimate the damage caused by the tested doses on individual plants. The treatments were applied on the leaves, stem, and furrows of the maize plants.

2.6. Effect of treatments on pests

Pest attacks were assessed by systematically counting the number of maize plants that were affected by insects and other pests. This allowed for the evaluation of the repellent effect of urine, particularly when used at an optimal concentration. The duration of the period when pest attacks were most prevalent was also carefully recorded, providing valuable information on the timing and intensity of these attacks.

2.7. Effect of treatments on ear quantity

The evaluation of maize yield in each treatment involved quantifying the number of ears and measuring their weight. This approach was used to assess the effectiveness of the test products in improving the yield of corn.

3. RESULTATS

The different treatments exhibit variations according to the evaluation criteria examined in this study. Therefore, a comprehensive analysis of each parameter was conducted, leading to the following findings.

3.1 Effect of phytotoxicity of doses (diseases)

The average number of individuals exhibiting disease symptoms varied across the different treatments, with T0 having an average of 4 individuals, T1 with 3 individuals, T2 with 4 individuals, and T3 with 3 individuals, as illustrated in Figure 2 below.

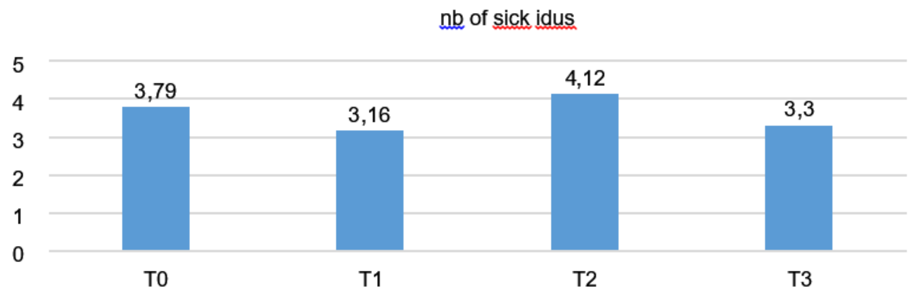

Figure 2: Average number of diseased individuals per treatment.
(**nb of sick idus**: the number of individuals showing disease symptoms)

To provide a more comprehensive explanation of these results, an analysis of variance (ANOVA) and subsequent statistical tests were conducted (see Table 1). The ANOVA results regarding the variation in the number of infected individuals per treatment revealed a p-value of 0.621, which is higher than the predefined threshold of 0.5. Thus, the treatment did not exhibit a toxic effect on the number of infected individuals. Therefore, the presence of disease among the individuals can be attributed to random factors rather than the treatment itself.

Table 1: Variance analysis of product phytotoxicity.

Effect	Ddl	SCE	F	<0,0001
Treatments	64	3,482	0,621	
week	64	11,413	2,67E-09	*
Résiduals	5,456	0,5455		

* indicates a significant effect p < 0.0001; **Ddl**: degree of freedom; **SCE**: sum of squared differences.

3.2 Effect of treatments on pests

The average number of individuals gnawed by insects and caterpillars oscillates according to treatments and thus T0 = 79, T1= 52, T2= 48 and finally T3 = 34 individuals and thus the percentage is illustrated by (Figure3).

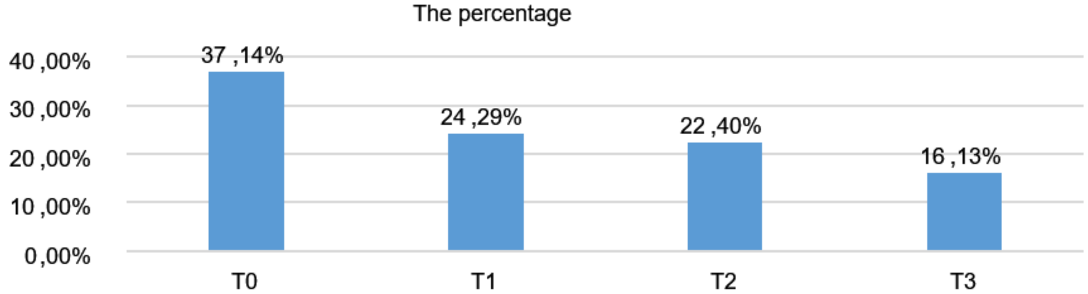

Figure 3: Average number of individuals attacked.

The percentages above indicate the presence of significant differences between treatments at a 5% significance level. Specifically, T0 exhibited significantly higher attack rates compared to T1, T2, and T3. Additionally, T3 demonstrated a significant effect in comparison to T1 and T2. The impact of the treatments on pest attacks is further supported by the analysis of variance, as depicted in Table 2.

Table 2: ANOVA results for testing the effect of treatments on pest attacks.

Effect	Ddl	SCE	F	p<0,0001
Treatments	50	21.410	4.67e09	*
week	50	12.082	6.56e09	*
Résiduals	50	0,944	0,0016	

* indicates significant effect at the 0.001 level.

On the other hand, significant differences in pest attacks were observed across different weeks. Specifically, certain weeks exhibited a notably higher number of individuals affected by insect damage, as depicted in Figure 4.

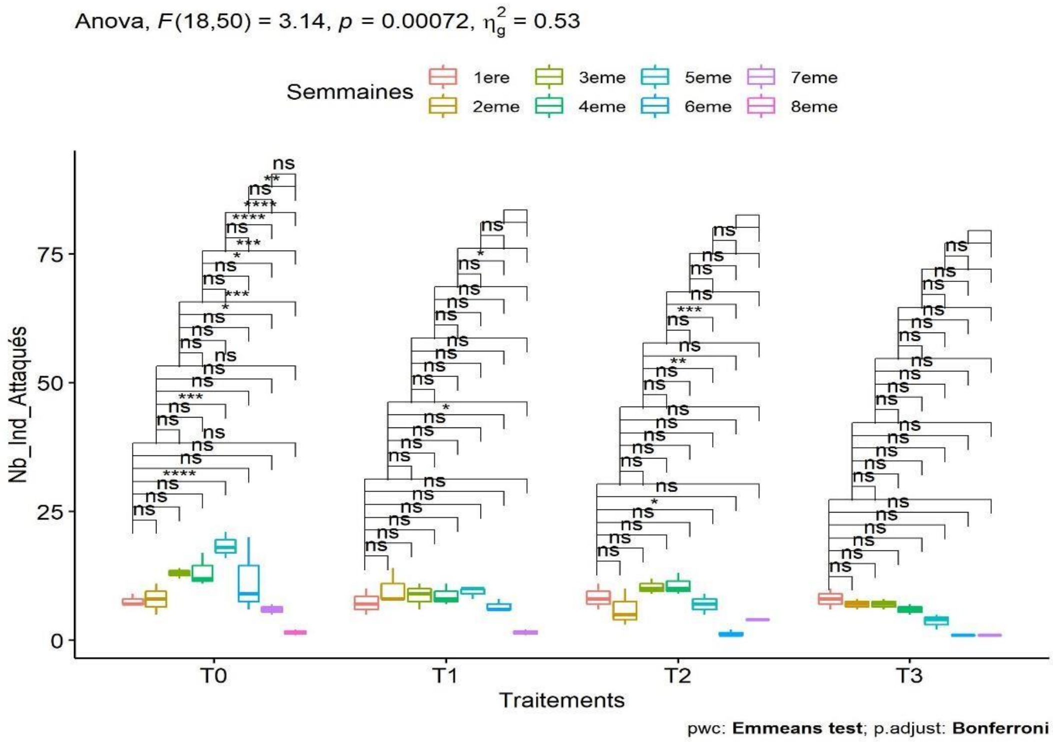

Figure 4: Treatment effect according to weeks and attacks

For the random treatment, particularly T0, a highly significant effect is observed between the fourth and first week, as well as between the third and sixth week. This can be attributed to the fact that pest attacks are more prevalent during a specific stage of plant growth, specifically between five to eight weeks after sowing. Conversely, the T3 treatment, which serves as a reference chemical, did not exhibit any significant effect.

3.3 Effect of treatments on yield

The average values of the number of ears and the weight of the ears show variations across different treatments. In terms of the number of ears, the average values are as follows: 101 for T0, 203 for T1, 178 for T2, and 186 for T3. The significant difference is observed between T0 and T1 (Figure 5).

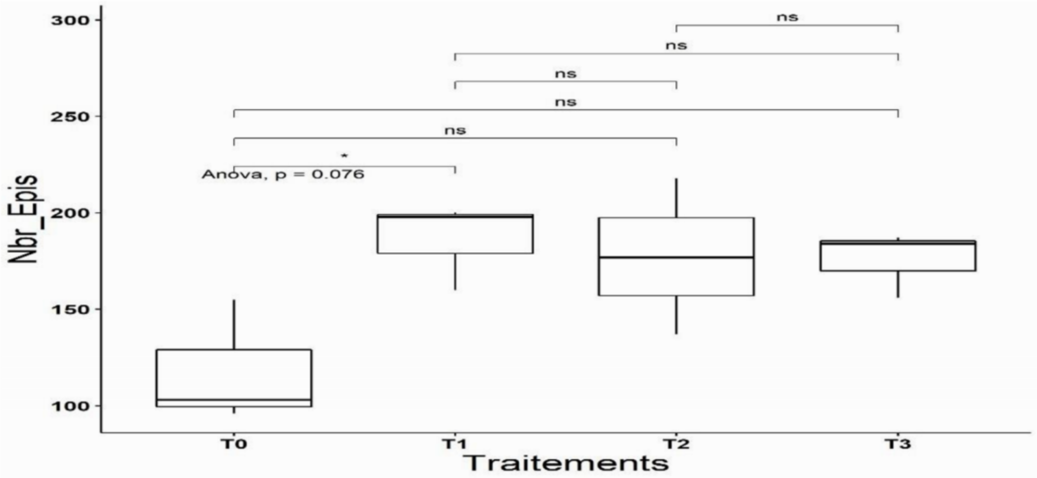

Figure 5: Mean and ANOVA values of the number of ears.
*indicates significant effect at p = 0.076; ns = non-significant values.

For the weight of the ears, the average values vary across different treatments, with T0 measuring 12 kg, T1 measuring 32 kg, T2 measuring 28 kg, and T3 measuring 34 kg (Figure 6).

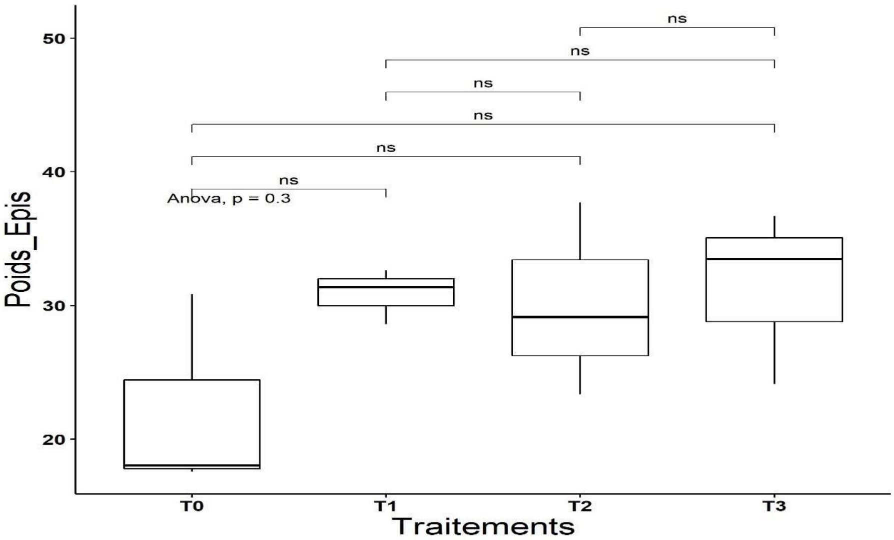

Figure 6: Average values of ear weight according to treatments

The variation in average ear weight among treatments showed no significant effect, as indicated by the analysis of variance with p = 0.3. This suggests that the treatment did not have a dominant effect on the size of the ears

4. DISCUSSION

The experimental design employed in this study to assess the influence of treatments on maize utilized a completely randomized block design. The aim was to evaluate the efficacy of rabbit urine in comparison to GREMEC 50 WG, a chemical pesticide, based on criteria such as phytotoxicity, tolerance to attacks, weight, and number of cobs per treatment. The number of diseased individuals per treatment was found to be approximately equal, indicating that the urine did not have a detrimental effect on the corn plants, despite the varying doses applied in the fields. These results suggest that higher doses would be required to cause harm to the plants, as nature exhibits greater tolerance toward organic products. These findings align with the study conducted by Jin et al., (2018) [18], which explored the use trends and development of biopesticides, and highlighted their potential to mitigate environmental pollution caused by chemical pesticide residues while promoting sustainable agricultural practices. Additionally, it was noted that biopesticides are highly effective in controlling agricultural pests without causing significant damage to the ecological chain.

However, these results also partially coincide with those obtained by Kumar et Singh et al., (2015) [11], who investigated the current evolution and future prospects of biopesticides and found that they may be less susceptible to genetic variations in plant populations, which can lead to problems related to pesticide resistance. Thus, when appropriately deployed, biopesticides can contribute to the sustainability of agriculture for food security.

Furthermore, significant differences were observed between the treatments concerning the impact on pests. Specifically, T0 (the untreated control) exhibited higher levels of attack compared to T1, T2, and T3. This discrepancy can be attributed to the repellent effect of urine, which can effectively protect plants from insects, particularly the armyworm infestation prevalent in the region. Supporting this notion, [12], in their research on biopesticides as food and environmental safety, demonstrated that when used as part of integrated pest management, biopesticides can be equally effective as conventional pesticides, especially in fruit, vegetable, nut, and flower crops. However, the number of attacks significantly decreased with T3 when compared to T1 and T2, indicating that the chemical pesticide was more effective than urine in this scenario. Dosage appears to be a limiting factor influencing the outcomes. Nonetheless, urine offers extensive advantages as it serves a dual role as both a fertilizer and a pesticide. The work conducted by Roose E, Kouakoua et al., (2015) [19] on the valorization of human and animal urine for soil fertilization has emphasized that animal urine, when combined with solid waste, contributes to the production of high-quality manure. Furthermore, concentrating waste in small areas enhances soil fertility heterogeneity.

In addition, our findings revealed that certain weeks experienced a significant peak in pest attacks, particularly with treatments T0, T1, and T2. This observation aligns with previous this finding of N'Gbesso et el., (2013) [16], which characterized different growth stages in cowpea and identified the period between the 30th and 75th day after sowing as the most vulnerable phase. The impact of the treatments on yield, number of ears, and ear weight exhibited significant variations, particularly in the number of ears. Specifically, treatment T1 demonstrated a significantly higher number of ears compared to T0. This variation can be attributed to the interaction between this particular urine concentration and the environment, facilitating optimal release of fertilizing elements. These results corroborate the findings of Siene et aol., (2020) [21], who tested four types of natural fertilizers on maize growth and production and reported a four to sixfold increase in yield with the application of biofertilizers compared to no fertilizer application. However, the effect of treatments on ear weight exhibited considerable variation without statistical significance. This can be explained by the limited impact of urine on ear size, which is primarily controlled by the genotype of the individual plants. This observation aligns with the research conducted by Kott and Polsoni (2019) [10], which investigated the culture of isolated micropores of Brassica napus and highlighted the correlation between bud size, spore seeds, and genotype. Consequently, rabbit urine holds promise as a valuable component in the context of future agriculture.

5. CONCLUSION

In conclusion, our study demonstrated the potential of urine as an effective and environmentally friendly alternative in pest management and crop production. The application of urine, particularly at a concentration of 1.5 liters in 10 liters of water, resulted in a significant reduction in pest attacks compared to the control treatment. This highlights its repellent properties and its ability to mitigate pest infestations during critical growth stages of the plants. Moreover, the use of urine showed a positive impact on the number of ears, with treatment T1 significantly outperforming the control treatment. This can be attributed to the favorable interaction between urine and the environment, facilitating the release of essential nutrients and promoting plant growth. Although no significant effect on ear weight was observed, indicating that urine did not directly influence ear size, our findings emphasize the importance of genotype in determining this trait. Overall, our results support the potential of rabbit urine as a valuable bioresource for sustainable agriculture practices, providing an eco-friendly alternative to chemical pesticides and synthetic fertilizers. Further research and field trials are warranted to explore its full potential and optimize its application in different agricultural systems.

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Rivalry of interest: All authors declare that there are no conflicts of interest whatsoever.

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Contribution of the Authors

This work was done thanks to the contribution of all the authors mentioned above, the author JAO and MDN wrote the protocol, collected the data, did the literature review and wrote the first draft of this article. Author EWK was responsible for analyzing the data and drawing the other figures. Authors WEM, YTD and FEN facilitated the work. All these authors read and approved the final work.

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