

**DETERMINING THE COMPARATIVE EFFECTIVENESS OF CHEMICAL  
METHOD AND MECHANICAL METHODS OF BREAKING SEED DORMANCY IN  
SOLANUM AETHIOPICUM**

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## ABSTRACT

Dormancy of seeds in *solanum aethiopicum* groups thus gilo and shum, hinders uniform germination. This leads to disturbances in the harvesting schedules and the overall yields. This study evaluated the effectiveness of chemical methods (Gibberellic acid, potassium nitrate), and mechanical methods (hot water and mechanical scarification) in breaking seed dormancy in these varieties (shum and gilo). Gibberellic acid is a plant hormone based chemical, which is responsible for plant cell elongation and combating the effects of ABA. Potassium nitrate is a nutrient based chemical containing potassium and nitrates essential for plant growth. The seeds of various accessions of shum and gilo were presoaked in different concentrations of Gibberellic acid ( $GA_3$ ) and, potassium nitrate ( $KNO_3$ ) i.e.  $GA_3$  (500mg/l, 300mg/l, 700mg/l) and  $KNO_3$  (0.25%, 0.75%, 1.0%) for 24 hours. Hot water treatment, the seeds were treated with water heated up to 80 °C for 5 minutes and mechanical scarification, seeds were scratched with sand paper carefully and then rinsed. The sowing of seeds were followed, where they were sown in petridishes lined with wet cotton wool and arranged in a 4X3 factorial experiment using CRD design.

The outcomes indicated that when treatments compared, Gibberellic acid 500mg/l with 92.5% germination and mechanical scarification with 70% germination are the effective treatments for breaking seed dormancy in shum, while gilo responds same way to mechanical scarification and hot water treatment. While comparing the effectiveness of chemical and mechanical methods in breaking seed dormancy in shum and gilo, the chemical treatments outperformed the mechanical treatments more especially in shum with 58.2% germination and MGT (3.9 versus 8.3) and higher germination percentage (58.2% versus 46.0%). For gilo variety however, mechanical methods resulted into higher GP (34.8 versus 23.4) but indicated similar GVI and slower MGT (8.3). When comparisons are made within the treatments, GA 500mg/l significantly increased germination percentage in shum with 82.89% mean GP compared to gilo that indicated 39.37% mean Gp. Mechanical scarification also improved germination significantly with 70% mean GP in shum compared to hot water that resulted in no significant difference between hot water and mechanical scarification. Moreover, shum exhibited a significantly lower mean germination time with 3.2 days compared to KNO and distilled water. Therefore, null hypothesis one was rejected as the results show significant differences ( $p < 0.001$ ) in effects of chemical treatments on seed performance in both shum and gilo with GA 500mg/l being the best and reject the second null hypothesis as mechanical methods indicated significant differences in the effects of hot water and mechanical scarification on germination parameters with  $p < 0.001$ .

## DECLARATION

I, **TUHIRIRWE JENIPHER**, declare that I generated research dissertation and any assistance I got in its preparation is fully recognized and disclosed in the report. The different sources used in getting information are also cited in the document. I also certify that this paper was prepared by me specifically for the partial fulfillment for the award of degree in Bachelor of Agricultural Science and Entrepreneurship at Uganda Christian University.

Signed.....

Date.....

## APPROVAL

This is to certify that this dissertation has been submitted for examination with my approvals as the academic supervisor as a requirement for the award of a degree in Bachelor of Agricultural Science and Entrepreneurship.

Signature .....Date.....

Supervisor.....

**Special Project Supervisor**

## DEDICATION

I dedicate this research dissertation to my beloved family, for the endless love and support towards my academic journey. Also to my fellow students and lecturers for the advice that helped me in drafting this research report.

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## LIST OF ACRONYMS

GA	Gibberellic Acid
KNO	Potassium Nitrate
%CV	Coeficiencie of Variance
UCU	Uganda Christian University
GP	Germination Percentage
MGT	Mean Germination Time
HWT	Hot Water Treatment
MS	Mechanical Scarification
LSD	Least Significant Difference

## CHAPTER ONE

### INTRODUCTION

#### 1.0. Introduction

#### 1.1. Background

African scarlet eggplant also known as *solanum aethiopicum* belongs to domain *eukaryote*, kingdom *Plantae*, phylum *spermatophyte*, subphylum *angiosperm*, family *solanaceae*, species *solanum aethiopicum* (Han *et al.*, 2021). It falls under African eggplants and arranged into groups based on morphology and use that is to say shum, gilo, Aculeatum, and kumba. (Aguessy, Idossou, Dassou, *et al.*, 2021). African scarlet eggplant is grown mostly in Africa especially Uganda, Nigeria and Cameroon. Gilo grows more widely than any other group for its fruits, which are usually orange to red in color at ripening stage. The fruits are eaten both raw and cooked with sweetness at ripening stage. Its leaves are not eaten and it is believed to have originated from *solanum anguivi*. It's preferred for its economic and therapeutic functions that include treatment of some diseases, it contains macro and micronutrients thus possess properties of fighting hidden hunger (Aguessy, Idossou, Dassou, *et al.*, 2021), (Anyakudo *et al.*, 2022). On the other hand, shum is preferred for its leaves and produces small fruits, which are rarely eaten but can be consumed (Han *et al.*, 2021), (Aguessy, Idossou, & Agre, 2021), (Ummah, 2019).

Despite the usefulness of these crops, seed dormancy remains a challenge in their production, in addition to temperature, humidity and moisture. In addition, soil quality, water quality and pests and diseases (Fouelifack, *et al.*, 2021), also affect the production of *solanum aethiopicum* all over the world (Oyetunji *et al.*, 2023). Other factors like low market demand (Aguessy, *et al.*, 2021), low fruit storability, inadequate high yielding varieties and water stress contribute to the failures in cultivation of *solanum aethiopicum*.

*Solanum aethiopicum*, shum and gilo are propagated by seeds (Boureima *et al.*, 2018). A seed is a complex entity that contains all the genetic information needed to produce new plants through the process called seed germination (Sajeev *et al.*, 2024) (Sajeev *et al.*, 2024). The processes of seed germination in generally all

African eggplants, which include *solanum aethiopicum*, face seed dormancy. Seed dormancy in *solanum aethiopicum* categorize into two forms i.e. exogenous dormancy that occurs due to the external factors affecting shum and gilo seeds' ability to germinate and endogenous dormancy that occur due to internal factors with in the seed itself. Unfavorable environmental conditions, impermeable seed coats, immature embryos and innate inhibitors in the seed can influence dormancy. (Han *et al.*, 2021; Oyetunji *et al.*, 2023).

Scientifically, abscisic acid is key in initiating and maintaining seed dormancy whereas gibberellic acid is useful for germination and counteracting ABA effects in seed dormancy (Kamali & Shaban, 2014) (Khalid, 2022). Hormones play a crucial role in breaking seed dormancy. For example, abscisic acid promotes dormancy through inhibiting germination by affecting gene expression related to growth and metabolism. Gibberellins promote germination by stimulating enzymes that breakdown stored food reserves. A number of environmental factors, which include light, temperature, moisture and many more, influences seed dormancy. (Fu *et al.*, 2024). In species such as *solanum aethiopicum*, which includes Shum and gilo varieties, overcoming dormancy, is crucial for successful cultivation and crop production to reduce the effects of food insecurity.

To solve the problem of seed dormancy, various methods have been explored by different researchers which include the mechanical methods like mechanical scarification, soaking of seeds in water e.g. hot water treatment and cold shocking and chemical scarification that include sulfuric acid, hydrochloric acid, gibberellic acid and potassium nitrate KNO<sub>3</sub> (Jagga, 2023). Among the chemical methods, gibberellic acid and potassium nitrate are among the most widely used chemical treatments and proven to break seed dormancy. Gibberellic acid is a plant hormone known for its role in cell elongation and breaking dormancy in seeds thereby enhancing germination rates. Gibberellic acid is a hormonal based method in breaking seed dormancy and its role is to produce enzymes for the breakdown of the stored food, soften the seed coat, help seed to respond to environmental signals and activate the alpha catalase that hydrolyses starch into sugar. Whereas potassium nitrate being a nutrient based method, it supplies nutrients to the seed for example potassium and nitrates that are essential in metabolism processes

during germination. In addition KNO<sub>3</sub> activates enzymes, synthesizes amino acids and gibberellins that are essential in breaking seed dormancy. (Shu'aibu Abubakar & Lawal Attanda, 2022)

Furthermore, various mechanical methods have also been used in breaking seed dormancy e.g. cold shocking, hot water, and mechanical scarification (Oyetunji et al., 2023), however hot water treatment and mechanical scarification are the widely used methods of breaking seed dormancy. The hot water treatment involves immersing seeds in hot water to soften the seed coat thus facilitating water uptake and triggering germination (Koobonye et al., 2018). This method is widely appreciated for its simplicity and cost effectiveness. On the other hand, mechanical scarification physically changes the seed coat through abrasion reducing barrier to water absorption and gas exchange (Kumar et al., 2018)

Despite the potential of these treatments, the comparative analysis of their efficacy in breaking seed dormancy and promoting growth across different cultivars of *solanum aethiopicum* specifically gilo and shum are limited (Mohammed & Baldwin, 2023; Oyetunji et al., 2023). This research aims at providing a comparative analysis of the effects of GA and KNO<sub>3</sub> and mechanical methods that is to say hot water treatment and mechanical scarification on seed germination and growth in various groups of *solanum aethiopicum*. By identifying the most effective dormancy breaking method, this study seeks to enhance cultivation practices and improve yield consistency in this vital crop.

## **1.2. Problem Statement**

Seed dormancy affects germination and establishment of *solanum aethiopicum* varieties, which include Gilo and Shum group (Jagga, 2023; Oyetunji et al., 2023; State, 2017). This dormancy can lead to non-uniform germination patterns of seeds, which is a problem in crop yields or harvesting schedule and agricultural productivity. The preliminary study on African eggplants indicates a wide variation in percentage germination. The germination percentages ranged from 0% to 25% for dried seeds and the fresh seeds ranged from 53% and 87% (Botey et al; 2022). Relating this percentage with the set standard percentage of crops which is 70% (FAO; 2010, Deonice et al; 2014) it indicates a wide range. This indicates the need

for specific and efficient method for optimizing the germination rates and ensuring successful crop establishment. (Balaguera-López et al., 2009) (Gupta & Chakrabarty, 2013) (Oyetunji et al., 2023).

Researchers have intervened in solving seed dormancy problem in different crops where different methods have been applied for example hot water treatment, pre chilling, scarification, use of chemicals like sulfuric acid and HCL. Among the methods used included GA, which is hormonal based, and KNO<sub>3</sub>, which is nutrient based and the mechanical methods are hot water treatment and mechanical scarification (Han et al., 2021; Oyetunji et al., 2023; Sindhuja et al., 2023). However, most of the studies focused on *solanum aethiopicum* cultivars but responses of shum and gilo considering different accessions within them experiencing seed dormancy were not addressed considering the fact that they are genetically different (Adeniji et al., 2012) and more likely to vary in their responses to different methods. In addition, the concentrations for the chemical treatments that were used in other crops are not guaranteed to work for shum and gilo due to genetic variability.

This creates the need to carry out the comparative analysis in order to find out the most effective method and optimization to use in both cultivars while putting into consideration of different accessions of shum and gilo. The horticultural farmers are the most affected group because high levels of seed dormancy reduce the overall yield and this affects their standards of living. This study aims to conduct a comparative analysis of the effects of gibberellic acid and potassium nitrate on seed germination and seedling growth in Gilo and Shum species. The results are to provide valuable insights that can enhance agricultural growth. (Gupta & Chakrabarty, 2013; Oyetunji et al., 2023).

### **1.3. Main objective**

To compare the effectiveness of chemical methods and mechanical methods in breaking seed dormancy in *solanum aethiopicum* (shum and gilo)

#### 1.4 Specific objectives

1. To compare the effectiveness of different chemical treatments on breaking seed dormancy in shum and gilo.
2. To determine the efficacy of physical methods in overcoming seed dormancy in *solanum aethiopicum* shum and gilo.

#### 1.5 Hypothesis.

1. There is no significant difference in germination rates of *solanum aethiopicum* when seeds are treated with chemical methods in *solanum aethiopicum* shum and gilo
2. There is no significant difference in the effects of Mechanical methods (hot water treatment and mechanical scarification) in enhancing germination in *solanum aethiopicum* shum and gilo.

#### 1.6 Justification

Seed dormancy is crucial challenge in agriculture particularly in species like shum and gilo, which are economically and nutritionally important crops (Oyetunji *et al.*, 2023). This disturbs uniform germination leading to delay in seedling establishment and reduced productivity. Potassium nitrate and gibberellic acid ( $GA^3$ ) are widely used seed dormancy-breaking agents (Jagga, 2023). Potassium nitrate ( $KNO_3$ ) stimulates seed germination by giving nitrate ions, a known germination cue, especially for light-sensitive seeds. Gibberellic acid ( $GA_3$ ) promotes enzyme stimulation and cell elongation, which aids in breaking dormancy by enhancing embryo growth (Hern *et al.*, 2021). The mechanical methods are preferred due to their cost effectiveness, as they require simple tools and materials than purchase of chemicals. In addition, they increase water uptake and nontoxic in addition to being easily accessed by most farmers (Jena *et al.*, 2024). Evaluating these treatments' comparative effectiveness is crucial to developing efficient, cost-effective strategies for overcoming seed dormancy in shum and gilo, contributing to better crop management and yield optimization. The purpose of this study is to carry out a comparative analysis of the effectiveness of chemical method ( $GA_3$  and  $KNO_3$ ) and mechanical methods (hot water treatment and

mechanical scarification) as dormancy breaking methods for seeds of *solanum aethiopicum* specifically Gilo and shum groups' accessions. This research aims at evaluating the impact of the treatments on germination rates. By examining the differences in effectiveness of GA<sub>3</sub> and KNO<sub>3</sub> (chemical) and mechanical methods (hot water treatment and mechanical scarification) in breaking seed dormancy in Shum and gilo, the study seeks to provide insights on the most effective methods for enhancing seedling growth specifically in shum and gilo. The findings will contribute to improved agricultural practices for cultivating *solanum aethiopicum*, promoting productivity and improving farmer's standards of living especially the horticultural farmers. In relation to the existing studies, this study will help fill the gaps regarding variety specific requirements in breaking seed dormancy due seed genetic variability of these crops.

### **1.7 Significance**

Overcoming dormancy will ensure uniform germination, faster establishment, and better crop yields, which are vital for addressing food security issues. Improving the cultivation success of shum and gilo can boost their commercial production, enhancing the income of farmers in regions where these crops are staple foods. This research fills a knowledge gap on the dormancy-breaking mechanisms specific to these *Solanum* species, laying the groundwork for further studies on related crops. The findings will provide actionable insights to extension services and agricultural practitioners for better seed management practices. In addition, farmers and researchers will gain insights concerning variety specific requirements for the cultivation *solanum aethiopicum* varieties.

## 1.8 CONCEPTUAL FRAMEWORK

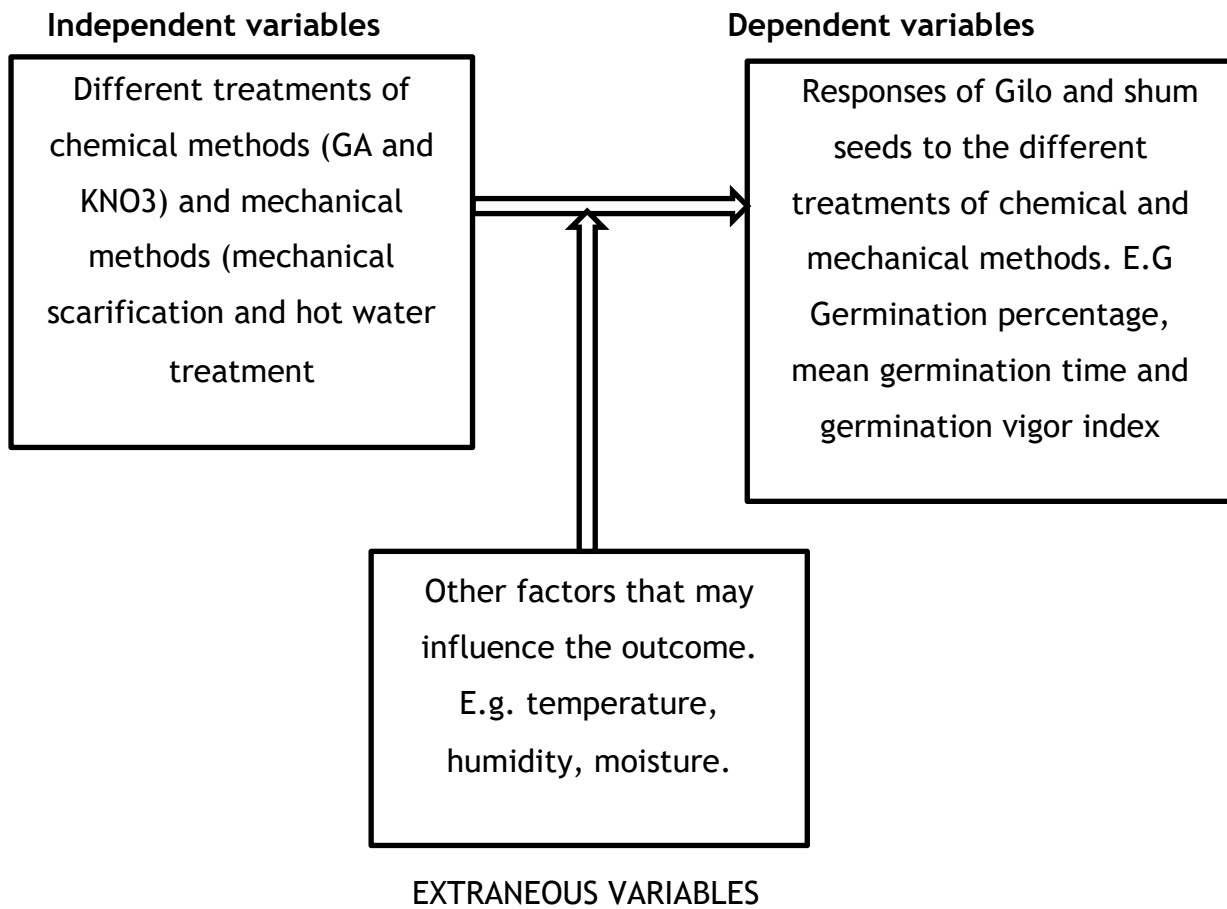


Figure 1: *Dependent, independent and extraneous variables*

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1. *Solanum aethiopicum* botany.

*Solanum aethiopicum*, commonly referred to as African eggplant, belong to the family *solanaceae* and is among the indigenous vegetables in Africa (Aguessy *et al.*, 2021), (Solanum, 2024), (Ukom *et al.*, 2023). The species is divided into four main cultivar groups i.e. gilo, shum, kumba and aculeatum each with distinct morphological traits and regional significance (Nakyewa *et al.*, 2021). The gilo group is characterized by its bitter fruits that are consumed when immature (Ummah, 2019). The shum group, which is primarily valued for its leaves, represents the most economically significant varieties across sub-Saharan Africa. According to (Aguessy *et al.*, 2021). *S. aethiopicum* is an erect herbaceous annual or perennial crop, which is capable of growing up to 2 meters in height. The leaves are simple and ovate with entire or lobbed margins measuring 10 to 20 cm in length and 5 to 10cm in width (Mohmand & Sciences, 2015). African eggplant (*Solanum aethiopicum*) is propagated by seeds which contain all the genetic information for development of new plants (Management, 2018), the seeds are discoid and pale yellow to light brown in color and a significant characteristic of these seeds is dormancy that usually call for pretreatment in order to achieve uniform germination (Botey *et al.*, 2022; Mahmood ur Rehman *et al.*, 2024).

#### 2.2 Production Environment

African eggplants (*s. aethiopicum*) are well adapted to a wide range of tropical and subtropical environments, which indicates considerable resilience to vast growing conditions that limit other vegetable crops. They do well in regions with annual rainfall between 500 to 2000mm and temperatures that range from 18-35°C and optimal growth happens at 23-30°C. According to (Ahmad *et al.*, 2015), (Botey *et al.*, 2022), (Fitriana, 2014), *S. aethiopicum* performs well in well drained, fertile loam soils with pH of 5.5 and 6.8. The crop is adapted to various soil types including sandy and clay soils and this contributes to its wide spread cultivation.

In terms of photoperiod requirements, African eggplants are day- neutral, facilitating year round production in tropical regions. The water requirement range from 600-1200mm distributed throughout the growing season and in areas with limited water supply, drip irrigation have been increasingly adopted in commercial setting to optimize production (Botey *et al.*, 2022), (Mwinuka *et al.*, 2021). Fertilization is crucial in *S. aethiopicum* production and requires moderate compared to other horticultural crops with recommended application of 80 to 120kg/ha nitrogen, phosphorus 60 to 80kg. The duration of the crop in the field ranges from 70 to 90 days for leaf production in shum and 100 days to 150 days in gilo and the productive cycle can extend up to 12 months depending on the care and maintenance(Hanson *et al.*, 2016).

### **2.3. Relevance of growing *solanum aethiopicum* (African eggplants).**

African eggplants possess significant cultural, medicinal, nutritional and economic importance across Africa particularly eastern Africa(Anosike *et al.*, 2012),( David-Rogeat *et al.*, 2023). According to (Anyakudo *et al.*, 2022) the production exceeds 1.5m tones and this makes it one of the most useful indigenous horticultural crops in terms of production and market values. The economic importance goes beyond farm production to employment generation along its value chain. From the nutritional perspective, the crop contains high levels of protein (3.2-4.6mg/100g), calcium (507 to 595mg/100g), iron and vitamins (Aguessy, Idossou, Dassou, *et al.*, 2021; Ik *et al.*, 2021). They also contain substantial concentrations of phenolic compounds especially chlorogenic acid in both fruits, leaves, and is essential in treatment of hypertension, asthma, diabetes, and some inflammatory conditions(Edeke *et al.*, 2021). It is also useful in culture conservation through traditional dishes and agricultural heritage in numerous ethnic communities.

### **2.4. Production constraints and seed dormancy.**

Despite the economic and nutritional purposes of African eggplants, the crop faces a number of production constraints that limit it's productivity and expansion(Mousavi & Rezaei, 2014). Among these challenges include seed dormancy as it stands out as a fundamental problem affecting commercial and small holder production of shum and gilo (Oyetunji *et al.*, 2023), ( Xu *et al.*, 2024).

Other production constraints include pests and diseases with bacterial wilt, fusarium wilt and various viral diseases being the common ones and pests being fruit borers, white flies, and aphids, which are capable of causing both direct damage and transmit viral diseases (Fitriana, 2014). In addition, limited improvement compared to major commercial vegetables is a significant limitation to its production plus post-harvest losses and market constraints (Gurung *et al.*, 2018). Finally, climate change is an emerging threat to production of African eggplant. While the crop demonstrates resilience to environmental stress, extreme environmental conditions challenge traditional production processes.

## **2.5. Methods of Breaking Seed Dormancy**

Several methods used to break seed dormancy and among all are chemical and mechanical methods. With chemical methods, a number of methods have been used but GA<sub>3</sub>, KNO<sub>3</sub> was the most used, and hot water and mechanical scarification for mechanical methods have been widely used.

### **2.5.1. Chemical methods.**

#### **2.5.1.1. Gibberellic acid**

It is a well-studied plant hormone known for its role in promoting seed germination (Guardia *et al.*, 2016). It stimulates enzymatic activity that breaks down stored food reserves, facilitating the mobilization of nutrients necessary for germination (Gupta & Chakrabarty, 2013), ( Oyetunji *et al.*, 2023). Studies have indicated that GA<sub>3</sub> can effectively enhance germination in different crops species by overcoming physiological dormancy (Opabode & Owojori, 2018). For example application of gibberellic acid have shown improvements in germination and seedling vigor in *solanucaeae* specie *s. torvum* where it indicated positive effects of GA in breaking seed dormancy with 74% success germination ability. (Sindhuja *et al.*, 2023).

#### **2.5.1.2. Potassium Nitrate.**

Potassium nitrate on the other hand serves as both source of nutrient and an osmotic agent that enhance seed hydration thereby promoting germination. KNO<sub>3</sub> promotes germination rates and improve seedling quality across range of crops. For instance in a study carried out by Oyetunji *et al* 2023, potassium nitrate was compared with the mechanical and chemical treatments in breaking seed

dormancy in *solanum aethiopicum L*, potassium stood out to be the best after the comparisons with the highest percentage viability which indicates its ability in breaking seed dormancy (Oyetunji *et al.*, 2023). Also potassium nitrate was used to break seed dormancy in peas and it indicated the ability to break seed dormancy (Hern *et al.*, 2021). Both methods were used simultaneously in dormancy breaking in *agrimonis ecipatoria* and both successfully broke seed dormancy but with different levels of impact in percentages. Tapfumaneyi *et al*, 2023, used the two methods in amaranths dodo and both managed to bring positive results. Also potassium nitrate and gibberellic acid were used to test their ability in breaking seed dormancy in shepherds purse and 40.08% and 17.75% success were got for GA<sub>3</sub> and KNO<sub>3</sub> respectively(Sato & Köhler, 2022).

While the individual effects of GA<sub>3</sub> and KNO<sub>3</sub> on seed germination have been documented, comparative studies specifically focusing on *solanum aethiopicum* cultivars (gilo and Shum) are limited(Lee *et al.*, 2022).

## **2.5.2. Mechanical methods.**

### **2.5.2.1. Hot water treatment**

Hot water treatment involves soaking seeds in warm water to soften hard seed coats and enhance water uptake. This method is particularly useful for seeds with physical dormancy caused by impermeable seed coats. Studies on leguminous and *Solanaceous* species have shown positive effects on germination rates when seeds were exposed to optimal water temperatures (Baskin & Baskin, 2014). In a research carried out by (Oyetunji *et al*;2023), the seeds were immersed in hot water boiled to 80 degrees for 5 minutes and the current research followed this procedure for hot water treatment in addition to removal of floated seeds.

### **2.5.2.2. Mechanical Scarification**

Mechanical scarification involves physically altering the seed coat using abrasion, cutting, or scratching to facilitate water and gas exchange. In this research, seeds were scratched with sand paper to create an abrasion. This method is commonly used for seeds with hard seed coats. Research on several plant species has shown that mechanical scarification significantly improves germination by overcoming physical dormancy barriers (Debouba *et al.*, 2015). Mechanical scarification

physically interferes with the seed coat creating an abrasion, which facilitates entrance of moisture and gases essential for germination to occur. Oyetunji et al, 2023 carried out research on *solanum aethiopicum L* using the same method but their research focused on one variety and did not compare the effectiveness of mechanical and chemical methods.

Despite the documented significances of seed dormancy and different methods being used in *s. aethiopicum*, there is a gap concerning the comparative effectiveness of different dormancy breaking methods across different varieties (shum and gilo). The current study addresses this gap by directly comparing chemical and mechanical methods of breaking seed dormancy in shum and gilo. By evaluating treatment effects on germination parameters (germination percentage, mean germination time, germination vigor index). The findings contribute to improved understanding of seed dormancy and practical application for enhancing its establishment.

## CHAPTER THREE

### METHODS AND METHODOLOGY

This chapter gives details about where the research was done and how the research was conducted. This study employed a complete randomized design where treatments were assigned randomly.

#### 3.1.1. Area of study.

The study was conducted in Mukono district at Uganda Christian University from November to February 2025. Uganda Christian University is located about 22km from capital city Kampala along Jinja road. According to (Onok, 2016), Mukono district has two main soil types: ferratic soils and ferrisol, a plateau of 100-300m above the sea level with mean annual rainfall of 1100mm. The rain fall is distributed in 106 days with rainfall peaks in March to June and September to November.

#### 3.1.2. Scope of the study.

The study was carried out at Uganda Christian University in the chemistry laboratory. This study focused on comparative analysis of GA<sub>3</sub> and KNO<sub>3</sub>, hot water treatment and mechanical scarification in breaking seed dormancy across the different varieties of *solanum aethiopicum* (shum and gilo) accessions. It focuses on how the two varieties differ in response to different treatments and optimizations due to the fact that they vary genetically (Adenji;.2012). Different treatments of gilo (300mg/l, 500mg/l, and 700mg/l) and shum (0.25%, 0.75%, and 1.0%) were used to analyze their effects on breaking seed dormancy. Key parameters were measured for example germination percentage, germination vigor index, and mean germination time. The experiment was laid in complete randomized design (CRD) where treatments were assigned randomly. A hundred seeds were planted for each treatment. The collected data was analyzed using excel, anova, posthoc tests (turkey HSD test) and graphs for presentation of data

#### 3.1.3. Objective one chemical treatments

Seeds from two groups of *solanum aethiopicum* i.e. Shum and gilo were used in the study. Different accessions of shum (168G, 148, 184G, 157G, and E6) and gilo (G6, G7, G9, G11, GOGWE) were used in the experiment. These seeds were grown in

the UCU screen house and others grown in the DEMO gardens and harvested in 2023. The seeds were stored in airtight polythene bags and in a cool dry place at room temperature. They also have a history of failure to germinate thus being chosen for the experiment.

For the chemical method, GA<sub>3</sub> and KNO<sub>3</sub> were used where the seeds were soaked in different chemical concentrations i.e. GA<sub>3</sub> (300mg/l, 500mg/l, 700mg/l) and KNO<sub>3</sub> (0.25%, 0.75%, 1.0%) plus the control experiments where seed were soaked in distilled water for 24 hours.

### **3.1.3.2. Treatments preparation.**

For potassium nitrate, grams per 100ml of the solution needed were obtained by the amount of potassium nitrate (Oyetunji *et al.*, 2023). Therefore, 0.25g of potassium nitrate was weighed using analytical balance. The amount weighed was dissolved in small amounts of water in a beaker and mixed thoroughly. The solution was transferred to 100ml measuring cylinder, filled with distilled water up to 100ml mark, and mixed thoroughly. The procedure was repeated for 0.75% and 1.0% concentrations. (Dev *et al.*, 2020)

For gibberellic acid, the amount needed was obtained milligrams by the volume needed in liters (Mohammed & Baldwin, 2023). For instance to get 300mg/l, 300mg of GA<sub>3</sub> were weighed using the analytical balance. The weighed powder was dissolved in small amounts of distilled water in a beaker. Then the solution was transferred into the 1 liters amount of distilled water. This procedure was repeated for 500mg/l and 700mg/l. (Oyetunji *et al.*, 2023; Sheriff, 2022)

### **3.1.3.3. Procedure.**

The seeds of different accessions of shum (148, 184G, 168G, E6 and 157) and gilo (G6, G7, G9, G11, GOGWE) were soaked in distilled water for 15 minutes before being transferred to different concentrations of GA<sub>3</sub> (300mg/l, 500mg/l, 700mg/l) based on experiment a (Sheriff, 2022) and in KNO<sub>3</sub> (0.25%, 0.75%, 1.0%) based on (Sheriff, 2022) (Oyetunji *et al.*, 2023) and distilled water (as control experiment) for 24 hours. The seeds that remained floating were removed as they have low chances of germination compared to those that settle at the bottom of the water

container(Ukom *et al.*, 2023), (Baskin & Baskin, 2004). After soaking for 24 hours, the seeds were removed and sown in petridishes lined with a wet cotton wool.

#### **3.1.3.4. Experimental design.**

Based on the experimental design used by (Oyetunji *et al.*, 2023; Sheriff, 2022) i.e. 4 by 3 factorial experiment laid out in a complete randomized design was used where treatments were assigned randomly. The factors were treatment types (GA<sub>3</sub> and KNO<sub>3</sub>), plant varieties (Shum and gilo) and the different concentrations of treatment types.

The experiment had three replicates for each experimental unit to account for variability within experimental units. Each experimental unit consisted of 100 seeds planted in a petridish. Seeds for the different varieties were presoaked in various concentrations of KNO<sub>3</sub> and GA<sub>3</sub> for 24 hours. For the control experiment, the seeds were presoaked in distilled water and then planted in a petri dish lined with cotton wool and moistened. Then the experiment was covered with black polythene to provide a dark environment for germination to occur.

#### **3.1.3.5 Experimental Layout**

240 experimental units were laid out with 100 seeds in each experimental unit and this made a total number of seeds needed to be = 24000 seeds (gilo = 12000 seeds, Shum = 12000seeds). Different levels of treatments of GA<sub>3</sub> (300Mg/L, 500 Mg/L, 700 Mg/L) and KNO<sub>3</sub> (0.25 %, 0.75%, 1.0%,) will be used and treatments were assigned randomly for each of the accessions of shum and gilo and for all treatments (mechanical and chemical methods). Each accession was treated with different concentrations of GA<sub>3</sub> and KNO<sub>3</sub> and these treatments were replicated three times each and assigned randomly in a CRD design. This layout was used on all the 10 accessions of shum and gilo with both chemicals (GA and KNO). The experiments were set in the biology lab which had average temperature of 27.3°C, max 48.9°C, min 20.5°C and humidity of AV 39%, max 56.6%, min 20.0%. The weights per 100 seeds ranged between 0.6 to 0.95 as represented in appendix.

### **3.1.4. For mechanical methods.**

#### **3.1.4.1. Materials.**

Shum and gilo accessions' seeds, which were harvested in 2023, were collected from Uganda Christian university seed bank (same accessions used in objective one).

#### **3.1.4.2. Procedure.**

##### **3.1.4.2.1. Hot water treatment.**

For hot water treatment, water was heated up to 80°C and used to soak the seeds for 5 minutes. The seeds that remained floating on top of water were removed and disposed off since such seeds are believed not to possess germination properties (Daneshvar et al., 2016).

##### **3.1.4.2.2. Mechanical scarification**

For mechanical scarification, the seeds were scratched with sand paper using two sheet sand paper methods. A mass of seeds were held in between rough surfaces of two pieces of sand paper and rotated gently and carefully to make an abrasion on the seeds. The seeds were then soaked in water for 15 minutes and those that settled on top were removed.

For the control experiment, untreated seeds (no treatment was applied to the seeds) were also presoaked in distilled water for 15 minutes.

The seeds were then sown in the petridish lined with cotton wool. (Lujan Rocha *et al.*, 2022)(Li, X., *et al* 2022). Then covered with black polythenes to provide dark environment for initial germination to take place. The experiments were laid out in a CRD design where treatments were assigned randomly as used by (Oyetunji *et al.*, 2023)

The experiments were set in the biology lab, which had average temperature of 27.3°C, max 48.9°C, min 20.5°C and humidity of AV 39%, max 56.6%, min 20.0%. The weights per 100 seeds ranged between 0.6g to 0.95g as represented in appendix.

Completely randomized design was used where each treatment was replicate three times for each of the concentrations as shown above.

### **3.1.5. Data collection and analysis.**

#### **3.1.5.1. Data collection for objective one**

The daily counting of the seeds that germinate everyday was carried out. The numbers of seeds that germinate each day were recorded. The number of seeds that germinate each day will be recorded and seeds with radicle protrusion of at least  $\geq 2\text{mm}$  was considered to have germinated to determine the germination percentage after 7 and 14 days. (Gp).

#### **3.1.5.2. Data analysis for objective one.**

The following variables were calculated using Microsoft excel, following what (Sheriff, 2022) considered.

Germination percentage. Where germination was monitored daily for 14 days and a seeds would be considered to have germinated when the radicle has protruded at least 2mm from the seed coat. Then the germination percentage was calculated

$$GP = (\text{germinated seeds} \div \text{total seeds planted}) \times 100$$

#### **Mean germination time.**

The average time taken for seeds to germinate in each treatment group was calculated using the formulae

$$MGT = \frac{\sum(n \times t)}{\sum n}$$

Where n is the number of seeds germinated on day t. (Oyetunji *et al.*, 2023).

Also germination velocity index (GVI) was calculated using a formulae  $GVI = \frac{\sum(Gt/Dt)}{\sum n}$ , where Gt represents the seeds that germinated at day t, Dt represent time in days corresponding to the number of seeds that germinated on that day.

After calculating the germination parameters, data was imported to R studio for analysis to find the descriptive statistics (means, standard deviation and standard error mean and coefficient of variance), ANOVA analysis to identify the

difference(p values), then Turkey's HSD test (LSD groups) to find specific differences between the treatments.

#### **3.1.5.3. Data collection for objective two.**

After sowing the seeds treated with hot water and mechanical scarification, the following day seed counting started. Seeds that germinate each day were counted and recorded for all the 14 days. Seeds with a radicle protrusion of at least 2mm were considered to have germinated

#### **3.1.5.4. Data analysis for objective two.**

At the end of the experiment (after 14 days), the following variables were calculated using Microsoft excel ,following what (Sheriff, 2022) considered.

Germination percentage (GP). Here, seed germination was monitored daily for 14 days and seeds were considered to have germinated when the radicle had protruded at least 2mm from the seed coat. Then the germination percentage was calculated  $GP = (\text{germinated seeds} \div \text{total seeds planted}) \times 100$

#### **Mean germination time.**

The average time taken for seeds to germinate in each treatment group was calculated using the formulae

$$MGT = \frac{\sum(n \times t)}{\sum n}$$

Where n is the number of seeds germinated on day t. (Oyetunji *et al.*, 2023).

Also germination velocity index (GVI) was calculated using a formulae  $GVI = \frac{\sum(Gt/Dt)}$ , where Gt represents the seeds that germinated at day t, Dt represent time in days corresponding to the number of seeds that germinated on that day. This measures the speed at which germination occurred.

After calculating the germination parameters, the excel sheet was imported to R studio for analysis to find the descriptive statistics (means, standard deviation and standard error mean and variance), ANOVA analysis to identify the difference(p values), then Turkey's HSD test (LSD groups) to find specific differences between the treatments and groups.

## CHAPTER FOUR

### 4.1. Results from the experiments.

This section represents the effectiveness of different chemical (GA<sub>3</sub>, KNO<sub>3</sub>) and mechanical methods (hot water treatment and mechanical scarification) on seed germination parameters of two *solanum aethiopicum* groups (shum and gilo).

The experiments about chemical treatments was laid in CRD design, for chemical methods control experiments were soaked in distilled water and for mechanical methods, the seeds were not treated with any method. This allowed systematic assessment of both treatment types and cultivar types.

The ANOVA was used to assess the significance of treatments effects and the results revealed that different seed dormancy breaking methods had a highly significant effect with p values <0.001 in three germination parameters. The table below represents the outcomes concerning the effects of GA<sub>3</sub>, KNO<sub>3</sub>, Hot water and mechanical scarification on germination parameters in both crop varieties (shum and gilo)

**Table 1: Showing means, standard deviations and standard error mean for all the germination parameters (GP, MGT, GVI) in shum and gilo**

Chemical	Treatment	Group	GP (Mean ± SD)	MGT (Mean ± SD)	GVI (Mean ± SD)
Distilled Water	Control	Gilo	10.4 ± 14.9 <sup>g</sup>	5.7 ± 2.3 <sup>de</sup>	2.1 ± 4.7 <sup>f</sup>
Distilled Water	Control	Shum	16.7 ± 14.5 <sup>fg</sup>	4.7 ± 2.3 <sup>f</sup>	5.1 ± 5.7 <sup>ef</sup>
GA <sub>3</sub>	300 mg/L	Gilo	31.8 ± 35.6 <sup>de</sup>	5.3 ± 2.4 <sup>ef</sup>	7.1 ± 12.6 <sup>cde</sup>
GA <sub>3</sub>	300 mg/L	Shum	71.2 ± 31.9 <sup>bc</sup>	3.4 ± 0.9 <sup>gh</sup>	26.0 ± 13.4 <sup>b</sup>
GA <sub>3</sub>	500 mg/L	Gilo	42.6 ± 29.9 <sup>d</sup>	5.4 ± 2.2 <sup>ef</sup>	9.9 ± 12.0 <sup>cd</sup>
GA <sub>3</sub>	500 mg/L	Shum	92.5 ± 5.4 <sup>a</sup>	3.1 ± 0.6 <sup>h</sup>	33.5 ± 6.4 <sup>a</sup>
GA <sub>3</sub>	700 mg/L	Gilo	41.1 ± 28.9 <sup>d</sup>	5.0 ± 2.3 <sup>ef</sup>	10.4 ± 13.1 <sup>cd</sup>
GA <sub>3</sub>	700 mg/L	Shum	85.0 ± 15.9 <sup>ab</sup>	3.1 ± 0.8 <sup>h</sup>	32.0 ± 8.5 <sup>a</sup>
KNO <sub>3</sub>	0.25%	Gilo	6.9 ± 4.1 <sup>g</sup>	6.8 ± 2.0 <sup>bcd</sup>	0.8 ± 0.4 <sup>f</sup>
KNO <sub>3</sub>	0.25%	Shum	40.6 ± 22.8 <sup>d</sup>	4.6 ± 0.9 <sup>fg</sup>	10.1 ± 6.6 <sup>cd</sup>
KNO <sub>3</sub>	0.75%	Gilo	9.8 ± 5.2 <sup>g</sup>	6.7 ± 2.0 <sup>cd</sup>	1.4 ± 1.3 <sup>f</sup>
KNO <sub>3</sub>	0.75%	Shum	24.4 ± 13.0 <sup>ef</sup>	4.5 ± 1.3 <sup>fg</sup>	6.4 ± 4.2 <sup>def</sup>
KNO <sub>3</sub>	1.00%	Gilo	8.5 ± 5.4 <sup>g</sup>	6.9 ± 2.2 <sup>bcd</sup>	1.0 ± 0.8 <sup>f</sup>
KNO <sub>3</sub>	1.00%	Shum	35.5 ± 13.7 <sup>de</sup>	4.4 ± 0.9 <sup>fg</sup>	9.1 ± 4.1 <sup>cde</sup>

Mechanical	Hot Water	Gilo	30.7 ± 23.1 <sup>de</sup>	8.1 ± 1.1 <sup>ab</sup>	4.3 ± 3.8 <sup>ef</sup>
Mechanical	Hot Water	Shum	41.8 ± 24.3 <sup>d</sup>	7.7 ± 0.8 <sup>abc</sup>	6.0 ± 4.1 <sup>def</sup>
Mechanical	MS	Gilo	38.8 ± 25.1 <sup>de</sup>	8.6 ± 0.9 <sup>a</sup>	4.9 ± 3.67 <sup>ef</sup>
Mechanical	MS	Shum	70.0 ± 19.2 <sup>c</sup>	6.8 ± 0.9 <sup>bcd</sup>	11.5 ± 4.1 <sup>c</sup>
Mechanical	Untreated	Gilo	8.8 ± 8.2 <sup>g</sup>	7.6 ± 1.0 <sup>abc</sup>	1.3 ± 1.3 <sup>f</sup>
Mechanical	Untreated	Shum	37.4 ± 17.6 <sup>de</sup>	6.9 ± 1.3 <sup>bcd</sup>	6.3970 ± 3.9 <sup>cdef</sup>
% CV			59.27	7.12	1.68
P. value			<0.001	<0.001	<0.001

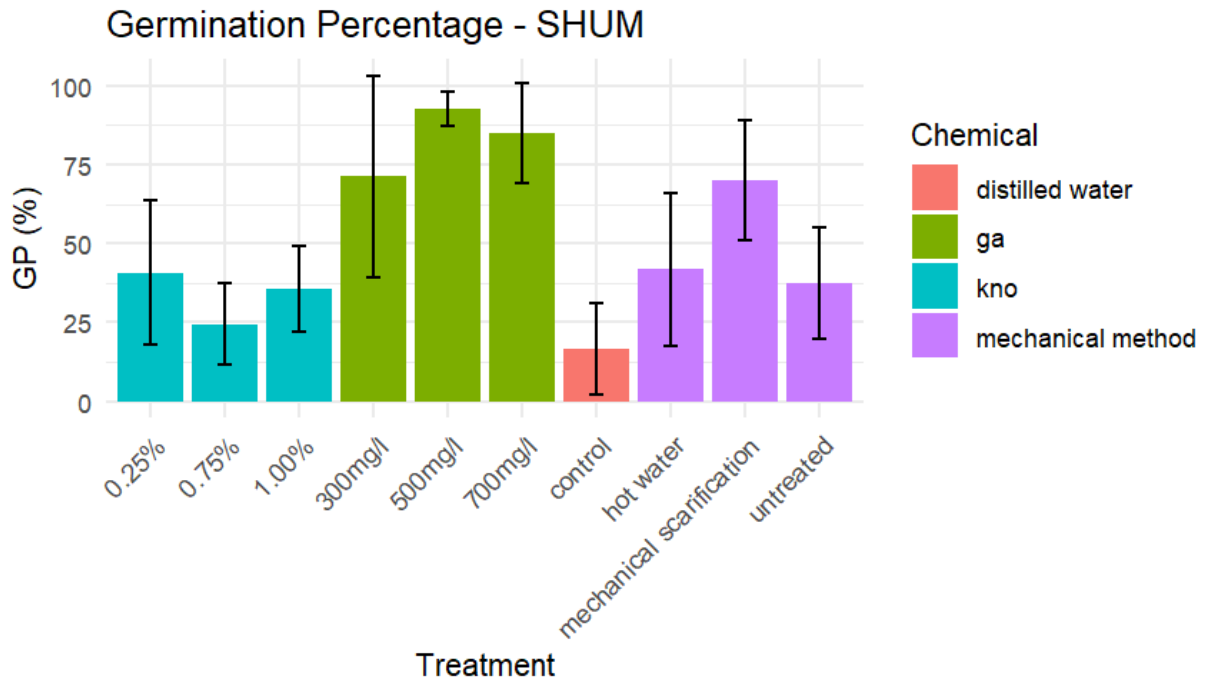
#### 4.1.1. Effects of various treatments on germination parameters in shum.

##### Germination percentage (GP).

The germination percentage of shum seeds varied significantly across different treatments with p value < 0.001. Gibberellic acid treatments indicated the strongest performance with GA3 500mg/l yielding the highest germination percentage (92.5%), followed by 700mg/l with 85% and 300mg/l with 71.2%. These GA3 treatments demonstrated statistically superior performances compared to KNO3 and mechanical treatments.

Mechanical scarification also resulted in relatively high germination percentage of 70% which was statistically comparable to GA3 300mg/l but significantly lower than higher concentrations of GA3. Hot water indicated moderate effectiveness (41.8%) performing similarly with (40.6%)

Potassium nitrate treatments demonstrated concentration dependent effects with the lowest concentration 0.25% yielding the highest germination percentage of 40.6%, followed by 1.00% concentration with 35.5% and 0.75% concentration with 24.4%. The untreated mechanical controls produced a germination percentage of 37.4% and the distilled water resulted in the lowest germination percentage of 16.7%



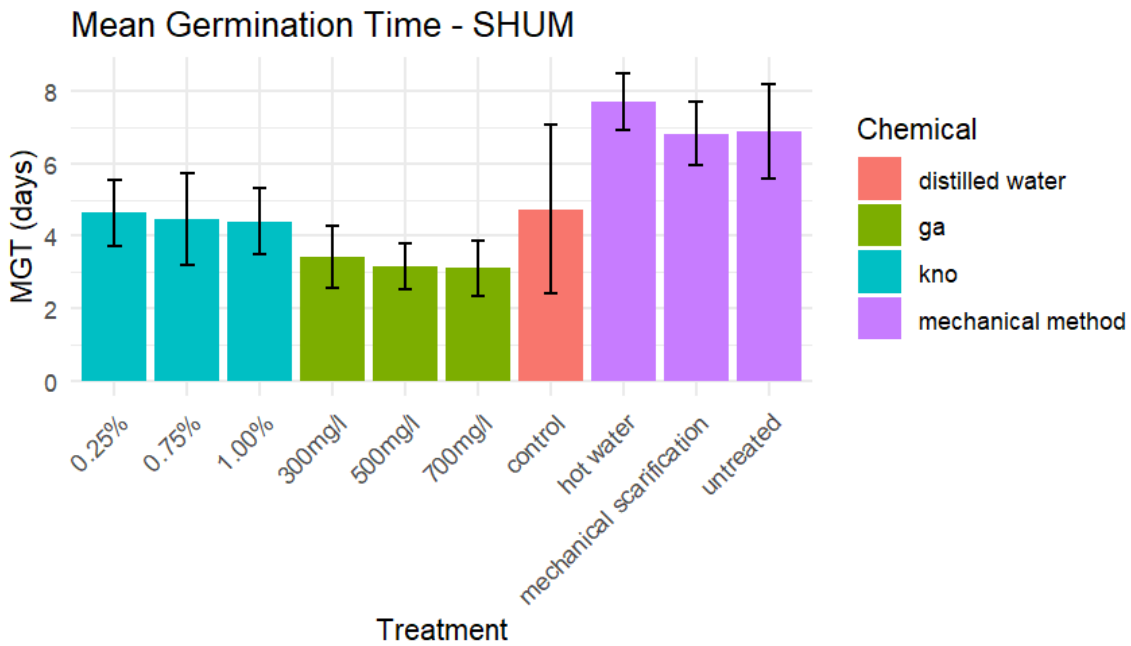
**Figure 2: Showing germination percentage against treatments (GA, KNO, HWT, and MS) in shum**

#### Mean germination time

The mean germination time for shum seeds exhibited significant differences across treatments with  $p < 0.001$ , lower values indicating faster germination. GA3 treatments resulted in faster germination times with GA3 500mg/l and 700mg/l both producing the lowest MGT of 3.1 days, followed by GA 300mg/l with 3.4 days.

Potassium nitrate treatments indicated moderate germination speed ranging from 4.4 days at 1.0% concentration and 4.6 days in 0.25% concentration. These were not significantly different from the distilled water control.

Mechanical treatments resulted in the slowest germination times with untreated seeds taking 6.7 days to germinate, mechanical scarification with 6.8 days and hot water with 7.7 days thus performing poorly compared to chemical treatments.



**Figure 3: Showing MGT against treatments (GA, KNO, HWT, and MS) in shum**

Germination velocity index.

The germination velocity index of shum seeds indicated significant variations across treatments with  $p < 0.001$ . Gibberellic acid treatments reported the highest vigor index with 500mg/l yielding the highest (35.5), followed closely by 700mg/l with 32.0 and 300mg/l with 26.6 GVI. These values were significantly higher than all other treatments.

The mechanical treatments resulted in moderate GVI of 11.5, followed by KNO<sub>3</sub> treatments which indicated concentration dependent effects with 0.25% having 10.1, 1.00% having 9.1 and 6.4 for 0.75%. Mechanical hot water treatment (6.0) and untreated mechanical treatment (6.4) produced similar GVI values to KNO<sub>3</sub> 0.75%

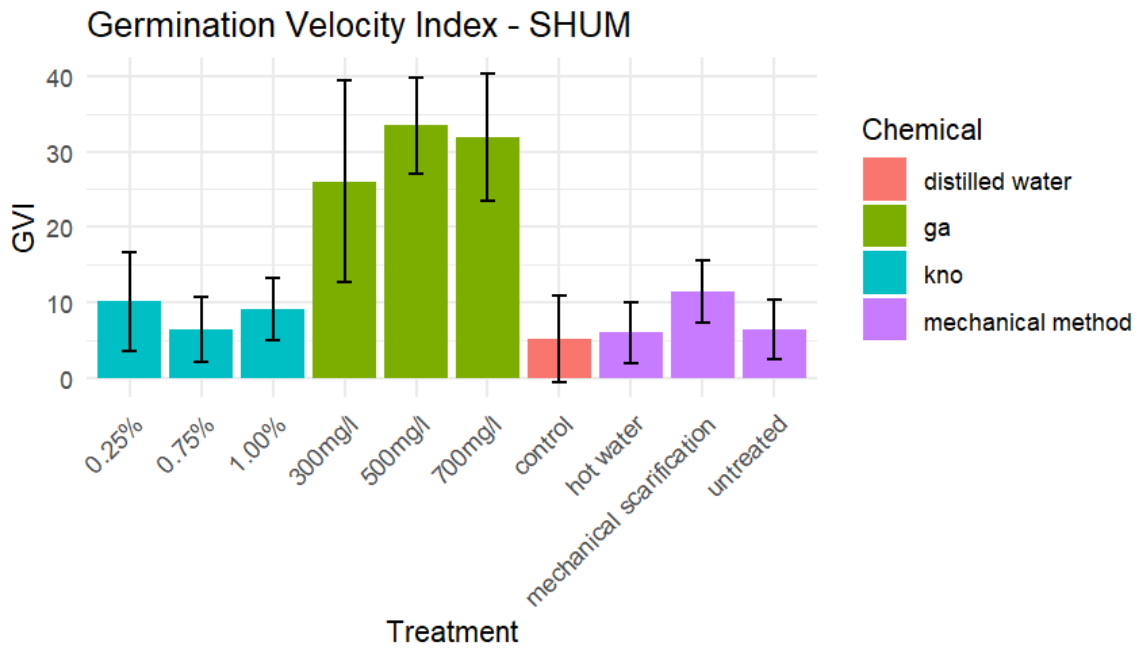


Figure 4: Showing MGT against treatments (GA, KNO, HWT, and MS) in shum

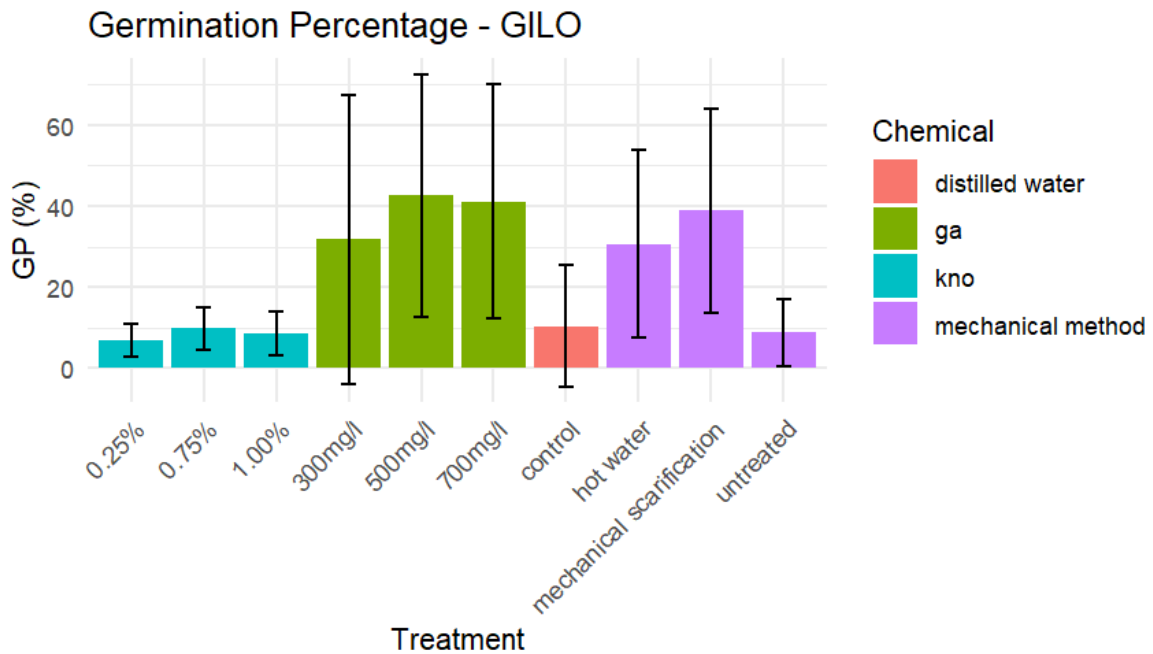
#### 4.1.2. Effects of various treatments on germination parameters of gilo.

##### Germination percentage.

Gilo seeds demonstrated significantly lower germination percentages compared to shum cross all treatments with  $p < 0.001$ . Gibberellic acid treatments were the most effective for gilo, with GA3 500mg/l resulting in the highest germination percentage (42%), followed by 700mg/l with 41.1% and 300mg/l with 31.8%. despite being the most effective, there was high variability in germination responses as indicated by the high standard deviations (table1).

Mechanical treatments showed variable effectiveness, with mechanical scarification treatment scoring 38.8% and hot water 30.7% producing similar germination percentages comparable to GA3 in gilo. In contrast, the untreated mechanical control resulted in very low germination (8.8%).

Potassium nitrate treatments were largely ineffective for gilo seeds, with germination percentages ranging from 6.9% for (0.25%), 9.8% for (0.75%). These values were significantly different for distilled water control (10.4%) suggesting that potassium nitrate treatments provided no benefit over the control for gilo seeds.

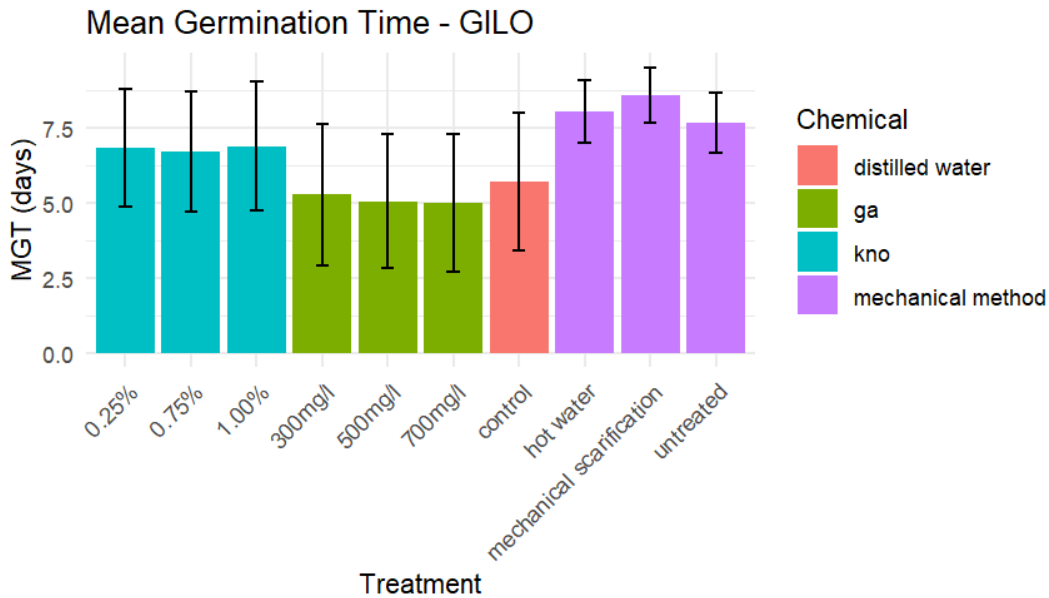


**Figure 5: Showing MGT against treatments (GA, KNO, HWT, and MS) in gilo.**

Mean germination time. (MGT).

The mean germination time for gilo seeds varied significantly across treatments with  $p < 0.001$ , with a pattern different from that observed in shum. In contrast to shum, mechanical treatments resulted in the longest germination times for gilo with mechanical scarification taking 8.6 days and 8.1 days for gilo and untreated mechanical having 7.6 days.

Potassium nitrate indicated intermediate germination times ranging from 6.7 days for 0.75% concentration to 6.9 days with 1.0% concentration. The distilled water control and gibberellic acid treatments demonstrated the fastest germination times, with values of 5.7 days for control and ranging from 5.0 days for 700mg/l and 5.4 days for 500mg/l



**Figure 6: Showing MGT against treatments (GA, KNO, HWT, and MS) in gilo**  
Germination velocity index (GVI).

The germination velocity index of gilo seeds indicated significant differences across treatments with  $p < 0.001$ , generally indicating much lower values compared to shum. GA3 acid treatments resulted in the higher velocity indices with GA3 700mg/l (10.4), 500mg/l (9.9). 300mg/l (7.1). However, the high standard deviations indicate substantial variability in response.

Mechanical treatments resulted in low to moderate velocity indices with mechanical scarification having (4.9), 4.3 for hot water and untreated with 1.3. Potassium nitrate treatments resulted in the lowest velocity indices ranging from 0.8 for 0.25% concentration to 1.4 for 0.75% concentration. The distilled water control indicated a low velocity index (2.1) but with high variability.

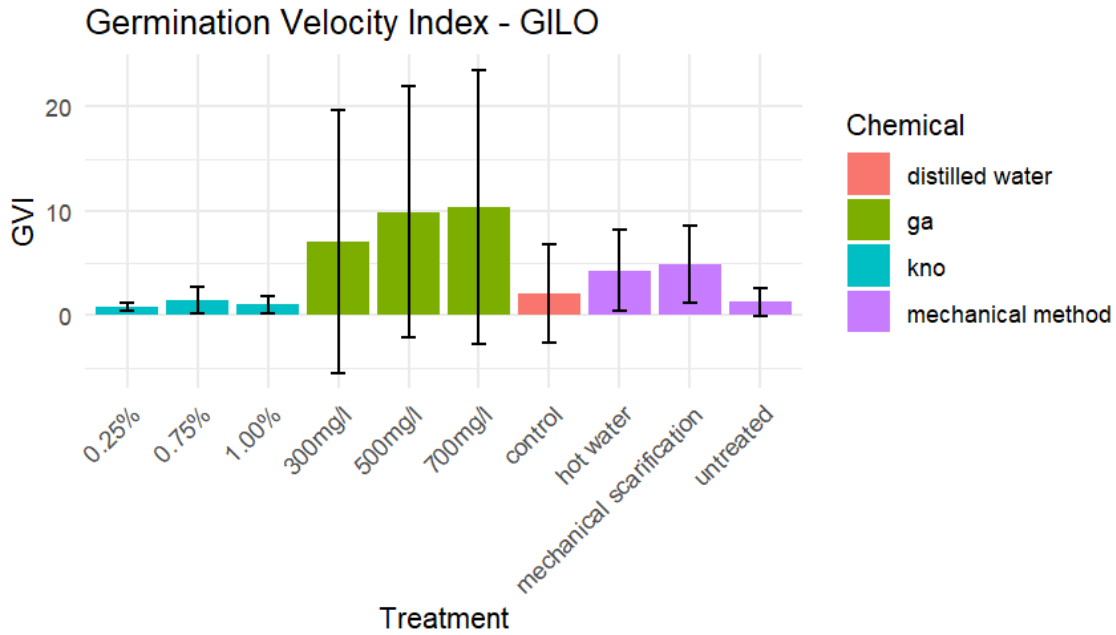


Figure 7: Showing MGT against treatments (GA, KNO, HWT, and MS) in gilo

4.1.3. Comparing the effectiveness of chemical and mechanical methods of breaking seed dormancy.

In comparison of the overall performance of chemical versus mechanical methods in the different groups of *solanum aethiopicum*, chemical methods resulted into superior performance in all the three parameters (GVI 19.5 vs 5.7) and MGT (3.9 vs 8.3) and higher GP (58.2% vs 46.0%). For gilo variety however, mechanical methods resulted into higher GP (34.8 vs 23.4) but indicated similar GVI and slower MGT (8.3).

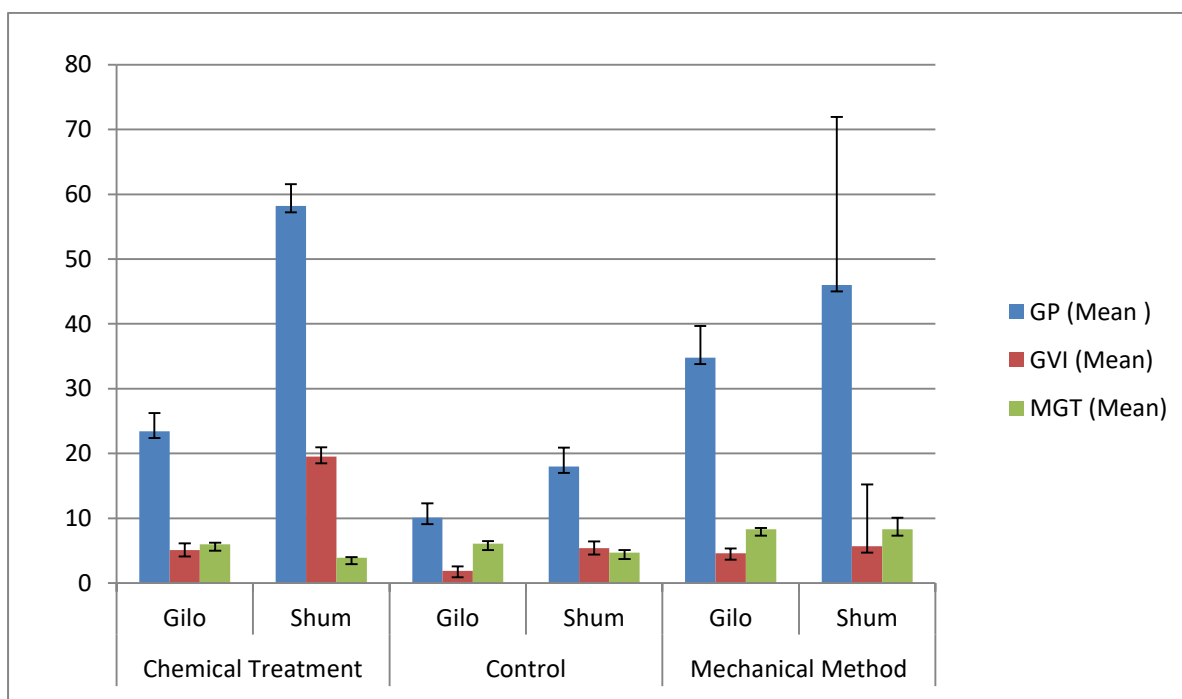
Table 2: Showing comparison of the overall performance of mechanical and chemical treatments between shum and gilo.

METHODS	GROUP	GP (Mean ± SD)	GVI (Mean ± SD)	MGT (Mean ± SD)
Chemical Treatment	Gilo	23.4 ± 26.9 b	5.1 ± 9.6 b	6.0 ± 2.3 a
	Shum	58.2 ± 32.0 a	19.5 ± 13.7 a	3.9 ± 1.1 b
Control	Gilo	10.1 ± 13.7 b	1.9 ± 4.2 b	6.1 ± 2.2 a
	Shum	18.0 ± 16.0 b	5.4 ± 5.8 b	4.7 ± 2.29 b

Mechanical Method	Gilo	34.8 ± 23.9 b	4.6 ± 3.7 b	8.3± 1.00 a
	Shum	46.0 ± 21.8 a	5.7 ± 0.9b	8.3± 4.1 a
%CV		72.85	89.3	42.02
P values.		0.003	0.003	0.027

Note. The values followed by same letter are not significantly different at  $p \leq 0.005$

Figure 8: Showing comparison of means of GP, MGT and GVI of both chemical and mechanical methods in shum and gilo.



## CHAPTER FIVE

### 5.1 Discussion

#### 5.1.1. Variations in effectiveness of GA<sub>3</sub>

The differences in response in shum and gilo to GA<sub>3</sub> treatments give clear insights into seed dormancy in *solanum aethiopicum*. The marked variations in GP between the varieties suggest that there is genetic variation and varietal specific dormancy characteristics. In shum, GA<sub>3</sub> treatments indicated remarkable efficacy with a peak germination percentage of 92.5% at 500mg/l. This finding aligns with previous research by (Oyetunji et al., 2023; Sheriff, 2022) who observed similar GA<sub>3</sub> induced germination improvements in *solanaceae* specie. The concentration dependent response indicates that GA<sub>3</sub> acts as a potent germination stimulant through overcoming physical dormancy, promoting enzymatic activities, and stimulating cell elongation.

The gilo varieties responded moderately to the treatments compared to shum and this suggests existence of genetic differences in hormonal sensitivity.

#### 5.1.2. Variations in effectiveness of KNO<sub>3</sub>.

Potassium nitrate indicated less effectiveness compared to GA<sub>3</sub> in breaking seed dormancy in both varieties of shum and gilo. The consistently low germination percentages more specifically in gilo indicate that KNO might not be the optimal treatment for these two varieties and that the physiochemical mechanism differs between the two chemicals (GA<sub>3</sub>, KNO<sub>3</sub>). This also aligns with some of the previous researches for example the research carried out by Mohammed *et al*, 2014, where KNO<sub>3</sub> did not effectively affect the germination of shepherds' purse. Additionally, Oyituji *et al*, 2023, also found out that the performance of KNO in breaking seed dormancy in *solanum aethiopicum* was less than Gibberellic acid performance

#### 5.1.3. Performance of mechanical methods of breaking seed dormancy.

The mechanical treatments indicated a distinctive pattern of seed dormancy breaking with mechanical scarification proving to be superior over hot water treatment. Increase in germination percentage with mechanical scarification was

observed by up to 88% in shum variety as hot water indicated moderate improvements compared to the controls. Therefore, physical interruption of the seed coat appears to be more effective than hot water. These outcomes align with (Jagga, 2023; Oyetunji et al., 2023; Rodríguez, Velastequí, 2019) who found out that mechanical scarification overcomes physical dormancy and performs better than hot water.

The pronounced differences between shum and gilo varieties underscore the genetic complexity of seed dormancy in *solanum aethiopicum* and suggest need for variety specific germination protocols and complex interactions between genetic factors and dormancy breaking treatments.

#### **5.1.4. Differential responses of *solanum aethiopicum* varieties to dormancy breaking methods.**

The results reveal significant variations in response of shum and gilo to different dormancy breaking methods. The shum variety indicated higher GP in all treatments compared to the gilo variety which suggest genetic differences (Botey; 2023) in dormancy mechanisms between these varieties. The above findings align with (Botey et al., 2022) whose experimental results indicated differences in dormancy response patterns in different eggplant varieties. The superior response of shum is attributed to differences in coat thickness, endogenous hormone levels and physiological maturity(. et al., 2002; Khalid, 2022). The theoretical contribution is that the study demonstrated variety specific responses to dormancy breaking treatments and provided an evidence of differential hormonal and mechanical sensitivity.

The practical implication is that the study recommended GA 500mg/l for improved germination in two varieties of shum and gilo and recommended mechanical scarification as a primary dormancy breaking method. While this study provided significant insights, several limitations should be acknowledged i.e. the need for long-term interaction with other environmental factors and environmental variations

## CHAPTER SIX

### 6.1. Conclusion.

The study aimed at evaluating the effectiveness of chemical and mechanical treatments on seed germination parameters for gilo and shum. The results of the study indicate that both chemical and mechanical methods significantly influence seed dormancy breaking in shum and gilo. The statistical analysis indicated a  $p < 0.001$  in germination percentage, mean germination time and germination velocity index. This indicates the type and concentration of the treatment had a strong effect on germination performance.

The chemical treatments, GA, significantly improved GP, MGT, SVI, with 500mg/l GA on shum yielding the highest GP of 92.5%. However, KNO indicated moderate improvements compared to controls but were less effective than GA treatments.

For the mechanical treatments, MS significantly enhanced GP and GVI in shum, while hot water treatments provided moderate improvements. Therefore, shum seeds outperformed gilo seeds across most treatments, suggesting inherent differences in seed physiology.

The coefficient of variance (%cv) in germination percentage (GP) OF 59.27 indicate high variation among treatments across concentrations. For Mean germination time (7.12%) and germination velocity index (1.68%) indicate low variation and this suggests consistent performances in timing and vigor

In comparison of the overall performance of chemical versus mechanical methods in the different groups of *solanum aethiopicum*, chemical methods resulted into superior performance in all the three parameters (GVI 19.5 vs 5.7) and MGT (3.9 vs 8.3) and higher GP (58.2% vs 46.0%). For gilo variety however, mechanical methods resulted into higher GP (34.8 vs 23.4) but indicated similar GVI and slower MGT (8.3). This shows that the effectiveness of dormancy breaking methods in shum and gilo are variety dependent. Shum variety indicated higher response to the treatments when compared to gilo variety which indicates genetic variability (Adeniji et al., 2012). The chemical methods particularly GA<sub>3</sub> (92.5%) were highly effective in shum and gilo with GP 58.2%.

Therefore, hypothesis on is rejected as results show significant differences in effects of chemical treatments ( $p < 0.003$ ) on seed performance in both shum and gilo with GA 500mg/l being the best. I also reject the second null hypothesis as mechanical treatments indicated significant differences ( $p < 0.001$ ) with scarified seeds coming up with 70% germination compared to hot water treated seeds that came up with 41.8% in shum and in gilo hot water (30.7%), mechanical scarification (38.8%) germination.

## **6.2 Recommendations**

Based on the findings, further research is needed in assessment of the field trials to validate the effectiveness of optimized seed with combined chemical and mechanical methods

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## APPENDIX

Temperature and humidity recordings for the whole experiments

Day	average hum (%)	maximum hum (%)	min hum (%)	AV temp °C	max temp °C	min temp °C
1	35	55	20	28	49	20
2	38	55	20	28	49	20
4	45	56	20	27	49	20.9
4	49	55	20	26	49	20.9
5	40	55	20	28	49	20.9
6	35	56	20	28	49	20.9
7	37	59	20	28	49	20
8	35	59	20	27	49	20.9
9	35	59	20	27	49	20
10	40	59	20	26	49.1	20
11	45	55	20	27	49.1	20
12	40	55	20	26	49.1	20.9
13	40	55	20	28	48	20.9
14	40	59	20	28	48	20.9
<b>AVERAGES</b>	<b>39.6</b>	<b>56.6</b>	<b>20.0</b>	<b>27.3</b>	<b>48.9</b>	<b>20.5</b>

Weight per 100 seeds for each accession of shum and gilo.

ACCESSION	Seed weight per 100 seeds
168	1.68
G7	0.74
184	0.76
E6	0.95
G6	0.75
148	0.72
157	0.8
G11	0.76
G9	0.74
G6	0.76
gongwe	0.84