

A study of greenhouse germination of *Solanum aethiopicum* Gilo at the Evergreen State College Organic Farm

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Acknowledgements

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Abstract

Solanum aethiopicum, 'Gilo,' has the potential to become an equitable crop in PNW climate of Olympia, WA State, however, these varieties lack public data and horticultural research in the region. This study is intended to facilitate future research for the benefit of public horticultural data, local growers, seed manufacturers, and other individuals and/or communities seeking access to this cultural crop. To adhere to this goal, it was necessary to perform a germination analysis and document morphological and phenological observations. To replicate a standard farm procedure, this study takes place in a shared heated greenhouse at the Evergreen Organic Farm. The standard procedure included seeding in a pre-mixed soil blend, with 72-cell plastic trays, and manual watering. This field study revealed early damage on *Solanum aethiopicum*, specifically due to mice. This pest was managed using biological procedures and physical barriers. Mice damage was observed yet proved no detrimental interference within germination counts, this is because many plants germinated prior to the onset of mice impacts.

Introduction

Solanum aethiopicum, gilo, garden egg, jiló, djakattou, nakati, bitter tomato, scarlet eggplant, or African eggplant is a popular cultivation and culinary crop for African communities, known to be indigenous to Africa (Han M., et al, 2021). It is also known to be a common cultural crop in Brazil. *Solanum aethiopicum* is particularly of interest due to its intraspecific biodiversity, and lack of genealogical documentation (Han M., et al, 2021; National Research Council. 2006). *Solanum aethiopicum* is available by various seed providers in the United States. This study is using *Solanum aethiopicum* varieties 'Zebra' and 'Simeon's White' from North Circle seeds and 'Comprido Verde Claro' and 'Morro Redondo' from Thresh Seed Company. Both companies are currently based in the Midwest, United States.

Solanum aethiopicum seeds from Thresh Seed Co., 'Comprido Verde Claro' and 'Zebra', were chosen due to their distinct morphological features and prevalence in Brazilian cuisine. Seeds from Thresh Seed Company were originally provided by the USDA National Genetic Resources Program (Thresh Seed Co., 2024). *Solanum aethiopicum* seeds from North Circle Seeds were selected, 'Simeon's White' and 'Zebra', for their specific fruit patterns, as well as their adaptation to the northern Midwest (North Circle Seeds, 2024). The 'Orient Express' variety of *Solanum melongena*, supplied by Johnny's Selected Seeds, was used as a control in the study to establish a comparison with other varieties. This variety has a documented reliability of success at the Evergreen Organic Farm, particularly in terms of yield, market, and tolerance to cold temperatures (Johnny's Selected Seeds, 2019).

Optimal Germination Conditions

Like other members of Solanaceae, *Solanum aethiopicum* prefers warmer growing conditions. *Solanum aethiopicum* is commonly seeded in temperatures ranging from 68-86 Degrees Fahrenheit (Botey H.M., et al., 2022; Mshida, D. A., 2014). Adequate light and moisture are necessary for germination. Proper light conditions for emergence have been reported at 8 hours per day, with 16 hours of darkness; as well as continuous light for higher germination rates (Botey H.M., et al., 2022; Mshida, D. A., 2014). *Solanum aethiopicum* germination may increase with temperature fluctuations: alternating ambient temperatures, or cold treatments prior to seeding (Mshida, D. A., 2014; Oyetunji, O.S., 2023). This plant is sensitive to frost, and can tolerate drought conditions (Lin et al., 2009, pp. 230–232). The resilience to fluctuating temperatures could prove *Solanum aethiopicum* to be a crop fit for climate change conditions, so long as frost is avoided. Its indigenous environment is in humid areas, in tropic environments throughout Africa (Han M., et al, 2021).

Method

In TESC Organic Farm's heated greenhouse, all eggplant varieties were seeded in separate, 72-cell trays on March 18, 2024. Trays were filled with soil using a pre-mixed soil blend: Black Gold® Natural & Organic Potting Mix. 60 seeds were placed in each tray, leaving two rows at the end of each tray empty. Morro Redondo, *Solanum aethiopicum*, was mistakenly seeded with 72 instead of 60 seeds. Seeds were placed in 1/4-inch dibbled holes, topped with soil, and watered. To replicate this crop's Indigenous environment in hot climates, trays were placed on heat mats at ~65 degrees Fahrenheit. Seedlings were watered overhead daily by hand. Beginning on day 7, soil and ambient temperature was recorded daily. Temperature records were not accounted for on days 1-2 due to lack of proper temperature probes. Soil temperature was recorded as an average between the four trays, measurements were recorded using a digital soil temperature meter. Air temperatures were determined using the temperature gauge located inside the greenhouse. On day 18, the germination emergence data for each variety was collected. Emergence was determined by visible plant growth above the soil surface.

Pest Damage and Response

Prior to emergence data collection, seedlings were impacted by pest damage from mice. The over-planted variety of *Solanum aethiopicum*, Morro Redondo, was the variety experiencing the most damage due to mice. Pest damage was noticed by a loss of shoot apical meristem, with the potential for axillary meristem growth remaining. Also, lost cotyledons and true leaves. The visible foliage was depleted on many plant specimens; although, lateral node growth was observed during the week after mice damage. The mice damage was \leq the overall seed population of Morro Redondo, *Solanum aethiopicum*, 'Gilo.' In other words, 47.7% of the germinated sprouts of Morro Redondo, *Solanum aethiopicum*, 'Gilo' were damaged. Biological control was implemented with the Evergreen farm cat, Butch, with the intention to control the mice populations by a predatory relationship. Physical barriers to deter mice included raising the plants on a heightened table and adding covers to the seedling trays.

Germination Data Analysis

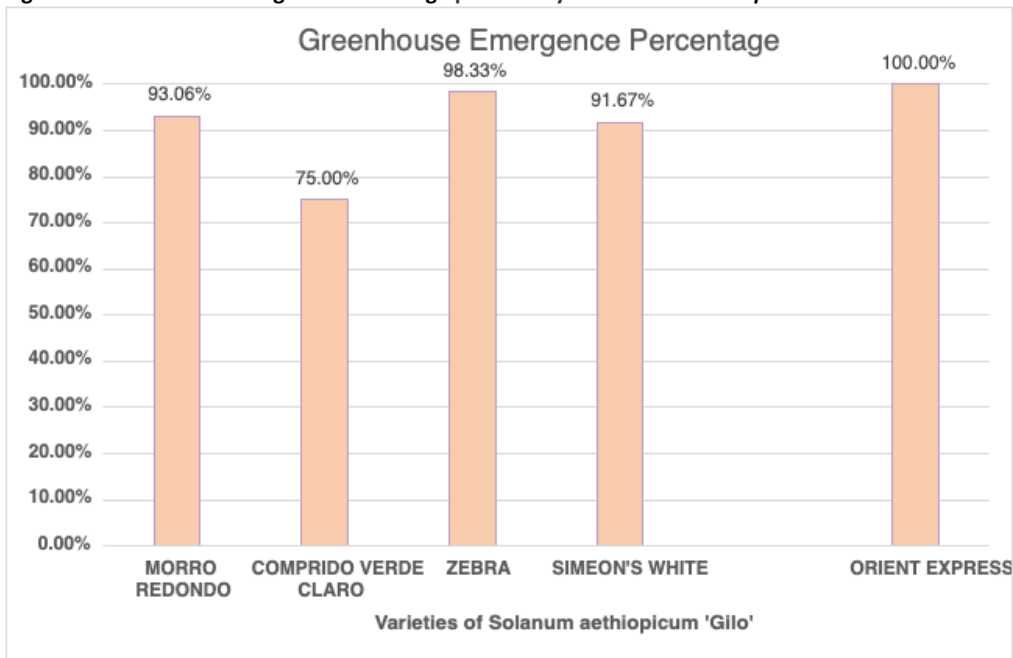
In *Table 1*, the percentage of emergence was calculated using the following formula:

$$\% \text{ Emergence} = \frac{\# \text{ of Seeds Emerged}}{\# \text{ of Seeds Planted}} \times 100$$

Figure 1: Greenhouse Germination Emergence per Variety of *Solanum aethiopicum*

GREENHOUSE GERMINATION STUDY: <i>SOLANUM AETHIOPICUM</i> 'GILO' VARIETY TRIAL AT THE EVERGREEN ORGANIC FARM					
SOW DATE: 3/18/2024					
OBSERVATION DATE:	4/4/2024	PROVENANCE OF SEEDS	# OF SEEDS PLANTED	# OF SEEDS EMERGED	% EMERGENCE
<i>SOLANUM AETHIOPICUM</i> 'GILO' VARIETIES					
MORRO REDONDO	THRESH SEED COMPANY	72	67	93.06%	
COMPRIDO VERDE CLARO	THRESH SEED COMPANY	60	45	75.00%	
ZEBRA	NORTH CIRCLE SEEDS	60	59	98.33%	
SIMEON'S WHITE	NORTH CIRCLE SEEDS	60	55	91.67%	
CONTROL EGGPLANT VARIETY					
ORIENT EXPRESS	JOHNNY'S SELECTED SEED	25	25	100.00%	

Figure 2: Greenhouse Emergence Percentage per Variety of *Solanum aethiopicum*



Performance error was defined using statistical analysis. Root Mean Square Error (RMSE) was implemented using germination rates derived from each seed provenance. Germination rates were obtained in direct communication with seed companies, based on the seed lots that our specimens were derived from.

$$RMSE = \sqrt{\sum \frac{E^2}{N}}$$

Error = $E = (Observed_i - Predicted_{ii})$ $N =$ Number of Error Samples

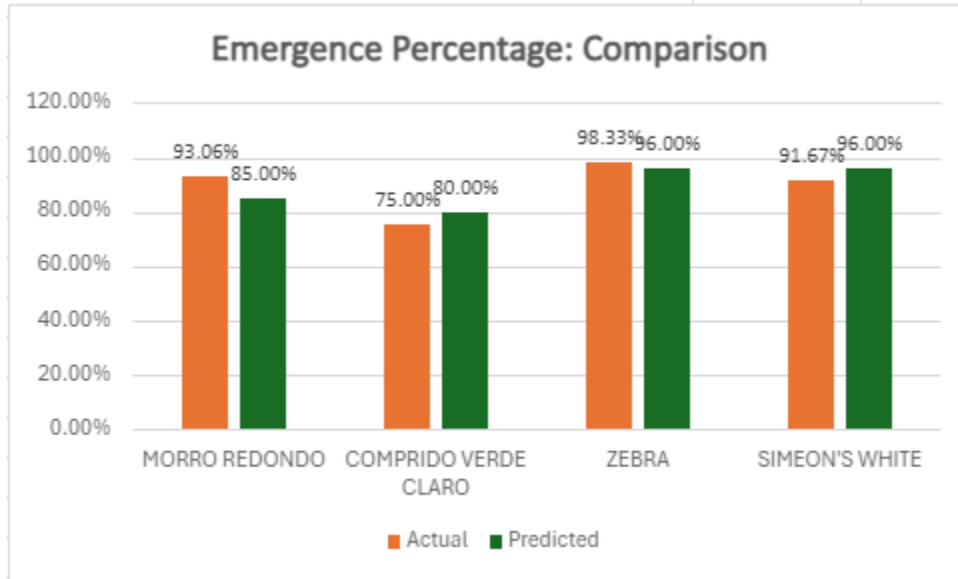
$\sum E^2 =$ Sum, E , en Error Squared

Figure 3: Statistical Analysis using RMSE: Germination Emergence per Variety of *Solanum aethiopicum*

GREENHOUSE GERMINATION STUDY: <i>SOLANUM AETHIOPICUM</i> 'GILO' VARIETY TRIAL AT THE EVERGREEN ORGANIC FARM						
Statistical Analysis: Root Mean Square Error (RSME)						
	PROVENANCE OF SEEDS	% EMERGENCE	Predicted Germination Rate	Error	Sum (Error) Squared	RMSE
<i>SOLANUM AETHIOPICUM</i> 'GILO' VARIETIES						
MORRO REDONDO	THRESH SEED COMPANY	93.06%	85.00%	8.06%	0.01141414	4
COMPRIDO VERDE CLARO	THRESH SEED COMPANY	75.00%	80.00%	-5.00%		
ZEBRA	NORTH CIRCLE SEEDS	98.33%	96.00%	2.33%		
SIMEON'S WHITE	NORTH CIRCLE SEEDS	91.67%	96.00%	-4.33%		
CONTROL EGGPLANT VARIETY						
ORIENT EXPRESS	JOHNNY'S SELECTED SEED	100.00%	98%	2.00%	0.0004	1

According to *Table 2*, RMSE ~0.053, for *Solanum aethiopicum*, 'Gilo', varieties. The <1 RMSE value suggests statistically low error in sample values. In the context of this data set's dependent variable range, (Emergence %), RMSE of .053 is small, indicating that the predicted germination rates fit well with this dataset. *Graph 2* shows representative emergence rate for the actual germination rates derived from this localized study and predicted values from the seed sources: North Circle Seeds and Thresh Seed Company.

Figure 4: *Solanum aethiopicum* Emergence Rate Comparison



From these values, average rates are applied. *Solanum aethiopicum* proved an average actual emergence of 89.52% and average prediction of 89.25%. Comparatively, the control, *Solanum melongena*, had a 100% actual and 98% predicted value. *Solanum aethiopicum* variety 'Zebra' had the highest emergence average ~ 97.17%; while the lowest emergence rate was *Solanum aethiopicum* variety 'Comprido Verde Claro' at average: 77.5%. Furthermore, *Solanum aethiopicum* variety 'Zebra' and 'Morro Redondo' performed higher than their predicted values.

Discussion

Solanum aethiopicum emergence was monitored using standard field procedures. Results reviewed accurate germination results, comparative to predicted values derived from seed companies using Root Mean Square Error (RMSE). RMSE was low at ~0.053, suggesting a close relationship to experimental values compared to predicted values from the seed providers. Results showed *Solanum aethiopicum* having an average actual emergence of 89.52% and average prediction of 89.25%. Rodent damage was present, yet proved no effect on emergence counts. *Solanum aethiopicum* variety 'Zebra' had the highest actual emergence average of 98.33%, closest to the control, *Solanum melongena*, which read 100% emergence. All treatments, *Solanum aethiopicum*, in this study appear to be higher other credited data averages, >68.5% (Mshida, D. A., 2014).

Conclusion

Interestingly, the uncontrolled environment, pests, and moderate temperatures still revealed high emergence rates. Especially in comparison to informal seed saving of *Solanum aethiopicum*, which suggests $\leq 25\%$ germination, even as low as zero germination (Botey H.M., et al., 2022). Furthermore, experimental data shows promising evidence towards this crop's resiliency due to its ability to recover from rodent damage, adapt to moderate and fluctuating temperatures, and present statistically consistent emergence rates. While this study shows representative data from a field perspective, with uncontrolled environments, variability is possible within other local conditions. This *Solanum aethiopicum* study lacks variety replications, and controlled results without the impact from biotic

factors; however, it is intended to benefit growers and marketeers looking for data in variable PNW field environments. Moving forward, we hope to conduct a controlled germination chamber study with replications to compare variety emergence; additionally, to document phenological and morphological germination using the BBCH scale. A controlled study would be necessary to compare the varieties without biotic and environmental influences. Even in the context of variability, *Solanum aethiopicum* proved to be higher than other study predictions, as well as meeting the market expectations of seed providers; this indicates that *Solanum aethiopicum* is a reliable market crop, with the potential to recover from pest damage and adapt to shifting temperatures.

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