BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF AGRICULTURE AND ENVIRONMENTAL SCIENCE

ALLELOPATHIC EFFECTS OF THORN APPLE (*Datura stramonium L.*) RESIDUES ON GERMINATION AND EARLY SEEDLING GROWTH OF SUGAR BEANS *(Phaseolus vulgaris)*.

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS OF THE BACHELOR OF SCIENCE HONOURS DEGREE IN AGRICULTURE (CROP SCIENCE)

DECLARATION

I RUCHIYO LAW M do hereby declare that this dissertation was the result of my own original efforts and investigations, and such work has not been presented elsewhere for any degree or any university programme. All other supplementary sources of information have been acknowledged by means of references.

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CERTIFICATION OF THE DISSERTATION

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Department of Crop Science

The undersigned certify that they have read and recommend to the Bindura University to accept a dissertation entitled: **ALLELOPATHIC EFFECTS OF THORN APPLE (*Datura stramonium L.*) RESIDUES ON GERMINATION AND EARLY SEEDLING GROWTH OF SUGAR BEANS *(Phaseolus vulgaris)*.**

Submitted by

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In partial fulfilment of the requirements for the Bachelor of Science Honors Degree in Agriculture.

SUPERVISOR...

DATE ....

DEDICATION

The work is dedicated to sugar bean growers in Chimanimani District.

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LIST OF ACRONYMS AND ABBREVIATIONS

D.Stramonium	*: Datura Stramonium*
D.S	: *Datura Stramonium*
Zim Agric Business	: Zimbabwe Agriculture Business
AGRITEX	: Agricultural Technical and Extension Services
ANOVA	: Analysis of Variance
FAOSTAT	: Food and Agricultural Organization Statistics
g	: Grammes
Kg	: Kilogrammes
t/ha	: Tonnes per Hectare
US$	: Amercan Dollars
%	: Percentage
m	:Metres
cm	: Centimeters
Fig	: figure
LSD	: Least Significance Difference

P<0.05: Probablty less than 5

ABSTRACT

A Laboratory experiment was carried out to determine the allelopathic effects of Thorn apple (*Datura stramonium)* residues on Sugar bean germination and early growth rate. *Datura stramonium* residues are problematic to crops, as they inhibit seed germination and seedling elongation when incorporated into the soil during land preparation. The substances released by *Datura stramonium* act as germination or growth inhibitors. The experiment was carried out to determine the allelopathic effects of *Datura stramonium* residues on germination of bean seed and early seedling growth of the roots and shoots. Complete Randomized Design (CRD) with six treatments and three replications was used during the research. Concentrations of 0% as the control, 10%, 30%, 50%, 70% and 100% of *Datura stramonium* residue solution were used to carry out an investigation of the allelopathic effects of *Datura stramonium* residues on the germination of bean seeds. There was significant reduction ($P<0.05$) in root and shoot length which was observed in higher concentrations of 100% *Datura stramonium* residue solution. It was established that the allelopathic effects of *Datura stramonium* residues was concentration dependent. The inhibitory effects significantly ($P<0.05$) increased proportionally as the concentration of both extracts increased from 0% to 100%. This research concluded that *Datura stramonium* residues have allelopathic effects on germination, root and shoot development of bean seeds. It can be recommended that sugar beans farmers should get rid of the thorn apple weed and its residues before land preparation so as to avoid poor seed germination and early seedling growth.

Key words: Allelopathy, Allelopathic, *Datura stramonium*, Residues, *Phaseolus vulgaris* Germination and early seedling growth.

CHAPTER ONE

1.0 Introduction

1.1Background of the Study

Sugar bean is native to Central and South America where it originated as a wild vine (Kelly, 2018). The crop is grown in over 100 countries and it is extensively cultivated in all tropical and subtropical regions, particularly in Asia, Africa and America (FAOSTAT, 2015). It is the world's most important pulse crop (Mharapara *et al.,* 2010) rich in fat-free protein (22%), carbohydrates (58%), (Fiber 4%) and other essential micronutrients. At most, twenty-five million metric tons of beans have been produced across the globe in a year with Asia, Africa and America being the major contributors (FAO, 2015).

The crop came into Africa through trade from South America this is according to (Okil *et al.*, 2014). Major producers of sugar beans in Africa are Uganda, Tanzania, Kenya and Zimbabwe (Committee on World Food Security 2018). It is a legume grown in Zimbabwe by smallholder and large scale farmers. Sugar bean has potential as a rain-fed and irrigated crop with potential returns of 600kg to 1.5 tons per hectare depending on available conditions (Murimwa *et al.*, 2019). Sugar beans have a very large market as they are consumed by every household and large institutions such as boarding schools, universities, hospitals and prisons. Like many crops, it has uses other than general ones, such as human food and animal feed (Piggot and Corner, 2003). According to Committee on World Food Security (2013), sugar beans have various importance which include; valuable source of protein, enhancement of soil fertility through nitrogen fixation, and making good compost manure.

Sugar bean production has been on a decline in Zimbabwe due to low-yielding cultivars, pest and disease outbreaks, weeds infestation, lack of capital, lack of market and climate change (Katungi *et al.,* 2009; Margaret *et al.,* 2014). Among the factors weeds are a potential threat to the decline of sugar bean production in Zimbabwe. Sugar beans compete poorly with weeds as they are slow-growing plants and do not easily overshadow weeds this is according to Dafaallah *et al., (*2019)**.**

Weeds harbor pests and diseases to the crops, compete for sunlight, water and nutrients with crops and inhibits allelopathic chemicals to the crops which led to low germination, root and shoot growth. Therefore, the objective of this project is to determine the allelopathic effects of *D. stramonium* on sugar bean germination, root growth and shoot growth.

Allelopathy is the harmful or beneficial effects of one plant on another through the production of secondary chemical compounds that are technically released into the environment in sufficient quantity and with sufficient persistence to produce the recorded effects (Khalid *et al.,* 2002 ; Thi *et al.,* 2015).). Allelochemicals released by many plants as residues, exudates and leaches from leaves, stems, roots, fruits and seeds have been reported to affect the growth of other plants (Asgharipour and Armini, 2010).

Datura stramonium has a strong inhibitory allelopathic effect on sugar beans, resulting in low germination rate, poor root and shoot development, and pale green color on plant leaves (Dafaallah *et al.,* 2019). As it produces allelochemicals like alkaloids, scopolamine, hyoscyamine and atropine this was reported by Elisante and Ndakidemi in (2014). *Datura stramonium*, commonly known as Jimson's weed or thorn apple is an invasive weed of the nightshade family (Tranca *et al.,* 2017). It reproduces by seed and the seeds have excellent germination ability all year round, increasing their density (Dafaallah *et al.,* 2019). *Datura Sramonium* seeds can be dormant for about 10 years and the residues take about 5 years to decompose leading to their persistence in fields this is according to Delabays *et al.,* (2004). Due to seed dormancy, it is difficult for farmers to completely eradicate the weed. *Datura. stramonium* has shown an allelopathic effect on various crops, which is supported by various references: Pacanoski *et al.,* (2014) reported of *D. stramonium* allelochemicals recovered from soil on a commercial farm reducing seedling emergence in many crops. These chemicals inhibit growth and development of shoots and roots in a concentration-dependent manner. According to Sakadzo *et al.,* (2018), the allelochemicals reduce cell division or alter the auxin that induces growth of shoots and roots of most legumes such as soybeans and cowpeas. The results of the laboratory experiment by Sakadzo *et al.,* (2018) showed that an increase in *D. stramonium* concentration resulted in a decrease in germination and emergence. The highest germination (100%) was recorded with the application of distilled water, while 0% was achieved with a *D. stramonium* concentration of 100% in the laboratory. Wheat and cowpeas experienced a 55.3% and 55.65% decrease in germination, respectively, with 8% *D. stramonium*. The results showed that increasing the concentration of *D. stramonium* aqueous extract from 0 to 8% resulted in a reduction in root and shoot length in all tested species in all environments.

1.2 Problem Statement

Among all weeds thorn apple residues are the potential cause of low germination, poor root and shoot formation due to long volatilization or decaying process. However, there is information gap on the effects of thorn apple residues on sugar bean as many researchers are focusing on aqueous solutions from the Datura plant not the residues. Farmers, especially small-scale holders do not really know the correct time to remove thorn apple and the effects of thorn apple residues if incorporated into the soil during land preparation. The continuous decline in sugar bean yield due to weed pressure in small scale farming systems has provoked the researcher to bring the idea of assessing the effects of thorn apple residues on sugar bean germination, root and shoot growth.

1.3 Justification

Datura stramonium is well known for its allelopathic effects on a variety of plant species including weeds and crops. Sakadzo *et al.*, (2018) observed the existence of both physical and chemical warfare between thorn apple *(D. stramonium)* and crop plants like wheat and cowpeas. It has significant implications if *D. stramonium* weed is left to grow among field crops and the residues are left to decompose in the field. Therefore, farmers need to know the potential consequences, how to manage and the essence of getting rid of *D. stramonium* at its earliest stage and also its residues to avoid physical and chemical warfare, if they want to release economic and high yields. Understanding well the mechanism of allelopathic interactions between thorn apple residues and sugar beans will enable to come up with proper and effective management ways to prevent further infestations and chemical warfare (Dafaallah*et al.*, 2019). Considering the economic importance of sugar beans, this study was carried out to investigate the allelopathic effect of Jimsonweed seed, leaves, stem and roots residues on seed germination and seedling growth of sugar beans when the residues are incorporated into soil during land preparation.

1.4 Objectives

1.4.1 Main Objectives

- ❖ To evaluate the allelopathic effects of Thorn apple (D. *Stramonium*) residues on germination, root and shoot growth of sugar bean in the laboratory.

1.4.2 Specific Objectives

- ❖ To investigate the allelopathic effects of Thorn Apple *(D. stramonium)* residues on sugar bean seed germination.
- ❖ To determine the allelopathic effects of Thorn Apple *(D. stramonium)* residues on sugar bean root growth.
- ❖ To investigate the allelopathic effects of Thorn Apple *(D. stramonium)* residues on sugar bean shoot growth.

1.5 Hypothesis

1.5.1 H0: *D. stramonium* residues have no effect on sugar bean germination.

1.5.2 H0: D. *stramonium* residues have no effect on sugar bean root growth.

1.5.3 H0: *D. Stramonium* residues have no effect on sugar bean shoot growth.

CHAPTER TWO

2.0 Literature Review

2.1 Origin of sugar bean and uses

Sugar bean is native to Central and South America where it originated as a wild vine (Kelly, 2018).The crop is grown in over 100 countries and it is extensively cultivated in all tropical and subtropical regions particularly in Asia, Africa and America (FAOSTAT, 2020). It is the world's most important pulse crop (Mharapara *et al.*, 2010) rich in fat free protein (22%), carbohydrates (58%), (Fiber4%) and other essential micro nutrients. At most twenty five million metric tons of beans have been produced across the globe in a year with Asia, Africa and America being the major contributors (FAO, 2015).

According to Murimwa *et al.,* (2019), sugar beans are very nutritious and rich in protein. They also add on saying that the leaves, green pods, young and mature seeds are edible as relish or greens in some meals. The residues are well suited as animal feed and also form a good basis for compost manure. As a result, there is always a market for sugar beans. Lewis (1933) adds on saying that together with bacteria, sugar bean forms root nodules. In the root nodules the bacteria can fix nitrogen from the air into a form that sugar beans can use for growth. He was supported by Mwenda *et al.,* (2023), part of the fixed nitrogen is used to make protein in the grains but some of the nitrogen is also left behind through falling leaves and roots. The nitrogen that is left behind improves soil fertility. This makes sugar bean a good crop to grow as an intercrop or in rotation with other crops, because these other crops then also benefit from the nitrogen. However sugar bean does not fix nitrogen as well as cowpeas this is according to Mwenda *et al.,* (2023) to get a good sugar bean yield you can inoculate bean seed with rhizobium inoculant or apply initial Nitrogen fertilizer at planting.

2.2 Sugar bean production in Zimbabwe

Sugar bean is the most important legume crop in Zimbabwe (Giller, K.E. (2008). As it is a major source of proteins in small holder farmers. In Zimbabwe sugar bean is best grown during the cooler months of summer (January to April) on the Highveld or in winter in the lowveld with irrigation to supplement the dry spells this was reported by Sulieman (2015). It is a legume grown in Zimbabwe by smallholder and large-scale farmers. Sugar bean has potential as a rain-fed and irrigated crop with potential returns of 600kg up to 1.5 tons per hectare depending on available conditions and resources (Murimwa *et al.,* 2019). According to Zim Agric Business News (2023), the approximate price range for sugar beans in 2023 is between US$0.98 and US$1.31 per kilogram. The crop is very versatile in terms of adaptability to varied agro-ecological regions and diverse growing seasons (Chibarabada and Mabhaudhi 2017). Sugar bean is one of the few crops grown in Zimbabwe which have a four-figure producer price. Sugar beans have a very huge market as they are consumed by every household and large institution such as boarding schools, universities, hospitals and prisons (Piggot and Corner, 2003).

2.3 Climatic and soil requirements of sugar bean in Zimbabwe

Sugar beans are an annual crop that thrive in warm climates. It grows optimally at temperatures between 18 and 24 °C. The maximum temperature during flowering should not exceed 30 °C. High temperatures during flowering lead to bud death and poor pod set, resulting in yield losses (Kelly, 2018). Daily temperatures below 20 °C delay ripening and result in empty or immature pods. Sugar beans should be grown under rain-fed conditions where at least 400-500mm of rainfall occurs during the rainy season. However, an annual rainfall of 600 to 650 mm is considered ideal (Mharapara *et al*., 2010). According to Sulieman (2015), sugar beans must be planted in warm soil (minimum temperatures preferably above 13°C) after all danger of frost has passed. Sugar beans grow well in soils with a depth of at least 90 cm, which have no nutrient deficiencies and are well drained this is according to Kelly (2018). Howard (2018) observed that sandy loam, sandy clay loam, or clay loam with clay content of between 15 and 35 % is suitable, however sandy soils causes problems of low fertility or nematode damage may occur. The seedbed must be deep, level and firm as this ensures better surface contact between the seed and the soil, increasing the absorption of moisture (Howard 2018). A level seedbed also facilitates planting to a uniform depth. Effective weed control is a prerequisite for high sugar bean yields. According to Sulieman (2015), sugar beans compete poorly with weeds because they are slow-growing plants and do not overshadow weeds easily. Early control is extremely important as the plant's root system is developing at this stage and some weeds secrete chemical substances that stunt plant growth. At a later stage, weeds hinder the harvesting and threshing processes and affect the quality of the crop (Kelly, 2018). Climatic conditions required by sugar beans, also favours the growth of thorn apple and also thorn apple can survive in diverse weather conditions.

2.4 Allelopathy and Allelochemicals

Allelopathy refers to the direct or indirect positive or negative effect of one plant on another through the release of biochemical compounds into the environment (Delabays *et al.,* (2004) cited by Dafaallah *et al.,* in 2019). These biochemicals are known as allelochemicals (Singh and Chaundhary, 2011). According to Chiang (2015), allelochemicals, which are non-nutrient-rich substances that arise mainly as plant secondary metabolites or microbial decomposition products, are the active media of allelopathy. According to Ahmed *et al.,* (2014), an allelopathic substance was first detected in Black walnut tree *(Juglausnigra)* whose folia leachate, which contained juglone was found to damage germination and seedling growth of crops beneath it. Allelopathic interaction can be one of the significant factors contributing to species distribution and abundance within plant communities and can be important in the success of invasive plants, (MuhdArif Shaffiq Sahrir (2023); Zheng *et al.,* (2021). According to Nawaz (2014), allelochemicals include phenolic acid, coumarins, terpenoids, flavinoids and scopulatenes. Zheng *et al.,* (2021) observed that some allelochemicals are beneficial while many are naturally harmful. They can also be in the form of plant regulators such as salicylic acid, gibberellic acid and ethylene. Allelochemicals can be useful in agroecosystems, crop protection, and plant restoration.

2.5 Types of Allelopathy and their mode of action

According to Signh *et al.,* (2003), there are three types of allelopathy which are Weed on Crop, Weed on Weed and Crop on Weed allelopathy. These are basically categorized with respect to the relationship between the plants species involved. Examples of allelopathic weeds noted were *Agropyron repens, Avena fatua, Datura Stramonium* and *Cynodon dactylon* among others and allelopathic agronomic crops taken note of were Coffee Arabica, lettuce and tea as well as some rice cultivars (Zhang *et al.,* 2018)

2.6 Factors affecting allelopathy

Allelopathy is influenced by a number of factors. Macias *et al.,* (2003), identified variety, specificity, auto-toxicity, crop to crop effects and environmental effects as the significant drivers of allelopathy. Moreover, the type and amount of allelochemicals released into the environment depends on the combined effects of the plant itself and environmental factors (Albuqurque *et al.,* 2010).

2.7 Uses of allelopathy in agro ecosystems

According to Jhala *et al.,* (2014), to ensure sustainable agricultural development, it is important to use cropping systems that utilize the stimulatory or inhibitory effects of allelopathy to regulate plant growth and development and avoid allelopathic auto toxicity. He goes on to state that allelochemicals can be used as growth regulators, herbicides, insecticides and antimicrobial crop protection agents. Zheng *et al.,* (2008) and Macias *et al.* , (2003) say that allelochemicals can simulate and facilitate plant germination and growth, and promote the development of plants with low levels of phototoxic residues in water and soil, thereby facilitating waste water treatment and recycling. They can replace synthetic herbicides as they cause no residual effects. This was supported by Bhadoria (2011), although he also points out that their specificity and efficiency are limited. Many authors including Li *et al.,* (2010); Han *et al*., (2013) and Jabran *et al*., (2015) argue that the purpose of research on allelopathy includes its application in agricultural production, with the aim of reducing the use of chemical pesticides due to their consequent environmental pollution and providing effective methods of sustainable development in agricultural production and ecological systems.

Mahmood *et al.,* (2013); Farooq *et al.,* (2014) and Haider *et al.,* (2015), among many other scientists, showed how allelopathy is used in agricultural activities in the form of crop rotation, mulches, green manure, and intercropping. Researchers are even trying to breed allelopathic crop varieties. Fragasso *et al.,* (2013) say that allelopathic cultivars, which have great potential to minimize the introduction of refractory chemicals and effectively control weeds in agricultural ecosystems, represent the most promising application of allelopathy. According to Gealy and Yan (2020), successful varieties must combine weed suppression ability, high yield potential, disease resistance, early maturity and good quality traits. Gealy and Yan (2012) provided an example of Rondo, a rice cultivar grown in commercial organic rice farming in Texas, characterized by hardiness and weed suppression ability superior to many commercial cultivars. Many other cultivars of different crops which have been hybridized for allelopathy have been cited in various literatures for example Huagan 3 (a weed suppressive rice cultivar in China) was cited by Kong *et al.,* (2011) and Spring wheat by Bertholdsson (2010).

2.8 Thorn Apple (*Datura stramonium)* ecology.

Datura stramonium is an annual poisonous plant that grows to about 1.5 m tall. It is characterized by single white, trumpet-shaped flowers (Fatoba *et al.,* 2011). The flowers are all fragrant and can hardly be confused with other plants. The seeds are in small fruits that are completely covered with short, sharp spines. The stems are bristly and a bit thin compared to the rest of the plant. The leaves are flat, mostly featureless, and can be either multi-edged or ovate (Spina and Taddei, 2007).

Jimson weed is a naturally fast growing weed and is widespread in all warm regions of the world. Its presence has been spotted along the borders and hedgerows of cultivated fields. Subsequently, seeds of this plant were found as contaminants in important agricultural crops (Ahmad *et al.,* 2014). The plant competes with the crop for light, nutrients, moisture and space, causing significant yield losses. (Ahmad *et al.,* 2014). In addition, the plant can manipulate partners, competitors, and ecosystems through a natural biological phenomenon known as allelopathy (Elisante and Ndakidemi, 2014). A plant can produce up to 30,000 seeds that can be viable for over 40 years (Soladoye, 2011). *Datura stramonium* is believed to be native to southern tropical America and was first observed in the United States in the 17th century in the Jamestown colony (Maibam 2011). Typical habitats include farmland (particularly corn fields), fallow fields, old forage areas, piles of dirt on construction sites, mounds of decomposed mulch and discarded vegetation, urban wasteland, and various garbage dumps. According to Awadallah *et al.,* (2019), disturbed areas are strongly favored.

2.9 Thorn Apple (Datura stramonium) uses.

A number of important uses have been attributed to *D. Stramonium*, including cultivation as an ornamental plant and medicinal use as a narcotic. It has been used as an analgesic to render patients unconscious during fixation of broken bones (Turner, 2009). It has been successfully used as a poison due to the presence of alkaloids such as scopolamine, hyoscyamine and atropine (Li *et al.,* 2015). It has also been used as a repellent against many insect pests that affect various plants. In China, it is used as an anesthetic during surgeries. *D stramonium* can also be used as a remedy for asthma when the leaves are smoked in a cigarette or pipe. However, this must be done with great care and with a few cautious recommendations in mind. Its oil extract is used to treat hair loss, as well as to restore and stimulate hair growth. Leaves relieve headaches; Leaf juice is used to treat earaches (Tranca *et al.,* 2017).

3.0 Methodology

CHAPTER THREE

3.0 Methodology

3.1 Study Site

The experiment was carried out in the Biological Sciences laboratory at Bindura University Of Science Education Astra Campus in Bindura, Zimbabwe at a geographical location of latitude17°18′06″ S and longitude 31°19′50″ E. The site is in agro-ecological region two, at an altitude of 1118 m above sea level. It receives an average rainfall of 800mm annually with a mean temperature of 28°C. The experiment was conducted from the 2nd of February 2023 to the 12th of February 2023.

3.2 Experimental design

The experiment was arranged in a Complete Randomized Design (CRD) with six treatments and three replications as shown in fig 3.1. A total of eighteen (18) Petri dishes were established comprising the three replicates of the six treatments which were 10%, 30%, 50%, 70% and 100% *D. stramonium*residues as well as distilled water as control. Each Petri dish contained five certified sugar bean seeds (cultivar-Nua 45), thus ninety (90) seeds were used for the experiment.

Fig 3.1: Layout of the treatments

Table 3.1: Treatment structure

Treatments were designed,guided by the method that was used by Dafaallah *et al.,* (2019).

TREATMENT	DESCRPTION
Treatment 1	0% *D.Stramonum*residues (100% distilled water.
Treatment 2	10% *D.Stramonum*residues added to 90mls of distilled water.
Treatment 3	30% *D.Stramonum*residues added to 70mls of distilled water.
Treatment 4	50% *D.Stramonum*residues added to 50mls of distilled water.
Treatment 5	70% *D.Stramonum*residues added to 30mls of distilled water.
Treatment 6	100% *D.Stramonium*residues with no water concentrate.

3.3 Preparation of concentrations

In order to initiate the experiment, parts of *D. Stramonium* were harvested in December 2022. The parts comprise leaves, stems, fruits, and roots from fully matured plants and they were washed using sterilized distilled water to remove pathogens and soil particles. The material was then cut into pieces and shade dried for one month in separate positions. After drying the material was crushed using a traditional mortar and pistil separately (Dafaallah *et al.*, 2019), measured using a 50g, cup and stored as 250 grams sachets of each plant part. That is 250g of *D. Stramonium* leaves, stems, roots and fruits.

In February 2023 the dried plant parts (material) were mixed with 1 litre of distilled water to form the *D. Stramonium* residue liquid which was used in the experiment. The material (powder and distilled water) was mixed and poured into a conical flask with its mouth closed and kept for 24 hrs in the dark at room temperature according to the method used by Dhavan and Narwal, (1994) as cited by Sakadzo *et al.,* (2018). After 24 hours all the residues were filtered using a sterile muslin cloth and stored in a glass container at 4 ° C in an incubator for later use.

3.4 Experimental procedure

The five treatments (concentrations) were made by adding 90ml, 70ml, 50ml and 30ml of dilute water to 10ml, 30ml, 50ml and 70ml of *D. stramonium* concentrate respectively. Thus 10%, 30%, 50%, 70% and 100% concentrations will be obtained and the control treatment will be just 100ml of dilute water (0% *D. stramonium*). The concentrations were stirred using an electric stirrer prior to use in the experiment.

Sterilized Sand (boiled), moderately acidic (pH 6.75) was used as a growth medium in the Petri dishes. The experiment was placed by putting the seeds of sugar beans on a layer of filter paper in a Petri dish (5 seeds / petri dish) and covered with sterilized sand (boiled) and the equivalent dilutions were given to the seeds. The Petri dishes were stored at 21° C in an incubator as shown in fig 3.2 where temperatures are uniform and can be regulated. The treatments were watered uniformly using 10ml of distilled water at four days intervals for 14 days.

Fig 3.2: Petri dishes in an incubator at 21° C

3.5 Measurements

The assessment indicators measured were:

1. Germination percentage

Seed germination was recorded on the 7th day; seeds with emerged radical were counted and recorded.

The percentage of seed germination was determined by the formula:

G% = (sprouted seeds in all Petri dishes with same treatment / Total number of seeds in all Petri dishes with same treatment) x 100.

2. Root length

On roots, length of tap root was measured using a string and a ruler after 14 days.

3. Shoot length

Shoot length was measured after 14 days using a string and a ruler.

3.6 Data analysis

The data was analyzed statistically using Analysis of Variance (ANOVA) technique with GenStat version 14 software. Comparison of treatment means was done using the Least Significance Difference (LSD), at 5% significance level.

CHAPTER FOUR

4.0 Results

The main purpose of this chapter is to present, interpret and analyse data collected in chapter 3. Raw data was collected and analyzed statistically using GenStat version 14 software. Output from data analysis was used to plot bar graphs using Microsoft Excel.

4.1 Effects of D. stramonium residues concentration on germination percentage of sugar bean seeds after seven days.

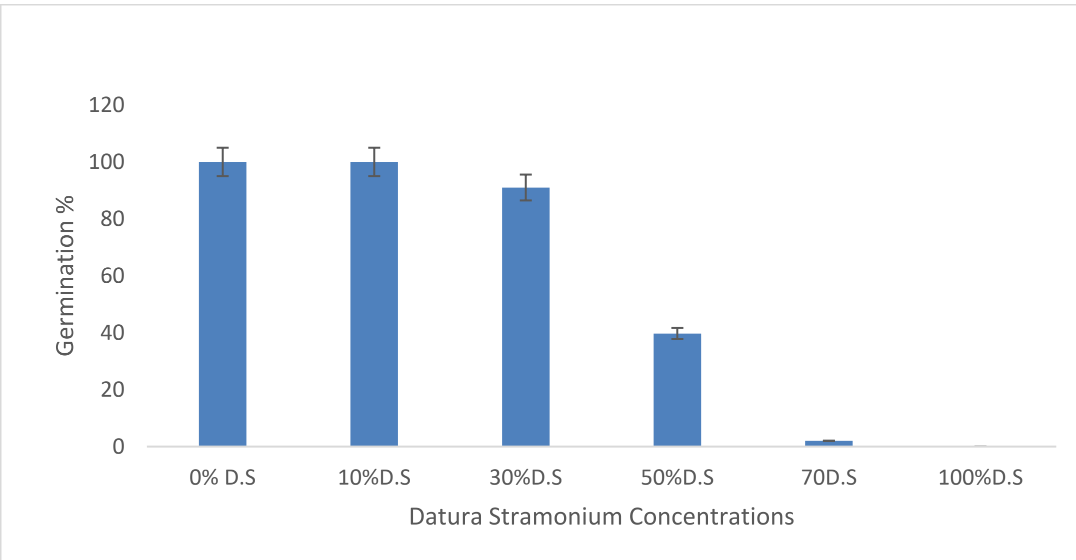

Fig 4.1 showing the effects of *D. stramonium* residues concentration on germination percentage of sugar bean seeds after seven days.

Germination percentage was significantly different (P< 0.001) among treatments. Fig 4.1 showed that an increase in *D. stramonium* residue concentration led to the decrease in germination and emergence. There is no significant difference observed between the control treatment and the treatment with 10% and 30% *D. stramonium* residue concentration. The control experiment with distilled water (0% *D. stramonium*) and the 10% *D. stramonium* scored the highest germination percentage of 100% what only differs is the time taken by the seeds to germinate; the control experiment took a short period as compared to the sugar beans treated with 10% *D. stramonium*. The lowest germination percentage (0%) was recorded where 100% concentration of *D. stramonium* was applied followed by 70% *D. stramonium* concentration which scored 2%.

4.2 Effects of D. stramonium residues concentration on root length of sugar bean seeds after fourteen days.

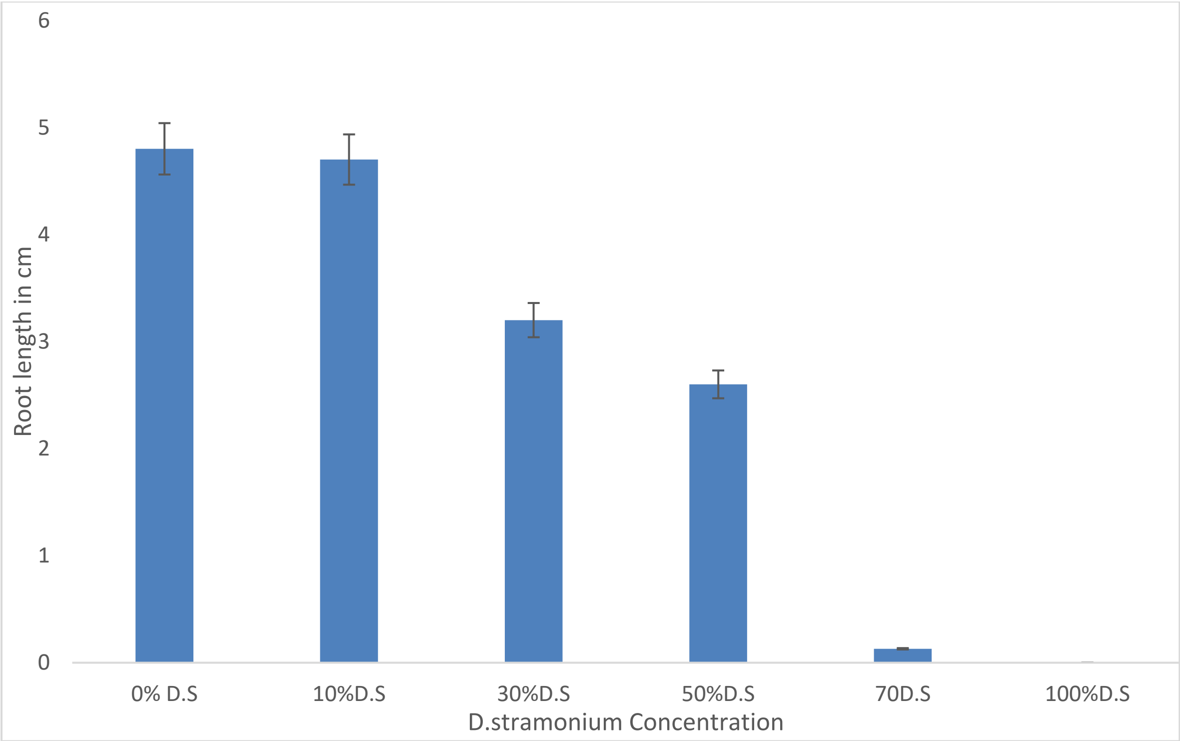

Fig 4.2 showing the effects of *D. stramonium* residues concentration on root length of sugar bean seeds after fourteen days.

A significant difference among *D. stramonium* residue treatments on bean root length was noted ($P<0.001$). Results showed that there was a decrease in root lengths with increase in *D. stramonium* residue concentration after fourteen days (figure 4.2). The highest root length was scored in the control experiment that has 0% *D. stramonium* at an average mean of 4,7 cm whilst the shortest root length was observed in treatment with 70% *D. stramonium* which had a mean root length of 0,13cm. There is no significant difference between 0% *D. stramonium* and 10% *D. stramonium.* On treatments with 100 *D. stramonium* there were no roots to measure since there was 0% germination rate.

4.3 Effects of D. stramonium residues concentration on shoot length of sugar bean seeds after fourteen days.

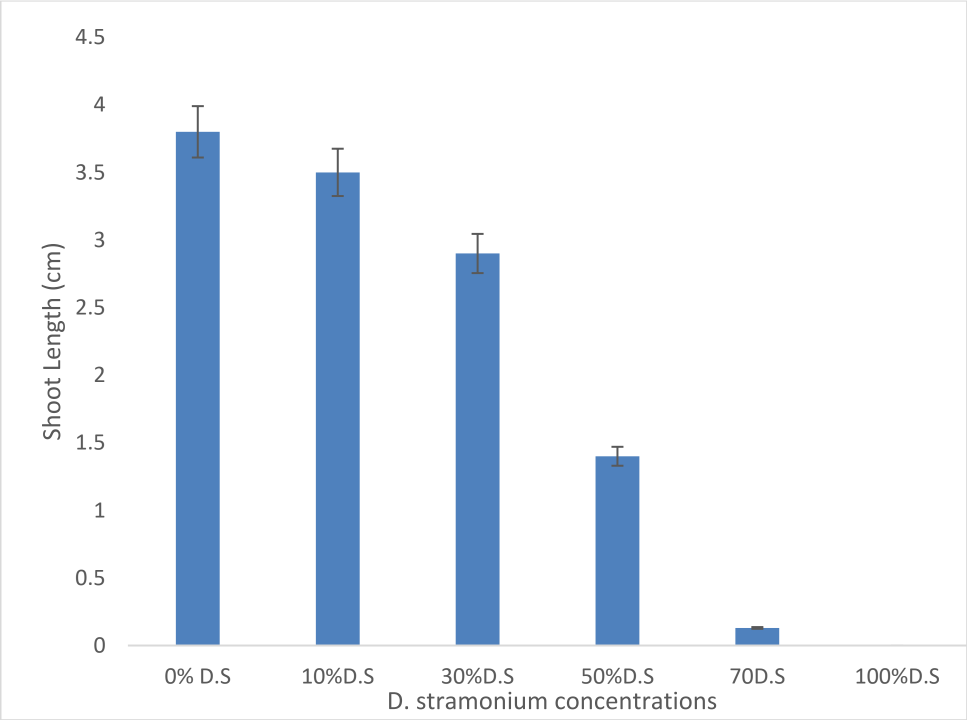

Fig 4.3 showing the effects of *D. stramonium* residues concentration on shoot length of sugar bean seeds after fourteen days.

Results from the research showed that the shoot length of sugar beans were reduced significantly ($p<0.001$) by *D. stramonium* residue concentrations in all the treatments. Sugar beans that were treated with 70% *D.stramonium* scored the least mean shoot length of 0,13cm followed by 50% *D. stramonium* with a length of 1.5cm. The control's mean plumule length (3.8cm) was not significantly different from the 10% D. stramonium concentration (3,6cm) and the 30% D. stramonium(3cm).

CHAPTER FIVE

5.0 DISCUSSION

5.1 Effects of Datura stramonium residues concentration on sugar bean seeds germination.

The concentration of *D. Stramonium* residues showed a strong influence on sugar bean seed germination. The results obtained showed that the germination percentage of sugar bean seeds treated with different concentrations of the *D. stramonium* residue solution varies. The percentage of germination of bean seeds treated with different concentrations of the solution varied depending on the concentrations applied, however the residue of *D. stramonium* at 100% concentration was most inhibitory at 0% bean seed germination. The results obtained showed that germination was very high (100%) when only distilled water was used, due to the absence of sprout inhibitors whilst there was no germination on seeds treated with 100% D. stramonium which might be due to lower water uptake. It shows that water is crucial for germination and triggers biochemical reactions. This study agrees with Sakadzo *et al.,* (2018) whose study found that allelochemicals inhibit water uptake, which is a precursor to physiological processes (hydrolysis of dietary nutrients) that should occur in seeds before germination is triggered, thus affecting germination. According to Dafaalla *et al.,* (2019) *D. stramonium* is able to alter the activity of gibberellic acid, which is known to regulate de novo amylase production during the germination process. In an experiment by Wasim *et al.,* (2008) on the effects of allelochemicals from *D. stramonium* on the vigor of T. aestivum (cultivar GW273), the results showed that allelochemicals are known to interfere with the activity of enzymes that break down the starch that nourishes the growing embryo during germination. The results obtained also agreed with those of Ullah *et al.,* (2015) who found that allelochemicals interfered with the activities of peroxidase alpha-amylase and acid phosphates, which promote starch breakdown in wheat.

5.2 Effects of *Datura stramonium* residues on sugar bean seeds root length.

The results from the research showed that root length was greatly affected by *D. stramonium* residue concentrations. Root length was concentration dependent. This might have been promoted by similar physiological processes that occur during cell division, cell expansion and auxin production. Results indicated that seedlings treated with 100% *D. stramonium* residues did not germinate at all while seedlings exposed to 10% of *D. stramonium* were much longer than all treatments with the residue solution. Treatments with distilled water only recorded the longest roots of 4cm. The results were in agreement with those by Murimwa *et al.*, (2019) who concluded that *D. stramonium* contains a collection of alkaloids such as atropine and scopolamine which prevent the growth and development of the roots. The allelochemicals found in *D. stramonium* might have interfered with auxin production on root tips which promotes root elongation and expansion (Nawaz *et al.*, 2014). Seham E Yassen *et al*., (2022) argues that Datura residue in low rate (10% and 30%) induced stimulatory effect and the root length of purslane exceeded the control value with 100% distilled water. In conclusion there are differences on results from the effects of Datura from this research and the research by Seham E Yassen *et al*., (2022) this might be due to differences in concentrations of Datura that was used ,different environmental conditions and also different crops were used.

5.3 Effects of Datura stramonium residues on sugar bean seeds shoot length.

The allelopathic effects of *D. stramonium* residues on shoot growth of sugar bean seed increased as their concentration was increasing. The results showed that shoot lengths treated with 70% D. stramonium were the shortest 0,98cm and some of the shoots were brown in colour. The longest shoot (5, 30 cm) were recorded in treatments with 0*% D. stramonium*. The brown colour could be due to disease infection as *D. stramonium* is susceptible to powdery mildew and also acts as a weed where the powdery mildew pathogen overwinters (Wasim et al., 2008). According to Oyun (2006), allelochemicals inhibit water absorption which is a precursor to physiological processes like photosynthesis. Reduced water uptake might have promoted reduced fresh biomass accumulation on bean seed. Photosynthesis encourages vegetative growth and rapid accumulation of fresh biomass as a result of inhibited photosynthesis there was low shoot growth due to lack of energy. The effects of *D. stramonium* allelopathy on seedling fresh weight and plant growth may occur through several mechanisms, including decreased mitotic activity in roots and hypocotyls, suppressed hormone activity, decreased water uptake, inhibited photosynthesis, respiration, inhibited protein formation, and reduced permeability of cell membranes and/or inhibition of enzyme action (zheng*et al.*, 2018). The results are consistent with those of Sakadzo*et al.*, 2018 as the concentration of *D. stramonium* residues increases and root length is reduced as *D. stramonium* residues affect cell division and water uptake by the roots.

CHAPTER SIX

6.0 Conclusion and Recommendations

6.1 Conclusion

The research revealed that *Datura stramonium* residues applied in the concentrations of 10%, 30%, 50%, 70% and 100% showed an allelopathic effect of inhibiting germination and elongation of sugar bean seeds. The highest germination percentage was noticed on treatments with distilled water and those with 10% *D. stramonium* which shows 100% germination rate whereas treatments with 100% concentrated *D. stramonium* recorded 0% germination. The results obtained showed that germination, elongation and growth of sugar bean depend on *D. stramonium* concentrations used. The inhibitory effect was accerelated along with increasing concentrations, (Ahmad 2014: Dafaalla *et al.*, (2019). Sugar bean seedlings exhibited a high level of inhibition due to different treatments performed from *D. stramonium* residues. Generally results showed that *D. stramonium* residues had an inhibitory effect on germination and early seedling growth of bean seeds. The inhibitory effect was dose dependent, the higher the dose the more the inhibition effect.

6.2 Recommendation

Based on the results and findings of this research, the recommendations to farmers are

- ❖ They should keep their fields free from *D. stramonium* weeds all year round as all parts of the weed (seed, leaves, stems and roots) have high negative allelopathic effect on sugar bean germination and early seedling growth.
- ❖ Also farmers should remove weeds near their fields as *D. stramonium* contain the dangerous alkaloids and can be dispersed in the fields during seed dispersal. These seeds remain in dormant stage for years and when their dormant stage is over they grow vigorously and could make the precious fields toxic for the crop species.
- ❖ After weeding farmers should remove thorn apple weed from the field, they should burn it or bury it deep down where the conditions are not favourable for germination of the seed.
- ❖ Farmers should not allow thorn apple to overwinter as it is susceptible to powdery mildew and can transmit the disease between seasons as it can act as an overwintering reservoir.

- Thorn apple residues should not be incorporated into the soil during land preparation, the residues should be removed before ploughing as a result farmers are not encouraged to practice zero tillage.
- Lastly farmers should not use *D. stramonium* residues when making compost manure due to long volatilization or decaying process and presents of high amounts of alkaloids.

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Appendices

Appendix 1: Analysis of Variance

Analysis of variance

Variate: Germinatin_Percentage

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	40.44	20.22	0.20	
Block.*Units* stratum					
Treatment	5	34241.78	6848.36	69.16	<.001
Residual	10	990.22	99.02		
Total	17	35272.44			

Analysis of variance

Variate: Root Length

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.02441	0.01221	0.13	
Block.*Units* stratum					
Treatment	5	66.18209	13.23642	143.47	<.001
Residual	10	0.92259	0.09226		

Total 17 67.12909

Analysis of variance

Variate: Shoot_Length

Source of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Block stratum	2	0.45250	0.22625	7.71	
Block.*Units* stratum					
Treatment	5	42.76992	8.55398	291.51	<.001
Residual	10	0.29343	0.02934		
Total	17	43.51585			

Appendix 2: Raw Data for treatments

Block	Treatment(d.stramonium concentration)	Germinatin Percentage	Root length	Shoot Length
1	0%	100	4.8	3.85
1	10%	100	4.55	3.83
1	30%	93	3.45	3.1
1	50%	39	2	1.98
1	70%	6	0.44	0.39
1	100%	0	0	0
2	0%	100	5	3.8
2	10%	100	4.88	3.45
2	30%	100	3.06	2.96
2	50%	20	2.66	1.29
2	70%	0	0	0
2	100%	0	0	0
3	0%	100	4.55	3.75
3	10%	100	4.52	3.35

3	30%	80	3	2.7
3	50%	60	3	1.1
3	70%	0	0	0
3	100%	0	0	0

Appendix 3 : Figures/pictures below show student doing the experiment