بسم الله الرحمن الرحيم

Sudan University of Science and Technology

College of Graduate Studies

Effects of Allelopathy of Some Plants on striga (*Striga hermonthica*) and Sorghum (*Sorghum bicolor)* Growth.

أثر التضاد البيوكيميائي لبعض النباتات على نموء البودا والذرة الرفيعة

A Thesis submitted in partial fulfillment of the requirements for the Degree of Master (M.Sc.) in Agronomy

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الآيـــــة

بسم الله الرحمن الرحيم

قَالَ تَعَالَىٰ: ﴿أَوَلَمۡ يَرَوۡاْ أَنَّا نَسُوقُ ٱلۡمَآءَ إِلَى ٱلۡأَرۡضِ ٱلۡجُرُزِ فَنُخۡرِجُ بِهِۦ
زَرۡعٗا تَأۡكُلُ مِنۡهُ أَنۡعَٰمُهُمۡ وَأَنفُسُهُمۡۚ أَفَلَا يُبۡصِرُونَ ٢٧﴾

صدق الله العظيم
السجدة الآية (27)

Dedication

To the fountain of happiness and peace, this was a symbol
Fulfillment and Tenderness by bringing out herself and her love,
Will come joy in myself.
My Mother
Oh symbol of giving and fulfilling to you my sincere invitation deeds
My Father
To who planted the glove and intimacy between our hearts and
Struggled for the sake of science and knowledge
MY wife
My children.
My brothers
My sisters
My sons
My friends
To all my teachers in department of Agronomy.

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Abstract

Greenhouse and Laboratory experiment was conducted in the Weed Science Center, (WSC), during the season 2018/2019, at the College of Agricultural Studies (CAS), Sudan University of Science and Technology (SUST) at Shambat, Khartoum North to determine the allelopathy effects of different nine plants (leaves and seeds) in form of water extracts concentrated 50% and 100% on *Striga hermonthica* seeds germination and radical length. The nine plants were *(Acacia nilotica, Cassia angutitifolia and Prosopis spp, Chicory spp, Calotrops procera, Ammi visnaga L., Citrulls colocynthis, Trigonella foenum graecam, and Lupines termis L).*

The results showed that the *Striga* seeds applied with GR24 showed the highest germination 63%, whereas, that treated with sterile distilled water did not germinate. There were some treatments acts as stimulants in 50%, concentration; *Cassia angustifolia*, *Acacia nilotica* and *Prosopis spp*. The other treatments act as inhibiters at 100%; *Ammi visnagal*, *Calotrops procera*, *Lupines termis L, Acacia nilotica,* and *Chiocory*.

The finding of the present study indicates that *Cassia agustifolia* (leaves), *Acacia nilotica* (leaves) and *Prosopis spp* (seeds) stimulant *S. hermonthica* seeds germination.

The pots experiment based on labrotary experiment results, the best three stimulent plants to striga germination were chosen, *Acacia nilotica, Cassia angutitifolia and Prosopis spp* powder (leaves and seeds) to determine the allelophathy effects on striga emergence and growth of Sorghum (*Sorghum bicolor*). Experiment lied with Randomized complete block design (RCBD) with four replications. Sorghum cultivar Wadbakoo was sown, seeds (Va) and leaves (Vb) powder of *Acacia nilotica, Cassia angutitifolia, and Prosopis spp* 50 gm/pot were added all this treatments applied some pots without striga and some with sriga and striga added 1 mg/pot. The measurements used were striga emergence, striga fresh and dry weight, and for sorghum; plant height, leaves number, chlorophyll content, shoot dry weight and root dry weight (g).

The results revealed that the different plants powder, have ability to increase Sorghum height, leaves number and chlorophyll content and at the same time stimulated *Striga* seeds germination. *Acacia nilotica, Cassia angutitifolia and Prosopis spp* powder (leaves and seeds) were act as stimulants of *striga* seeds germination on Sorghum. The finding of the present study indicate that *Cassia agustifolia*(leaves*),* *Acacia nilotica*(leaves) and *Prosopis spp*(seeds) can considered to be a stimulants to *striga hermonthica* seeds germination that had great effect on striga control and management. The results showed that the allelopathy effect of the nine plants is not completely inhibited or stimulanted for striga seed germination, some are stimulants and the others are inhibiters

الخلاصة

أجريت التجربة المعملية في معمل الحشائش المركزي، خلال الموسم (2019/2018). بجامعة السودان للعلوم والتكنولوجيا، كلية الدراسات الزراعية بشمبات، شمال الخرطوم. الغرض من الدراسة كانت لتحديد أثرالتضاد البيوكيميائي لتسعة نباتات مختلفة (البذور والورق) في شكل مستخلسات مائية ركزت 50% و100%على نمو بذور البودا وطول الجذير.النباتات المختلفة هي القرض، السنمكة، المسكيت، العشر، الترمس، المولبتا، الحرجل، الحلبة و الحنظل(البذور والورق).تم تهيئة بذور البودا للإنبات لمدة إسبوعين في الحضان ثم أجريت التجربة في الأطباق البتري وتم معاملتها بمستخلصات لتسعة نباتات لإنبات بذور البودا.. أشارة النتيجة أن بذور البودا تمت معاملتها بمحفظ النموGR24 لوحدها (شاهد) ظهرت أعلى معدل الإنبات (حوالي 63%) بينما تمت معاملتها بواسطت الماء المقطرة كانت لم تمبت . بعض المعاملات عملت كمحفز في 50%،تركيز؛ السنمكة،القرض والمسكيت. البعض المعاملات عملت كمثبت في 100% ؛ الحلبة،الخلة،الحنظل،القرض و الترمس. وجدت في التجربة تشير أن ورق السنمكة ،ورق القرض وبذور المسكيت يمكن تعتبر كمحفزفي50% تركيز لإنبات بذور البودا.

تم إختيارأفضل ثلاثة نباتات بناءآ على نتائج التجربة المعملية، تم إختيار أفضل ثلاثة نباتات محفزة لإنبات بذور البودا من نتائج التجربة المعملية لتأكيد أثر التضاد البيوكيميائي لها.ثلاثة نباتات؛ السنمكة،القرض والمسكيت بدرة (الورق والبذور) على البودا ونمو الذرة الرفيعة. صممت التجربة على القطاعات العشوائية الكاملة في أربعة مكررات.زرعت الصنف من الذرة ودباكو.أضيفت بدرة الورق والبذور للقرض(V1a ,V1b)، السنمكة (V2a ,V2b) والمسكيت(V3a ,V3b) 50جرام في كل أصيصة وكل هذه المعاملات بعض منها من غير بودا وبعض تمت معاملتها بالبودا. أضيفت واحد ملجرام بودا لكل أصيصة. القياسات التي أخذت حساب عدد البودا،الوزن الرطب والجاف للبودا بالجرام،طول النبات بالسنتمتر،عدد الأوراق ومحتوى الكلوروفيل للنبات و الوزن الرطب والوزن الجاف بالجرام في. أشارت الدراسة أن التضاد الكيميائي لبدرة النباتات المختلفة له القدرة على زيادة طول النبات، عدد الأوراق ومحتوى الكلوروفيل، وفي نفس الوقت تعمل على تحفيز لإنبات بذور البودا. بدرة القرض، السنمكة، والمسكيت (الورق والبذور) عملت على تحفيز نمو بذور البودا في الذرة. أشارة الدراسة الحالية أن ورق القرض،ورق السنمكةوبذورالمسكيت تعبركمحفزات لإنبات بذور البودا ولهاتأكبيرعلى تحكم البوداوإدارتها.

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List of Abbreviations

%	Percent
°C	Degree centigrade
Cm	Centimeter
GR24	Growth Regulator
Ppm	Part per million
G	Gram
Mg	Milligram
L	Littre
SE	Standard Error
H	Hours
Ha	Hectare
CV	Coefficient of variation
GFFP	Glass fiber filter papers
et al	And others
DAS	Days after sowing
No.	Number
*	Significant
**	High significant
Ns	Non-significant

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CHAPTER ONE

INTRODUCTION

Sorghum *(Sorghum bicolor L. Monech*)) was cultivated in ninety percent of the world's area in the developing countries, mainly in Africa and Asia. Major world's producers include Sudan, Nigeria, India, United States, Mexico, Ethiopia, China and Argentina (FAO, 2013). Meeting the food and fuel production challenges of the coming century will require production grains from traditional crop breeding, genomic selection, genome editing, and biotechnology approaches that develop plants with increased productivity and traits such as drought, pest and disease resistance, and canopies that have high photosynthetic efficiencies, (Ort *et al*., 2015;Park *et al*., 2015;Technow *et al*., 2015;Kromdijk *et al*., 2 016;Mondal *et al*., 2016).

Parasitic angiosperms, witchweeds (*Striga* spp.) and broomrapes (*Orobanche* and *Phelipanche* spp.) in the family Orobanchaceae are the two most devastating weeds that parasitize roots of host plants (Parker and Riches, 1993, Joel *et al*. 2007; Parker 2009). *Striga* spp. parasitize mainly tropical cereal crops, such as sorghum, Maize (*Zea mays*), Pearl millet (*Pennisetum glaucum*), and upland rice (*Oryza sativa*) (*Striga hermonthica* and *Striga asiatica*), but also cowpea (*Vigna unguiculata*; *Striga gesnerioides*; (Press *et al*., 2001). Crops infected by witchweeds can be heavily damaged even before the parasites emerge above the soil (Press *et al*., 2001). Striga parasitism often results in significant yield damage and yield losses of cereals. First, Striga plants compete effectively with the host for carbon, nitrogen and inorganic solutes (Gurney *et al*., 2000). Although the parasite has a so called ‘phytotoxic’ effect on the host plant within days of attachment ; a very small parasite biomass,with attachments of less than 4 mm in size, results in a large reduction in host height, biomass and eventually grain yield (Gurney *et al*., 2000). Striga control has been difficult to achieve through conventional cultural, chemical and biological methods (Koyama, 2000; Oswald, 2005; Kgosi *et al*., 2012). The present agricultural systems heavy amounts of synthetic chemicals are being used to control weeds and other pests. But the adverse impact of these chemicals on the environment has made it necessary to search substitute at weed control strategies and the current trends in agriculture production are to find a biological solution to reduce the apparent harmful impacts from herbicides and pesticides (Khanh *et al*., 2015). Recent research efforts have made it possible to use allelopathy for increasing crop production with quality food, reduce reliance on synthetic pesticides and improve the ecological environment (An *et al*., 2005). The intensive and repeated application of agrochemicals produces a wide range of side-effects that poses potential hazard to the environment (Meksawat and Pornprom. 2010). Based on before mentioned, there is a need to look for efficient methods of *Striga* control with little or non-hazard to the environment. The use of naturally occurring plant products is one of such method with potentials of reducing the detrimental impacts of agro-chemicals and their harmful effects on human health and the environment.

Direct or indirect stimulatory or inhibitory effects of one plant on another through release of chemical compounds into the environment are referred to as allelopathy. Root exudation, leaching by dews and rains, and volatilization or decaying plant tissue from allelopathic plants results in release of compounds into the environment (Rice, 2004). The use of allelopathic substances could inhibit the germination and seedling growth of crops and weeds (Farooq *et al*., 2008).Allelopathic efficacy of weeds on germination and seedling growth of crops vary from weed to weed (Hamayun *et al*., 2005). The allelopathic effects of various parts of same weed also differ for their effects on germination and initial growth of plants. Basic plant processes such as hormonal balance, protein synthesis, respiration, photosynthesis, plant water relations and chlorophyll production may be affected by allelochemicals (Yamane *et al*., 2002) and (Yokota *et al*., 2008). The seeds of these weeds only germinate in response to specific chemicals (germination stimulants) present in the rhizosphere of host plants and some of nonhost plants (Zwanenburg, 2009). Due to the wide spread and irregular utilization of chemical poisons (especially herbicides) in recent decades, application of allelopathic plants and their remaine in the soil was notified for controlling parasitic plants and improving crop growth conditions (InderJit and Keating, 1999). With perfect management of allelopathic ability, in addition to decreasing weed damage, herbicides application will be reduced. More research has been conducted on the use of allelopathic characteristics, as a proposed method in weed control (Duke *et al*., 2000).

The present research aimed to study, the allelopathic effects of nine plants *Acacia nilotica* (thorn mimosa, gum Arabic), *Cassia agustifolia* (synoym), *Prosopis spp* (mesquite), *Cichorium intybus* (Chicory), *Calotrops procera (*Oshar*), Ammi visnaga L. (*toothpick-plant), *Citrulls colocynthis (*colocynthis*), Trigonella foenum graecam* (Fenugreek), *Lupinus termis L. (*lupine*).*On Striga incident and growth of Sorghum.

CHAPTER TWO

Literature review

2.1. Sorghum

Sorghum (*Sorghum bicolor L. Meonch*), is belong to family Poaceae. It is a self- pollinated crop cultivated for its edible grains, commonly called sorghum and also known as durra in Sudan. Sorghum genetically considered as a drought tolerant crop and has evolved various eco types that with stand and array of biotic factor. It is considered more tolerant to many stresses, including heat, drought, and salinity and flooding as compared to other crops (Ali *et al*., 2011). However, the crop grown in rain-fed areas is highly affected by drought stress (Kebede and Menkir, 2001). The crop is crucially important to food security in Africa as it is exclusively drought resistant and can with-stand periods of high temperature (Taylor, 2006).

In Sudan, Sorghum is a multipurpose crop and cultivated in almost all regions by subsistence farmers for wide use. It has used to prepare different kinds of traditional food such as leavened bread "Kisra", Porridge "Asida," and animal feed and to prepare local beverages"Abraih"(Dirar, 1994). Sorghum grains are also considered as one of the major components of livestock and poultry feed. Further, the stalk is also used as animal feed and for house and fence construction. The grain is characterized by its high starch, protein, micronutrients, and crude fiber but low in fat (Kumer *et al*., 2015).

In Sudan, the amount and patterns of rainfall and length of rainy seasons as in sub-sahara Africa is fluctuating(Babiker, 2002).These climatic changes adversely affect traditionally sorghum growing areas of North Gadaref, Gezira, Sennar, White Nile state and North kordofan. The dominant varieties grown are the traditional feterita types e.g. Arfa Gadamak, Wad-Bako, Abdalla Mustafa and Korolo.Tetron and Dabar are grown on a limited scale (Babiker, 2013). Some farmers in South Gadarif grow the improved varieties, Wad Ahmed and Tabat. Sorghum grown in this regions used for commercialization purposes and is sold mainly in the local markets, with some of it for export (Babiker, 2013).

2.2. Economic important of Sorghum

Sorghum is an economically important C4 grass grown for the production of grain, forage, sugar/syrup, brewing, and lignocellulos biomass production for bioenergy (Voytas, 2013; Mullet *et al*., 2014). Sorghum importance and utilization worldwide the livelihood of more than 80% of the population in many African countries depends on agricultural production. In these countries, poverty and malnutrition are increasingly affecting large sectors of the population. Improving agricultural output is vital to reduce poverty and improve food security (Rosegrant *et al*., 2001). In the USA and some parts of the developing world, Sorghum is used as animal feed, and as feedstock for biofuel and the fiber industry, farmers use improved hybrids and advanced technologies. Whereas, in Africa and parts of Asia farmers who have minimal access to production inputs such as fertilizer(s), pesticides, hybrid seeds, good soil, water and improved credit facilities are the main producers. Globally, Sorghum is not only used for food, feed and beverage, but also as building material and in industry for production of starch and alcohol (Bantilan *et al*., 2004). Sorghum grains, typically, have protein levels of around 9% and high levels of iron and zinc thus enabling humans to survive famine and escape malnutrition and associated diseases (Dicko *et al*., 2006). Because of climate change and water scarcity the crop is crucially important for food security in

Africa, because unlike maize and rice it is drought resistant and can withstand periods of high temperature (Taylor, 2003).

2.3. Adaptation

Sorghum will grow in low fertility, moderately acidic and highly alkaline soils, but it is best adapted to fertile, well drained soils at a pH between 6.0-6.5. Sorghum is not tolerant of frost, shade, or sustained flooding (Clark, 2017; FAO, 2012; Understander, 2013). Sorghum grows across a wide geographic area at various altitude, day-length, rain-fall, and temperature regimes. Sorghum is recognized as a remarkably drought tolerant species and is for subsistence farming in water scarce, impoverished regions of the world (Wani *et al*., 2012). Grain Sorghum exhibits resilience to the effects of water stress, particular growth stages in its lifecycle are susceptible to drought stress. The early vegetative stage and reproductive stages (pre flowering and post flowering) of Sorghum are vulnerable to the effects of water deficit (Kebede *et al*,. 2001; Wani *et al*., 2012). Sorghum exhibits physiological responses that allow a continued growth under water stress (Dugas *et al*., 2011). Some Plants have robust ability to increase root growth at the early stage of drought stress to absorb the water in deep soil (Hu and Xiong, 2014). Delayed senescence, high chlorophyll content and chlorophyll fluorescence as well as canopy temperature and high transpiration efficiency are physiological traits that drought tolerance to Sorghum (Kapani gowda *et al*., 2013). The root system is the plant organ in charge of capturing water and nutrients, besides anchoring the plant into the ground. It is naturally viewed as acritical organ improve crop adaptation to water stress (Vadez, 2014).

2.4 *Striga*

Striga species, so-called witchweed, are obligate root hemi-parasites belonging to the family Orobanchaceae, and represent the biggest weed threat to agriculture of sub-Saharan Africa. Striga possibly originates from a region between the Semien Mountains of Ethiopia and the Nubian Hills of Sudan (Atera and Itoh, 2011). *Striga* species included *S. hermonthica, S. asiatica, S. aspera, S. forbesii, and S. gesnerioides*. Affected crops *S. hermonthica* and *asiatica,* which infect sorghum, maize, millet, and upland rice cause considerable yield losses (Ejeta, 2007). Cereal yield losses due to Striga attack vary from about 10% to complete crop loss and total abandonment of cereal production in severely infested fields (Gressel *et al*., 2004). These losses largely depend on Striga density, host species and genotype, land use system, soil nutritional status and rainfall patterns (Atera *et al.,* 2012). The most affected are the poor subsistence farmers, who are not aware of the threat that Striga poses to their land quality and food security as the weed continues to increase its soil seed bank and spreading to new areas.

The root-parasitic weeds of the genus Striga are among the most serious pests attacking the main cereals including sorghum, maize, pearl millet and sugarcane (Parker and Riches 1993). Striga species present the largest challenge to food security in the region affecting the livelihood of over 300 million people in 25 countries (Kroschel, 1999; Ransom, 2000; Babiker, 2007; Ejeta, 2007a). In Africa *S. hermonthica* and S. *asiatica* (L.) are the most devastating and widely spread parasitic weed species. The prevailing conditions such as drought spells and soil nutrient depletion favour the rapid expansion and proliferation of these parasites particularly in marginal areas of Africa (Ejeta, 2007a). Socioeconomic factors such as increased population pressure, limited education, mono-cropping, sub-optimal cultural practices, no or limited use of inputs and inflexibility to adopt new technologies have worsened the Striga problem especially for small subsistence farmers (Babiker, 2002). By now, over 21 million ha of arable land in Africa are infested by the worst species of the witchweeds, *S. hermonthica* resulting in a loss of 4.1 million tons of grain per year (Mboob, 1986). Currently the Striga problem in many African countries is pandemic and seems to be getting worse (Ejeta, 2007).

2.5. Germination of *Striga*

The germination stimulants play an important role in the fine-tuning of the lifecycle of the parasites to that of their hosts. Several studies confirmed that germination of *Striga*, *Orobanche* and *Phelipanche* seeds is induced by other natural compounds including Sesquiterpene lactones which are not strigolactones, cytokinins, auxins, gibberellins, cotylenins, fusicoccins and jasmonates (Logan and Stewart, 2012). Ethylene has been found to efficiently stimulate witchweed (*Striga* spp) seed germination. There are also several synthetic compounds that induce germination of parasitic plants. Among them are the strigolactones GR24 and Nijmegen-1. Suicidal germination is regarded as the induction of germination in the absence or away from the hosts root. Suicidal germination could be achieved by introducing either natural or synthetic germination stimulants in to the soil in the absence of a suitable host leading to both seed bank depletion and death of weed germining because of complete dependence on the host for their sustenance (Parker and Riches, 1993).Germination of Striga is induced by strigolactones (Xie *et al*., 2010). They are a recently discovered family of plant hormones which help plants to communicate with their environment (Andreo *et al*., 2015). The strigolactones seem to be synthesized mainly in the roots and have diverse roles in plant development (Al-Babili and Bouwmeester, 2015). Progresses in the isolation and analysis using ultra-performance liquid chromatography coupled to tandem quadrupole mass spectrometry (UPLC-MS/MS) have improved characterization and quantification of strigolactones in many plant species (Sato *et al*., 2005; Awad *et al*., 20 06; Xie *et al*., 2008).

Plant allelopathy offers a great prospective to resolve this critical issue and may be used in different ways to manage weeds (Javaid *et al*., 2006). Lack of stability precludes leaching of the chemical to desired soil depths. Another limitation of this approach is that the synthetic stimulants should be easy to handle and affordable to peasant farmers particularly in the African continent, where the problem exists. Ibrahim *et al*., (2011) reported that aqueous extracts from several *Euphorbia spp*. including *E. hirta* and *E.aegyptiaca* induced germination and haustorium initiation in *S. hermonthica*.

Several works have demonstrated the harmful influence of application of some plant species to Sorghum including reduced seed germination, seedlings emergence and biomass grain. Aqueous extracts of leaves have notably inhibited seed germination of Sorghum with application of *Calotrops procera* (Murthy *et al.*, 1995), *Ipomoea cornea* (Jadhav *et al.*, 1997),*Commelina bengahalensis and Cyperus rotundus* (Channappagoudar *et al*., 2003) and *Eucaliptus camaldulensis* (Mohamadi and Rajaie., 2009). However, the alleiochemicals sometimes have positive effects of Sorghum growth.

2.6. Crop

Sorghum bicolor is known by a variety of names, including milo or milo-maize in the United States, dura in Sudan, great millet and guinea corn in West Africa, kafir corn in South Africa, mtama in eastern Africa, and jowar in India (FAO 1995). There are many varieties.

2.7. Weed control

2.7.1. Methods of control

The tremendous impact of parasitic plants on world agriculture has prompted much research aimed at preventing infestation. Many potential control methods were developed against the parasite problem including physical, cultural, chemical and biological (Joel, 2000). In Sudan, a number of control measures for striga have been adopted by the farmers such as cultural practices, fertilizers, herbicides, germination stimulants, resistant varieties and biological control. Cultural practices include hand pulling, sowing date, planting method, intercropping, catch cropping and crop rotation with emphasis on trap crops. However, it has been proved to be difficult to fine selective products to control the parasite and each of them has one or more limitations that have led to low farmer adoption (Ahmed and Alamun, 2010). Striga seeds can easily be transferred from one field to another by cultivation, and also by water, wind and animals. However, the most significant seed transfer agents are people, transportation vehicles, and farming machines, which easily transfer seeds and contaminated soil. Extermination of seeds before their spread to new fields and regions is a crucial component in parasite weed prevention program (Panetta and Lawes, 2005).Preventing the movement of parasitic weeds from infested to un-infested areas is a crucial component of control. Both sanitation and quarantine are required in order to prevent the dispersal of seeds. Biological control: It has been reported that neem seed and leaf powder inhibit growth of striga hermonthica (Paul *et al*., 2004).

2.7.2. Cultural Methods

These comprise of many of the traditional methods, including crop rotation, hand-pulling, intercropping, trap and catch cropping and nitrogen fertilizers.

2.7.3. Crop rotation

Crop rotation of infested land with non-susceptible crops or fallowing is theoretically the simplest solution. Rotation with non-host crops interrupts further production of striga seed and lead to decline in the seed population in the soil.Ahonsi *et al*.(2002)reported that in west A Africa, rotating sriga susceptible cereals with leguminous crops has been decrease the striga seed bank and increase yield of subsequent cereal crops. The practical limitation of this technique is required more than three years for rotation (Teka, 2014). Rotating the infested sorghum areas to wheat, barley, pluses or groundnuts are viable and effective options in Ethiopia (Teka, 2014). In Ethiopia two years of cropping to a non-host was reported to reduce Striga infestation by 50% (Shank, 2002).In west Africa rotating striga susceptible cereals with leguminous crops has been reported to decrease Striga seed bankand increase yields of subsequent cereal crops (Ahonsi *et al*., 2002).The increase in yield due to millet-cowpea rotation was 37% as compared to three or five years continuous millet cropping (Samsk, 2003). De-Groote *et al* (2010) found that soybean triggers suicidal germination of striga and reduces the striga seed bank in the soil when intercropped with maize. Practical control measures are effective when a combined program of crop rotation, weeding, sanitation and resistant varieties is included (Teka, 2014).

Hand-pulling Hand –pulling is the most widely practiced used control method against Striga and it is recommended to prevent seed set and seed dispersal. It is necessary to prevent seed production and re-infestation of the soil (Teka, 2014). Hand pulling can only be recommended in cases of limited infestation to prevent any further increase in the parasite population and to reduce the seed bank in the soil. The removal of mature plants prevents the increase of the parasite weed seed bank. However, when the parasite emerges from the soil, most of the damage to the host crop has already occurred. However, even when hand weeding is still commonly used in some countries where no other feasible means of control are available and the wages for labor are cheap, it is only practical in preventing build-up of parasite seeds in slightly infested soils (Rubiales and Aparicio, 2010).

2.7.4. Intercropping

Intercropping is a potentially viable, low cost technology, which would enable to address the two important and interrelated problems of low soil fertility and Strata (Fasil, 2002). Intercropping with a false host crop that stimulates Striga seed germination without being itself attacked or parasitized, has been thought as a method for depletion of Striga seed reserves in soil (Parker and Riches, 1993).Intercropping cereals with legumes and other crops is a common parasitic in most area of Africa and has been reported as influencing Striga infestation (Teka, 2014). According to Khan *et al* (2007), intercropping different legumes with maize and sorghum helps reduce Striga but not eliminate the weed. Intercropping sorghum and groundnuts (*Arachis hypoguaea* L.), Sorghum and cowpea (*Vigna unguiculata*), and sorghum and dolichos bean (*Lablab purpurousL.*) reduced population density of S.hermonthica (Babiker *et al.*, 1996). Growing in sorghum association with cowpea and haricot bean was effective against S. hermonthica and produced significantly improved yield per unit area in Ethiopia (Fasil, 2002). Intercropping maize with cowpea and sweet potato significantly reduce the emergence of Striga in Kenya (Oswald *et al*., 2002). Work in Sudan showed that intercropping is a valuable cheap and effective method for suppressing localized infestation of the parasite on relatively small farms (Babiker, 2002). Intra-row planting of hyacinth bean(*Lablab purpureus*) with sorghum ,reduced S.hermonthica emergence by 48-93%,dry weight by 83-97%, number of seeds capsules by 52-100% and increased sorghum grain yield by several pold in comparison with the sol crop (Babiker,2002). Intercropping fodder legumes (*Desmodium uncinatum and D.introtum*) with maize reduced striga infestation in Kenya (Khan *et al*., 2000). The effect was significantly greater than that or other legumes such as cowpeas, as were the concomitant yield increase. The mechanism by which D.Uncinatum reduce Striga infestation in intercropping was found to be the allelopathic effect inhibiting the development of haustoria of Striga (Khan *et al*., 2001). Identification of the compounds released from D. Uncinatum involved in the suppression of the parasite may give more exploitation for developing reliable intercropping stratigies, as well as new approaches for molecular biology in S.hermonthica (Gressel, 2000). Parker and Riches (1993) attributrd the suppressive effects of intercropping to several factors, including its action as a trap-crop, interference with production of germination stimulants, exudation of germination inhibitors and or reduction of the parasite transpiration, through decreasing air temperature and increasing humidity .In common with most parasitic weeds Striga species have high transpiration rate, associated with stomata which remain open.

2.7.5. Trap and catch crops

The use of trap and catch crops that induce the germination of striga but are not themselves parasitized is currently one of the best methods to control agricultural root parasites. Trap crops cause suicidal germination of the weed, which reduces the seed bank in the soil (Teka, 2014). Common cultivated trap crops include cotton (*Gossypium barbadense*), groundnut (Arachis hypogaea), soybean, pigeonpea (Glycine max), green or black gram (*vigna mungo*), lucene (*Medicago sativa*), sunflower (*Helianthus annuus*) and sesame (*Sesamum indicum*) (Babiher, 2007). Trap crops cannot be expected to eliminated the seed bank in the soil immediately(Fernandez-Aparicio *et al*.,2011).Catch crops are planted to stimulate a high germination percentage of the parasite seeds but are destroyed or harvested before the parasite can produce the seeds (Teka,2014). Catch crops are planted to stimulate a high percentage of the parasite seeds to germinate but are destroyed or harvested before the parasite can reproduce (Teka, 2014). It is another mean of depleting striga seed reserves in soils. Contrary to trap cropping, which relies on false hosts, catch cropping employs true hosts of the parasite. A thick planting of Sudan grass at 20-25kg seed per hectare should be sown and either ploughed in or harvested for forage at 6-8 weeks before striga seeds. The main crop could then be planted during the main rains (Parker and Riches, 1993). The catch crop, when ploughed under is equivalent to green manuring it is restorative effects on soil fertility (Bebawi, 1987). Catch crops are considered to be less economically favored than trap crops because of the lack of direct financial returns.

2.7.6. Nitrogen fertilization

Nitrogen and phosphorus deficiency as well as water stress accentuate the severity of striga damage to the hosts (Teka, 2014). Striga is particularly a pest of low fertile soil and usually the infection decreases if mineral nutrients, especially nitrogen and phosphorus, are applied in sufficient quantities (Adagba *et al*., 2002). Nitrogen is believed to reduce stimulant production. The use of nitrogen to suppress striga has been demonstrated in the East and Central Africa highlands (Esilaba *et al*., 2000; Gacheru and Rap, 2001). Studies in western Kenya show that CAN at 0-40kg N/ha^{-1}had no significant effect on maize yield but reduced Striga populations. Farmyard manure trials indicated that 100t/ha^{-1}reduced striga counts and increased maize yield. Mumera and below (1993) found that although Striga infection generally declined with increasing N availability, the impact was partially dependent on the severity of infestation. Application of high dosage of nitrogen fertilizer is generally beneficial in delaying striga emergence and obtaining storage crop growth (Dugie *et al*., 2008). Also other advantageous effects of fertilizers include increasing soil nitrogen and other nutrients, replenishing the organic matter of the soil and increasing soil moisture holding capacity (Ikie *et al*., 2006).

2.7.7. Host plant resistance

Resistant host plants should provide the simplest, the easiest and the cheapest method for striga control. Resistance is the process by which host withstand the parasite attack in a manner that prevent parasite establishment and growth, whereas tolerance involves the ability to endure damage infected by the parasite (Eizenberg *et al*.,2013).Full immunity of host plants to striga or orbanche has not yet been found. Crop cultivars with resistance to striga has long been suggested as a cost-effective method of reduced striga related losses that would be combatable with the low input farming system predominant in sub-Saharan Africa(Joej *et al*.,2007).Genetic variation for low Strigagermination stimulant production in Sorghum is used to breed for striga resistant varieties and introduce them into high yielding sorghum cultivars in several African countries(Ejeta ,2007).Some host genotypes, particularly wild relatives of sorghum , have a reduced ability to initiate haustorial(Rich *et al*., 2004).In the latter case, this is likely to be production of low amount of haustorial inducing factor (Gurny *et al*.,2003).In other cases low haustorial initiation may be due the production of inhibitors , but this is a little researched area at present (Rich *et al*., 2004).

2.8. Chemical control

Various Chemicals including herbicides, fumigants, and synthetic germination stimulants were reported as means of Striga control.

2.8.1. Herbicides

Chemical herbicides have been applied to reduce S.hermonthica and can reduce infestation to some degree in maize and Sorghum (Babiker *et al*., 2010), and were more cost-effective than other methods.Many herbicide are useful in preventing the built-up of Striga seeds in the soil but may not prevent the damage by the Striga plants before emergence. Research efforts should therefore be directed towards identifying herbicides that persist in the soil, allowing the germination of Striga seeds but killing the seedling before attachment to the host (Babiker *et al* 2010). Several herbicides have been recommended for control of Striga on Sorghum and Maize (Langeston *et al* 1991). Aly (2007) reported Dicamba and 2, 4-D are the most widely used herbicides against Striga. Recent on-farm trials in Kenya and Tanzania indicate that seed dressing with Imazapyr and Pyrihiobac offers good Striga control and increased maize yields (Kanampiu *et al*., 2004). Work in India and Sudan (Korwar and Frisen, 1984) showed that 2, 4-D and MCPA, applied as soil directed sprays 3to 4 weeks after crop emergence, reduced Striga incidence and increased crop yield. Similar results were reported with oxyfluorfen, triclopyr and chlorsulfuron (Langeston and English, 1990). These products Kill the parasite during the early developmental Stages and thus make evasion of crop damage possible. Furthermore, most of these herbicides are either none selective to Sorghum (oxyfluorfen) or has a narrow safety margin (chlorsulfueon). Chlorsulfuron, triasulfuron and imazaquin herbicides significantly reduced the broomrape parasitizing tomato plants(Ghannam *et al.*,2012). Chlorsulfuron and its tank mix with dicamba, when used against Striga on Sorghum, effected excellent and persistent control of the parasite on both tolerant and resistant cultivars and increased yield and yied component (Babiker, 2002). Applying herbicides through soil for management of root-parasitic weeds targets the seedlings and its early development stages, the success of this mode of herbicide application depends on the viability of herbicide in the soil layer where the host roots are parasitized (Eizenberg *et al.*,2013). Chlorsulfuron at 2.38 and 2.98 g a.i.ha $^{-1}$ resulted in satisfactory to excellent suppression of the Striga emergence early in the season (Rashida, 2014).

2.8.2. Fumigants

Fumigants are chemicals that have the ability to kill most soil borne organisms including bacteria, fungi, nematodes, and weed seeds. The seeds must be physiologically active to be killed (Nandulla, 1998). Soil fumigation is one of the methods of control which was used in USA for eradication of the parasite. Three fumigants were reported to provide effective to control of parasitic weeds. Bromomethane (methyl bromide) and Basamide (3, 5-dimethyl-2h-1, 3, 5-thiadazine-2-thione) were reported to be highly effective on S. asiatica (Parker and Riches, 1993). However, high cost, high toxicity and requirement of special skills in handling limit the use Bromomenthane to experimental plots. The product is easy to handle. However, its potential for controlling Striga in farmers' fields remains to be determined. All fumigants are used at very high rate, expensive, labor intensive, and extremely environmentally hazardous (Aly, 2007).

2.9. Allelophay

Allelochemicals emancipated as residues, exudates and leaches by many plants from leaves, stem, roots, fruit and seeds reported to interfere with growth of other plants (Asgharipour and Armin, 2010). These chemicals products mainly affect plants at seed emergence and seedling levels (Alam and Islam 2002; Hussainet al., 2007; Mohamadi and Rajaie, 2009; Naseem et al., 2009). Allelopathy plays an important role in agricultural ecosystems and in a large scale, in the plant covers among the crop-crop, crop-weed and tree-crop covers.These interactions are detrimental and occasionally, are useful and gave attention to allelopathy in natural and agricultural ecosystems. Today, allelopathyis recognized as appropriate potential technology to control weeds using chemicals released from decomposed plant parts of various species (Naseem et al., 2009).

2.9.1. Allelopathy effects of Cassia angustifolia

Moringa oliefera and Cassia *angustifolia* leaf extracts enhanced germination of Sorghum by 29% (Phiri, 2010 and Hussain *et al*., 2007). Jayakumar (1995) studied allelopathic effects of *Cassia angustifolia* on Parthenium and reported that aqueous extracts of different plant organs of *Cassia angustifolia* viz, root, stem, pod wall and leaf inhibited seed germination and seedling vigour of Parthenium. Inhibition was statistically significant over control at higher concentration of aqueous extract (undiluted 1:10) than at lower concentration.

2.9.2. Allelopathy effects of Prosopis juliflora

The effect of aqueous extracts from different parts of *Prosopis juliflora* on the final germination percentages of seeds and early growth of seedling of various test crops was investigated. The data revealed that extracts of different parts of mesquite plant screened significantly inhibited the seeds germination of the test crops compared to control with considerable differences among crops (Asgaripour and Armin, 2010). Moreover, the effect of fruits and leaves extracts were found to be more pronounced than that of bark and roots (Asgaripour and Armin, 2010). This highly significant inhibitory effect of fruits and leaves extracts could be attributed to that the mesquite fruits and leaves aqueous extracts contain water-soluble allelochemicals than that of roots and bark and hence the inhibitory effect was more (Asgaripour and Armin, 2010). These results confirm with Sazada *et al.*, (2009) who reported similar results on seeds of wheat. Chellamuthu *et al.*, (1977) mentioned that the *P. juliflora* significantly reduced the germination percentage of gram and sorghum. In this regard, Chou, (1989) revieled that the Allelopathic metabolites leached out from woody plants often suppresses the growth of undergrowth species sharing the same habitat in the same line Akram *et al.*, (1990) and Kil and Yun (1992) who reported that the Allelopathic effects generally produce an inhibition of germination and early growth of seedlings. Moreover, Macias *et al.*, (1992) reported that although the specific mode of action of allelochemicals was not investigated, many other studies demonstrated inhibition occurring through limiting cell division, respiration, photosynthesis or by disrupting membrane regulation. Results was reported by Mehar *et al.*, (1995) who demonstrated that the roots extract of Mesquite has the least reducing effect on germination and early seedlings growth of various cultivars of *Sorghum*, Maze and Wheat.

2.9.3. Allelopathy effects of Lupines termis L.

Khan *et al*. (2008) noted that aqueous extracts of *Lupines (Lupines termis* L.) at a concentration of 10, 15 and 20% had inhibitory effect on wheat germination and effect was found significantly higher than control treatment. Fresh and dry weight of seedling was also reduced significantly over control. The inhibitory effects were increased as the extract concentration increased. These findings indicated that wheat sown in fields which had leaf litter of Eucalyptus *camaldulensis* L. adversely affected regarding germination, growth and ultimately resulting in lower yields of wheat.

2.9.4. Allelopathy effects of *Calotrops* and *Acacia*

Mansoor *et al.* (2004) designed an experiment to investigate the efficacy of various weed management strategies in mungbean. Water extracts of *Sorghum, Calotrops and Acacia* were used in comparison with hand weeding and preemergence herbicide. All the treatments significantly affected number of branches/plant, number of pods/plant, 1000 grain weight and grain yield. Application of water extract of Acacia ranked at the top in yield and almost all the yield components followed by two hand weeding + Pre-emergence herbicide treatments.

Khan *et al*. (2005) investigated the allelopathic potential of aqueous extracts of leaves of *Prosopis juliflora* and *Eucalyptus camaldulensis* and bark of *Acacia nilotica*. The results showed that the germination percentage, seedling length (mm) and biomass yield (mg) of *Ipomoea spp, Asphodelus tenuifolius*, *Brassica campestris* and *Triticum aestivum* were significantly affected by tree extracts as compared to control. *Eucalyptus* and *Acacia* had stimulatory effect on germination percentage of *A. tenuifolius,* while *P. juliflora* and *E. camaldulensis* had inhibitory effect on

B. campestris. All extracts had inhibitory effects on seedling length of *T. aestivum* and *B. campestris*. Treatment means indicated that *P. juliflora* and *E. camaldulensis* are more allelopathic than Acacia. Effect of Acacia on the test species was statistically comparable with control, exhibiting its non-inhibitory role in the test species. Species means indicated that *Ipomoea sp*. and *T. aestivum* were less negatively affected than *B. campestris* and *A. tenuifolius*.

Cheema (1988) reports at least nine water-soluble allelochemicals from mature Sorghum plants that are phytotoxic to weeds, such as *Phalaris minor Retz. Chenopodium album L., Rumex dentatus L. and Convolvulus arvensis L*. However, the most studied metabolites exudated by the living roots of sorghum are a group of hydrophobic benzoquinones called sorgoleone – 2-hydroxy-5-methoxy-3-[(Z,Z)-8’,11’,14’-pentadecatriene]-pbenzoquinone and its 1,4-hydroquinone (Czarnota *et al*., 2001, 2003a).

2.9.5. Allelopathy effects of Euphorbia spp

Ibrahim *et al*., (1985) reported that aqueous extracts from several *Euphorbias* spp. including *E. hirta* and *E. aegyptiaca* induced germination and haustorium initiation in *Striga hermonthica* and increased sorghum height, significantly, in comparison with the Striga infested control. The undiluted extract from *Curcuma longa* L and *Cichorium intybus* was found to inhibit completely *S. hermonthica* germination (Ma *et al*., 2004). Results obtained with *Azadirachta indica* and *Parkia biglobosa* confirmed the observations reported by Marley *et al*. (2004) in Nigeria. Seeds of *A. indica*, fruits and peels of *P. biglobosa* were effective reducing *Striga* emergence (Marley *et al*., 2004). Other studies reported that *A. indica* (bark and leaves) inhibited germination and growth of three weeds: *Echinochloa crus-galli*, *Monochoria vaginalis* and *Aeschynomene indica* in a bio-assay and in soil (Xuan *et al*., 2004). Previous findings on allelopathic plants suggested that effective compounds can be isolated and characterized to further use for Striga control. Six phenolic compounds having potential allelopathic activity were isolated from *A. indica* (Xuan *et al*., 2004) while -5-deoxystrigol was isolated from *Lotus japonicus* root culture (Sugimoto and Ueyama, 2008).

The evaluation of Chinese traditional herbs revealed that distilled water and methanol extracts of 26 species, stimulated the germination of *S. hermonthica* (Ma *et al*., 2004). *S.hermonta* seeds germination Stimulants cannot induce germination at high doses as oppose to low doses (Siame *et al*., 1993; Yasuda *et al*., 2003). The results revealed that the inhibition effect on *Striga* germination of water extracts from some plant species such as *E. camaldulensis* (leaves) is probably due to a high concentration of the applied compounds. Water extracts from six local plant species showed significant inhibitory effects on the germination of *Striga hermonthica* seeds. The current study pointed out that plant water extracts may have potential inhibition on *Striga* infestation and the list of allelopathic plants to *Striga* germination (Ma *et al*., 2004). Similar evaluation of water extracts from 383 Chinese traditional herbs showed that 27 herbs inhibited *S. hermonthica* seed germination and among them, undiluted extracts from sixteen herbs reduced *Striga* germination by more than 50% (Ma *et al*., 2004).

CHATER THREE

Material and methods

3.1. General

Laboratory and pot experiments were under taken to study the effects of allelophathy of nine plants on striga germination or, radical length and sorghum growth.

3.2. Laboratory experiment

The experiment was conducted in the Weed Sceince Center Laboratory (WSC), at the College of Agricultural Studies (CAS), Sudan University of Science and Technology (SUST) at Shambat, Khartoum North. The objective of the study was to determine the effects of allelopathy of nine plants (leaves and seeds) in form of water extracts concentrated at 50% and 100% on *striga hermonthica* seeds germination and radical length.

Plant Aqueous extracts were obtained by soaking 10 g powder of each plant material (*Acacia nilotica, Cassia angutitifolia and Prosopis spp*, *Chicory spp, Calotrops procera, Ammi visnaga L. Citrulls colocynthis, Trigonella foenum graecam, and Lupines termis L*) in 250 ml beaker glass with 100 ml of sterilized distilled water for 24 hours at 28º C. Each suspension was then filtered through two tools, nylon cloth followed by Whatman filter paper No. 1. Further solution were prepared in two doses 100% and50% and were prepared and stored at 4º C for use.

3.2.1. Plant materials

Seeds and leaves of *Acacia nilotica*, *Cassia angustifola*, *Prosopis sop, Cichorium intybus*, *Calotrops procera*, *Ammi visnaga L.*, *Citrulls colocynthis*, *Trigonella foenum graecam*, *Lupinus termis L.* were separately selected as the plant materials to examine their allelopathic effects on *S. hermonthica* incidence and Sorghum growth. The utilizable plant parts of the species were collected from Shambat area, Khartoum Nourth, Sudan. The plant materials were washed and dried at room temperature and separately ground into fine powder and stored until used. In this research, seeds of Sorghum local cultivar Wadbako commonly grown in Sudan were used. The *S.hermonthica* seeds were Parapered from the (WS C) Laboratory.

3.2.2. Strigol analogue (GR24) Stock solution

A stock solution of the synthetic germination stimulants GR24 was prepared by dissolving 1ml of acetone and completion to volume (100ml) with sterilized distilled water to obtain the desired concentration (10ppm).

3.2.3. Preparation of plant extracts

A total of nine plants known for ability to produce allelochemicals were selected for the present study namely *Acacia nilotica*, *Cassia angustifola*, *Prosopis sop, Cichorium intybus, Calotrops procera, Ammi visnaga L., Citrulls colocynthis, Trigonella foenum graecam, Lupinus termis L.* Fully grown healthy leaves and seeds collected from these plants were washed thoroughly with distilled water and dried in the open for 24 hours. Then the dried samples were separately ground into fine powder and stored dry until used. Aqueous leaf and seed extracts was prepared by soaking 10 gram of powdered leaf and seed materials in 100 ml distilled water for one hour in chaker. Then, this extract was filtered using filter paper (Whatman No. 1). The filtered solutions (stock solutions) were dried in freezedrier then placed in a refrigerator for a short time until experiment start. Stock deried matrials were diluted appropriately with distilled water to give the final concentrations of 50 and 100 %. To evaluate the phytotoxicity of allelochemicals produced by the plants, the effects of water soluble compounds on seed germination and powdered leaves on seedling growth was analyzed.The control treatment, distilled water, was used to estimate potential germination of seeds.

3.2.4. Striga seeds conditioning and Bioassay

The striga conditioned for two weeks in the incubator then the experiment carried in the Petri-dishs and treated by extracts of the nine plants solution by two concentrations (50% and 100%), used GR24 and sterile distilled water as control and placed to the incubator for striga seeds germination. Glass fiber filter papers (GF/C), discs (8 mm diameter) were cut, wetted thoroughly with water and placed in an oven at 100 ºC for 1 hour to be sterilized and ready for further use. The sterilized discs, placed in nine petri dishes lined with glass fiber filter papers (GF/C), were moistened with 4-5 ml distilled water. About 25-50 surfaces disinfected *S. hermothica* seeds were spreaed on each of the glass fiber discs in each petri dish. The dishes, sealed with para film, placed in black polythene bags were incubated at 30 ºC in the dark for 10 days. Each disc was treated with 20 µl aliquot, of each concentration of plant aqueous extract. Conditioned seeds, on discs treated with 20 µl distilled water or with the synthetic germination stimulants GR24 (,l ppm), were incluted as controls for comparison. Subsequently, seeds were examined for germination under a stereomicroscope. A seed was considered germinated when the radical protruded from the seed coat. All statistical

Analysis was performed using analysis of variance method by means of Excel software. Mean separation was performed using LSD test at 0.05% and 1% probability level.

3.3. Pot or Greenhous experimen

The experiment was carrid out in the season (2018-2019) in the experiment Farm of the College of Agricultural Studies, Sudan Univirsity of Science and Technology at (Shambat). It is located 23^{o} 35, longitude 15^{o}31, and altitude 288m sea leaves, within the semi-desert region.

The soil of the site is described as loam clay it is characterized by a deep cracking, moderately alkaline clays, and low permeability, low nitrogen content and PH (7.5 - 8) content (50 - 60%) and high exchangeable sodium percentage (ESP), in subsoil. The annual rain fall is about 151.8mm. Artificial infestation of the soil was conducted by mixing 1g of striga seeds with 1kg soil, used caly with striga free soil to give the required infestation level. Added 10mg soil content 1mg striga with 50g plants powder in each pot and watered the soil (conditioning) for two weeks then sorghum seeds, (Wadbako) cultivar were sown in immediately irrigated soil. Treatments were arranged by Randomized Complete Block Design (RCBD) with four replicates. Subsequent irrigation was carried out every two days.

3.3.1. Data collection

3.3.1.1. Striga emergence/pot: Counted at 30, 45, and 60 days after sowing.

3.3.1.2. Striga fresh and dry weight (g)

Two plants were taken, and weighed using sensitive balance, and then dried in oven drier at 105 c for 48 hours and then weighet by sensitive balance (KREN&Sohn Gmbh, D-72336 Balingen Germany).

Data collected on Sorghum growth attributes were taken 30, 45 and 60 days after sowing (DAS).The data recorded of:

3.3.2. Plant height (cm)

The plant height was measured from the base of the main stem to the tip of panicle using meter tape.

3.3.3. Number of leaves/plant

It was counted for the three tagged plants and the average was determined

3.3.4. Chlorophyll content/plant: Avarege of SPAD reading at 3 points was recorded for each leaf, using a chlorophyll meter (SPAD-502, Konica Menolta, Japan).

3.3.5. Sorghum fresh and dry weight (g)

Two plants were taken, and weighed using sensitive balance, and then dried in oven drier at 105 ^{0}c for 24 hours and then weighet by sensitive balance (KREN&Sohn Gmbh, D-72336 Balingen Germany).

3.4. Statistical analysis

Data on Sorghum growth attributes and *S.hermonthica* were subjected to analysis of variance (ANOVA) and means were separated for significance by the least Significance Differences (LSD) at 5%and 1% level using Statistics 8 statistical software, version2.0 (UK).

CHAPTER FOUR

Results

4.1. Laboratory experiment:-

4.1.1. Effects on Striga germination:

Striga seeds conditioned in distilled water and treated with GR24 at .1ppm displayed between 52.3 and 63% germination (Table 4.1). Treatment with p4a and p4b induced highest striga germination 40.66 and 30.66, respectively incomparison to other treatments.Striga seeds applied by p1 and p3 at low concentration (50%) displayed 12-13.33% germination. However at high concentration (100%) sustained 4.66 and 7.33% germination treatments p4, p5, p6, p7, p8 and p9, inrespective of concentration induced negligible striga germination and displayed between 2.66-3.33% germination (Table 4.1).

4.1.2. Effects on Radical length.

At 48 hours the heights percentage of the heights radical length in p4a 1.83cm and p4b 1.16mm. The compeletely inhibited treatments in the radical length at p5b and p8b were zero radical length (Table 8). Some treatments act as stimulants such as *Cassia angustifolia* 50%, Acacia nilotica 50% and *Prosopis* spp 50%. The treatments act as inhibiters such as *Ammi visnagal* 100%, *Calotrops procera*100% *Lupines termis* L. 100%, *Acacia*100%(Table4.1).

Table4.1. Allelopathy effect of nine plants on Striga seed germination and radical length.

Treatment	Seeds germination		radical length(mm)
	concenterations	After 48 hour	After 48 hour
P1a	50%	12.000^{cd}	1.166^{b}
P1b	100%	4.666^{efg}	1.000^{bcd}
P2a	50%	6.666^{cde}	1.133^{bc}
P2b	100%	4.000^{efg}	0.466^{ef}
P3a	50%	13.333^{c}	1.166^{b}
P3b	100%	7.333^{cde}	0.966^{bcd}
P 4a	50%	40.667^{a}	1.833^{a}
P4b	100%	30.667^{b}	1.033^{bcd}
P5a	50%	5.333^{efg}	1.200^{b}
P5b	100%	2.666^{efg}	0.000^{f}
P6a	50%	5.333^{efg}	1.033^{bcd}
P6b	100%	3.333^{efg}	0.633^{de}
P7a	50%	4.000^{efg}	0.800^{bcde}
P7b	100%	0.666^{fg}	0.566^{de}

P8a	50%	2.666^{efg}	0.666^{cde}
P8b	100%	0.000^{g}	0.000^{f}
P9a	50%	4.000^{efg}	0.566^{de}
P9b	100%	4.000^{efg}	0.400^{ef}
X		8.407	0.812
LSD pm		4.28	0.34
LSD pm*con		6.06	0.48
CV%		43.49%	35.69%

p1a (*Acacia 50%*), p1b (*Acacia 100%*), V2a (*Cassia 50%*), V2b (*Cassia* 100%).V3a (*Prosopis* 50%), V3b (*Prosopis* 100%), V4a (Lupines termis L.50%), V4b (Lupines termis L 100%), V5a (Chiocory50%), V5b (Chiocory100%), V6a (Calotrops procera50%), V6b (Calotrops procera100%), V7a (Trigonella foenum graecam50%), V7b (Trigonella foenum graecam100%), V8a (Ammi visagal 50%), V8b (Ammi visnagal 100%) and V9a (Citrullus colocynthis50%). V9b (Citrullus colocynthis 100%) pm= plant part and con= condition.

4.2. Pots experiment

Allelopathy effects of different plants on striga and sorghum growth.

4.2.1. Effects on sorghum

4.2.1.1. Plant height (cm)

Allelopathy effect of leaves and seeds of three plants showed significant differences at 30, 45 and 60 days after sowing (DAS) among all treatments and their interactions it showed no significant different between (S1)with Striga and (S2)without Striga. At 30 DAS the results revealed that the V1b (Acacia leaves) is the heights plant values 64.5cm in S1, and V1b 56.5cm in S2 and V0 (control) is the shortest plant high in all treatments S1 (26.75cm) S2 33.25cm (Table 1). At 45 DAS presented in (**Table 2**) it showed that the heights plant high V1b in S1 (92.28cm) and in S2 the heights plant high is in V3a (Prosopis seeds) 91.21cm and the control is the shortest than all in S1; 45.93cm and S2 (57.36cm). At 60 DAS obtained significant different between treatments and all values high than control the heights values is V2a (Cassia seeds) (137.63) cm in S1 and V2a (134.75cm) in S2 the control is shortest value in S1 (69cm) and in S2 (101.75cm). Over all in plant high the control had the shorter plants significantly among all treatments in30, 45 and 60 days after sowing (Table1).

Table4.2. Allelopathy effects of selected plants on sorghum height (cm) in presence of striga.

Plant height (cm)									
Days After Sowing(DAS)									
Treatment	30 DAS			45 DAS			60 DAS		
	S1	**S2**	**X**	**S1**	**S2**	**X**	**S1**	**S2**	**X**
V0	26.75^{d}	33.25^{cd}	30^{c}	45.93^{c}	57.56^{bc}	51.75^{b}	69.5^{d}	101.75^{c}	85.63^{c}
V1a	42.125^{bcd}	52.5^{abc}	47.81^{ab}	74.42^{abc}	80.97^{ab}	77.7^{a}	107.63^{abc}	104.25^{bc}	105.94^{bc}
V1b	56.5^{ab}	64.5^{a}	60.5^{a}	92.28^{ab}	89.27^{ab}	89.78^{a}	121^{abc}	120.69^{abc}	120.84^{ab}
V2a	49^{abc}	50.5^{abc}	49.75^{ab}	78.72^{abc}	87.7^{ab}	83.21^{a}	106.88^{abc}	131.63^{abc}	119.25^{ab}
V2b	55.5^{ab}	49.37^{abc}	52.43^{ab}	90.96^{a}	86.4^{ab}	89.68^{a}	137.63^{a}	134.75^{ab}	136.19^{a}
V3a	44.5^{bcd}	52.25^{abc}	48.37^{ab}	79.51^{ab}	91.21^{a}	85.36^{a}	107.75^{abc}	134.69^{abc}	121.22^{ab}
V3b	41.1^{bcd}	41.3^{bcd}	41.15^{bc}	74.76^{abc}	75.13^{abc}	74.95^{ab}	114.25^{abc}	115.75^{abc}	115.00^{ab}
X	47.71^{a}	46.58^{a}		77.59^{a}	80.24^{a}		109.23^{a}	120.5^{a}	
LSD	19.40			33.3			32.00		
CV%	28.4%			29%			18.64%		

V0(Control),V1a(*Acacia leaves*),V1B (*Acacia Seeds*),V2a(*Cassia leaves*) V2b(Cassia Seeds) V3a(Prosopis leaves)V3b(Prosopis Seede), S1 (With Striga), S2 (Without Striga

4.2.1.2. Number of leaves/plants

Statistical analysis showed that there were significant different in 30 DAS and 45 DAS in interaction among striga application and allelopathy effects of the three plants only at 30 DAS and 45 DAS, At 30 DAS the heights number of leaves/plant is V1b in S1 7.65 and S2 7.78 L/P (leaves/plant) and the lowest leaves number/plant is V0 in S1 5.62 and S2 5.5leaves/plant (**Table 3**). At 45 DAS, the heights number of leaves/plant is V1a in S1 8.12 leave/plant and V3a (Prosopis seeds) in S2 8.75.Among treatments obtained there were significant difference and no significant among interactions at 30, 45 and 60 DAS (**Table 3**).

4.2.1.3. Chlorophyll content of Sorghum/ plant

The results showed that in chlorophyll content of plant at 30, 45 and 60 had no significant different between treatments. At 30 DAS no significant different between S1 and S2 at 30, 45 and 60 but in 45 DAS and 60 DAS obtained significant different were clearly noticed and S2 is the greatest value of chlorophyll content. At 30 DAS, the greatest value in S1 is V3b (25.22) and S2 is V1b 30.6 and the control (V0) is lowest chlorophyll content S1 (18.7) and S2 (18.42) (Table 3). At 45 DAS the greatest value of chlorophyll content showed in S2 V1b (47.8) and in S1 V3b (38.48) and V0 is the lowest chlorophyll content S1 (26.3) S2 (22.32) (Table 3). At 60 DAS the heights value of chlorophyll content is S1 V3b (43.05) and S2 V2a (45.95), the lowest in V0 S1 (25.7) and S2 (33.2). Over all treatments control is the lowest value obtained at 30, 45 and 60 DAS (**Table 2**).

Table4.3. Allelophathy effects of different plants powder (*Acacia nilotica*, *Cassia angustifolia*, *Prosopis spp*) on Sorghum number of leaves/plant.

Number of leaves/Plant									
Days After Sowing (DAS)									
Treatment	30 DAS			45 DAS			60 DAS		
	S1	**S2**	**X**	**S1**	**S2**	**X**	**S1**	**S2**	**X**
V0	5.62^{cd}	5.5^{d}	5.56^{c}	7^{ab}	6.12^{b}	6.56^{a}	6.5^{a}	6.5^{a}	6.93^{a}
V1a	7.25^{ab}	6.75^{abcd}	7^{ab}	8.12^{a}	7.5^{ab}	7.81^{a}	7.62^{a}	6.87^{a}	7.25^{a}
V1b	7.62^{ab}	7.78^{a}	7.75^{a}	7.75^{ab}	7.75^{ab}	7.37^{a}	7.37^{a}	6.62^{a}	7.00^{a}
V2a	7.25^{ab}	7.12^{abc}	7.18^{ab}	7.12^{ab}	8.12^{a}	7.62^{a}	6.87^{a}	7.37^{a}	7.12^{a}
V2b	7.00^{abcd}	7.37^{ab}	7.18^{ab}	7.12^{ab}	8.12^{a}	7.62^{a}	7.25^{a}	7.25^{a}	6.87^{a}
V3a	6.6^{abcd}	7^{abcd}	6.81^{ab}	7.87^{ab}	8.25^{a}	8.06^{a}	7.37^{a}	6.87^{a}	7.12^{a}
V3b	6.5^{abcd}	6.25^{bcd}	6.37^{bc}	7.87^{ab}	7.37^{b}	7.12^{a}	7.25^{a}	6.62^{a}	6.87^{a}
X	6.8^{a}			7.55^{a}	7.60^{ab}		22.2^{a}	23.13^{a}	
LSD	1.55			1.51			1.29		
CV%	15.62%			14.49%			13.26%		

V0(Control),V1a(*Acacia leaves*),V1B (*Acacia Seeds*),V2a(*Cassia leaves*) V2b(Cassia Seeds) V3a(Prosopis leaves)V3b(Prosopis Seede), S1 (With Striga), S2(Without Striga).

Table4.4. Allelophathy effects of different plants powder (*Acacia nilotica*, *Cassia angustifolia*, *Prosopis spp*) on Chlorophyll content of sorghum.

Chlorophyll content/plant									
Days After Sowing (DAS)									
Treatment	30 DAS			45 DAS			60 DAS		
	S1	**S2**	**X**	**S1**	**S2**	**X**	**S1**	**S2**	**X**
V0	**17.7^{bcd}**	**18.42^{cd}**	**18.06^{bc}**	**26.3^{d}**	**32.22^{bcd}**	**29.26^{b}**	**25.07^{c}**	**38.20^{abc}**	**31.637^{b}**
V1a	**19.95^{bcd}**	**19.22^{bcd}**	**18.58^{c}**	**33.92^{bcd}**	**37.16^{abcd}**	**35.54^{ab}**	**34.77^{abc}**	**39.65^{ab}**	**37.063^{ab}**
V1b	**23.9^{abcd}**	**30.6^{a}**	**27.25^{a}**	**30.62^{bcd}**	**47.8^{a}**	**39.21^{a}**	**35.60^{abc}**	**42.62^{a}**	**39.112^{ab}**
V2a	**23.65^{bcd}**	**23.9^{abcd}**	**23.77^{ab}**	**37.62^{abcd}**	**37.46^{abcd}**	**37.54^{a}**	**40.12^{ab}**	**45.95^{a}**	**43.038^{a}**
V2b	**22.95^{bcd}**	**24.25^{abcd}**	**23.6^{ab}**	**28.6^{cd}**	**40.61^{ab}**	**34.60^{ab}**	**27.77^{bc}**	**43.02^{a}**	**35.40^{ab}**
V3a	**22.02^{bcd}**	**25.15^{abc}**	**23.58^{ab}**	**35.55^{bcd}**	**40.56^{ab}**	**38.05^{a}**	**37.27^{abc}**	**43.32^{a}**	**40.30^{ab}**
V3b	**25.22^{ab}**	**20.4^{bcd}**	**22.81^{abc}**	**38.48^{abc}**	**32.23^{bcd}**	**35.36^{ab}**	**43.05^{a}**	**33.40^{abc}**	**37.725^{ab}**
X	**22.2^{a}**	**23.13^{a}**		**33.01^{a}**	**38.29^{b}**		**34.66^{a}**	**40.83^{b}**	
LSD	**6.8**			**11.8**			**13.3**		
CV%	**20.77%**			**22.86%**			**25.6%**		

V0(Control),V1a(*Acacia leaves*),V1B (*Acacia Seeds*),V2a(*Cassia leaves*) V2b(*Cassia* Seeds) V3a(*Prosopis* leaves)V3b(*Prosopis* Seede), S1 (With Striga), S2(Without Striga).

4.2.1.4. Sorghum shoots fresh weight (g)

Statistical analysis showed that there were significant different between treatments and their interactions in highly shoots fresh weight but no significant different between S1and S2. The heights fresh weight obtained in treated by V1a (Acacia leaves), 222.25g in S1 and the heights fresh weight in S2 is V3a 227g and the lowest value of fresh weight is in V0 80g S1 and 175g S2 (**Table 5**).

4.2.1.5. Sorghum shoots dry weight (g)

Statistical analysis showed that there were significant different between treatments and their interactions in Sorghum shoots dry weight but no significant different between S1and S2. The heights dry weight obtained in treated by V1a (Acacia leaves), 104.5g in S1 and the heights dry weight in S2 is V3a 106.5g and the lowest value of dry weight is in V0 36.5g S1 and 70.75g S2 (**Table 5**).

Table4.5 Allelophathy effects of different plants powder (*Acacia nilotica*, *Cassia angustifolia*, *Prosopis spp*) on fresh and dry weight (g) of sorghum shoot.

Tre	Shoot fresh weight(g)/plant			Shoot dry weight(g)/plant		
	S1	S2	X	S1	S2	X
V0	80^{c}	153^{ab}	126^{b}	36.5^{b}	59.75^{ab}	48.12^{a}
V1a	149.25^{ab}	175^{ab}	151.1^{ab}	65.25^{ab}	70.5^{ab}	67.87^{a}
V1b	222.25^{a}	227^{a}	224.63^{a}	84.75^{ab}	91.25^{a}	88^{a}
V2a	193^{ab}	216.75^{a}	204.88^{ab}	80.5^{ab}	78.5^{ab}	84^{a}
V2b	140^{ab}	251a	195.5^{ab}	56.25^{ab}	106.5^{a}	81.3^{a}
V3a	171.75^{ab}	187.75^{ab}	179.75^{ab}	68.7^{ab}	78.25^{ab}	73.5^{a}
V3b	205.25^{a}	209.25^{a}	207.25^{ab}	104.5^{a}	68.25^{ab}	86.37^{a}
X	165.93^{a}	202.39^{b}		70.93^{a}	80.29^{b}	
LSD	84.59			37.47		
CV%	45.31%			48.75%		

V0(Control),V1a(*Acacia leaves*),V1B (*Acacia Seeds*),V2a(*Cassia leaves*) V2b(Cassia Seeds) V3a(Prosopis leaves)V3b(Prosopis Seede), S1 (With Striga), S2(Without Striga).

4.2.1.6. Sorghum root fresh weight (g)

Statistical analysis showed that there were significant different between treatments and their interactions in Sorghum roots fresh weight but no significant different between S1and S2. The greatest roots fresh weight obtained in treated by V1a (Acacia leaves), 151.25g in S1 and the greatest amount of fresh weight in S2 is V3a 140.5g and the lowest value of fresh weight is in V0 70.5g S1 and 85g S2 (Table 5).

4.2.1.7. Sorghum root dry weight (g)

Statistical analysis showed that there were significant different between treatments and their interactions in Sorghum dry weight but no significant different between S1and S2. The greatest root dry weight obtained in treated by V1b (Acacia leaves), 47.6g in S1 and the heights dry weight in S2 is V3a 36g and the lowest value of dry weight is in V0 18.2g S1 and 26.25g S2 (Table 5).

Table4.6. Allelophathy effects of different plants powder (*Acacia nilotica*, *Cassia angustifolia*, *Prosopissp*) on fresh and dry weight (g) of sorghum root.

Tre	**Root fresh weight(g)/plant**			**Root dry weight(g)/plant**		
	S1	**S2**	**X**	**S1**	**S2**	**X**
V0	70.5^{d}	85^{bcd}	77.75^{b}	18.2^{a}	22.25^{b}	20.22^{a}
V1a	112.5^{abcd}	135^{abc}	123.75^{a}	34.2^{ab}	35.5A^{b}	34.85^{a}
V1b	151.25^{a}	111.5^{abcd}	131 38^{a}	47.6^{a}	23.25^{b}	35.42^{a}
V2a	120.5^{abcd}	85.25^{bcd}	102.88 ^{a}	33^{ab}	26.25^{b}	29 .62^{a}
V2b	74.75^{cd}	104.25^{abcd}	90^{ab}	20.8^{b}	26.2^{b}	23.52 ^{a}
V3a	115.75^{abcd}	140.5^{ab}	128.13^{a}	34.6^{ab}	36a^{b}	35.3^{a}
V3b	95^{abcd}	106.5^{abcd}	100.75^{ab}	27.8^{b}	24.5^{b}	26.15^{a}
X	105.75^{a}	109.86^{a}		30.88^{a}	27.71^{a}	
LSD	44.79			13.68		
CV%	39.31%			45.16%		

V0(Control),V1a(*Acacia leaves*),V1B (*Acacia Seeds*),V2a(*Cassia leaves*) V2b(Cassia Seeds) V3a(Prosopis leaves)V3b(Prosopis Seede), S1 (With Striga), S2(Without Striga).

4.2.2. Allelophathy effects of leaves and seeds of (Acacia, Cassia and Prospis) on Striga emergence/pot.

At 30 DAS, 45 DAS and 60 DAS statistical analysis showed highly significant differences at ($p < 0.05$) in number of striga emergence/pot between treatments. (Table 4.2) Striga count made 30, 45 and 60 DAS showed that striga emergence on treatments. At 60 DAS, treated sorghum with V1a, V2a, V3a and V3b reduced striga emergemce, but not significantly by 30.8, 84.6, 57.7 and 61.5% respectively, as compareson to untreated control (Table 4.2). However V1b and V2b decreased number of striga to 5 and 4.5 plant/pot.

Table 4.7 Allelophathy effects of different plants (*Acacia nilotica*, *Cassia angustifolia*, *Prosopis spp*) on Striga emergence/pot.

Striga emergence/pot			
Days After Sowing(DAS)			
Treatment	**30 DAS**	**45 DAS**	**60 DAS**
V0	**2.5^{a}**	**5.25^{a}**	**6.50^{a}**
V1a	**1.45^{ab}**	**1.75^{ab}**	**2.00^{ab}**
V1b	**2.5^{a}**	**4.50^{ab}**	**5.00^{ab}**
V2a	**1.00^{b}**	**1.00^{a}**	**1.00^{a}**
V2b	**2.25^{ab}**	**4.00^{ab}**	**4.50^{ab}**
V3a	**1.00^{ab}**	**2.25^{ab}**	**2.75^{ab}**
V3b	**0.75^{ab}**	**2.50^{ab}**	**2.50^{ab}**
X	**1.46^{a}**	**1.73^{a}**	**1.9^{a}**
LSD	**2.101**	**2.101**	**2.101**
CV%	**62.19%**	**88.75%**	**86.99%**

V0(Control),V1a(*Acacia leaves*),V1B (*Acacia Seeds*),V2a(*Cassia leaves*) V2b(*Cassia* Seeds) V3a(*Prosopis* leaves)V3b(*Prosopis* Seeds), S1 (With Striga), S2 (Without Striga), DAS (Days After Sowing).

4.2.2.2. Striga fresh and weight (g)

Statistical analysis showed that there were significant different between treatments and the control.

Statistical analysis showed that there were significant different between treatments and the control. The heights dry weight obtained in treated by V1a (Acacia leaves), 3.35g and the lowest value of Striga dry weight is in V0 1g (Table 4.7). However, the observed increament considerable (8.32 and 9.2%).

Table 4.8.Allelophathy effects of different plants powder (*Acacia nilotica*, *Cassia angustifolia*, *Prosopis spp*) on striga fresh and dry weight/pot

Treatment	**Striga fresh weight(g)/pot**	**Striga dry weight(g)/pot**
V0	**4.00**^{b}	**1.95**^{ab}
V1a	**8.325**^{a}	**3.00**^{ab}
V1b	**9.200**^{a}	**3.35**^{a}
V2a	**5.325**^{a}	**1.40**^{ab}
V2b	**5.525**^{a}	**1.100**^{ab}
V3a	**4.275**^{a}	**0.825**^{ab}
V3b	**5.125**^{a}	**0.800**^{ab}
X	**5.96**^{a}	**1.49**^{ab}
LSD	**14.63**	**3.28**
CV%	**149.47%**	**100.24%**

V0(Contol),V1a(*Acacia leaves*),V1B (*Acacia Seeds*),V2a(*Cassia leaves*) V2b(*Cassia* Seeds) V3a(*Prosopis* leaves)V3b(*Prosopis* Seeds), S1 (With Striga), S2(Without Striga).

CHAPTER FIVE

Discussion

Sorghum (*sorghum bicolor L. Mench*) is an important crop in Sudanese economy and diet. The area under the crop is increasing but average yield are, invariably, low. The low yields are attributed, among other factors, to heavy infestations by the root parasitic weed *Striga hermonthica*. Researches yield several control measures however; most of them are not adapted because of erratic performance or high cost. An integrated approach, in which biological control is deployed as a component is imperative.

Obligate parasitic plant witchweed (*striga spp*) infects major cereal crops such as sorghum, maize and millet and is the most devastating weed pest. An understanding the nature of its parasitism would contribute to the development of more sophisticated management methods. Striga research in Africa has a long history and a range of effective component control technologies has been identified (Parker and Riches 1993).Examples of control options for striga hermonthica range from the use of leguminous trap crops to stimulate suicidal germination of striga seeds and therefore reduce the seed bank and improve soil fertility, to the use of resistant host-crop cultivars.

The results showed that the allelopathy of the nine plants completely inhibited or stimulanted striga seed germination, some are stimulants and the others are inhibiters. However, they significantly reduced percentage of striga seeds germination in comparison to the untreated control. The Striga seeds germination after 24 and 48 hours showed significant different between control and treatments. The heights germination value after 24 hours is (52.3%) and (63.3%) after 48 hours in (GR24), but Striga additioned strilied distilled water is not germinate. There were highly significant different between treatments. At 24 hours the heights percentage of Striga germination stimulants obtained in V2b (Cassia leaves) 13.66% and V2a (Cassia seeds) 12% and the heights radical length in V2b (Cassia leaves) 1.13cm and V2a (Cassia seeds) 1.06cm. The compeletely inhibited treatments in germination were V6b (Calotropis leaves) o.o and V8a (Ammi visnaga seeds) 0.0 in the radical length were V8b (Ammi visnaga leaves) 0 and V9b (Citrullus leaves) 0**.** At 48 hours the heights percentage of Striga germination stimulants obtained in V2a (Cassia seeds) 20.33%, V2b (Cassia leaves) 15.33% and the heights radical length in V2a (Cassia seeds) 1.83cm and V2b (Cassia leaves) 1.16cm. The compeletely inhibited treatments in germination were V8b () o.o and in the radical length were V5b () 0 and V8b () 0. Some treatments act as stimulants such as *Cassia angustifolia* 50%, Acacia nilotica 50% and Prosopis spp 50%. The treatments act as inhibiters such as Ammi visnagal 100%, Calotrops procera100% Lupines termis L. 100%, *Acacia 100%***.** According to the above results alellopathy of different plants had appeared clearly on striga germination and radical length. Azizi *et al*., (2011) reported that extracts and different parts of *fenugreek* had the stimulating effect in low concentration and inhibition effect in higher concentration on several crops and parasitic weeds. Sesban leaves and Cassia angustifolia leaves have been reported to stimulate S. hermonthica seed germination (Kwesiga and Berniest, 1998). Francis *et al*, 1986 Hullungale 1988 and Tejeda *et al*., 2004) Suryawanshi et al. (2011) reported that Cassia angustifolia leaves produced higher total dry matter (1154 kg ha-1) in sorghum than Parthenium hytrophorus.

The performance of the test crop (Sorghum) was significantly affected by the application of different forms of *Cassia angustifolia*, freshly crushed improved the growth performance of sorghum and striga emergence, which is related to the assertions by Bhuma *et al*. (2001) who reported that cassia have some growth promoting capability apart from its nutrient content and this results obtained were in accordance to this results agree to the findings of Chamle (2007) who reported leafy powder Cassia leave having the capability of improving the growth performance of Sorghum, due to better uptake of nutrients from the soil. According to Mathaura (2010), cassia leaves can lead to increase in the growth of root, stem and leaf which will result in better crop yield.

Water extracts from *Acacia* angustifolia (leaves) at the dose 5% and from *Chrysanthellum americanum* (leaves+stalks) at the dose 10% weakly stimulated *Striga* germination by 3.2 and 8.3%, respectively Ma *et al*. (2004).

The stimulation of *S. hermonthica* seed germination, only 1% water extracts from *Ceiba pentandra* (bark) and *Eucalyptus camaldulensis* (leaves) significantly induced *Striga* seed germination with sorghum. Present results are similar to that of Ma *et al*. (2004), who used Chinese plants. The evaluation of Chinese traditional plants revealed that distilled water and methanol extracts of 26 and 22 species, respectively, stimulated the germination of *S. hermonthica* (Ma *et al*., 2004). In this perspective, Tsanuo *et al*. (2003) managed to isolate an isoflavanone from *Desmodium uncinatum*. Which induced *S. hermonthica* seeds germination? Stimulants of *Striga* germination cannot induce germination at high doses as oppose to low doses (Siame *et al*., 1993; Yasuda *et al*., 2003).

Allelopathy effect of leaves and seeds of three plants on plant height, leaves number/plant, chlorophyll conten,fresh and dry weigh, root fresh and dry weight of sorghum growth showed no significant difference among striga and non striga plant significant, in all reading. Sighnificant differences obtain in different growth reading at 30, 45 and 60 days after sowing (DAS) among all treatments and their interactions. In general Acacia leaves displayed the highest value (V1a), and prossopis seeds (V3b). And the control is shortest value. The performance of the test crop Sorghum was significantly affected by the application of different forms of Cassia angustifolia, freshly crushed improved the growth performance of sorghum and Striga emergence, which is related to the assertions by Bhuma *et al*. (2001) who reported that Cassia have some growth promoting capability apart from its nutrient content and this results obtained were in accordance this results agree to the findings of Chamle (2007) who reported leafy powder Cassia leave having the capability of improving the growth performance of Sorghum, due to better uptake of nutrients from the soil. According to Mathaura (2010), cassia leaves can lead to increase in the growth of root, stem and leaf which will result in better crop yield.

Striga emergence / pots, treated with stiga revealed significant diffence, in 30, 45 and 60 days after sopwing the highest number obtained in, V3b (Prospers leaves), V2a (Cassia leaves) and V2a (Cassia seeds) respectively. It is fresh and dry weight in pots clearly shown in treatment of V1a (Acacia leaves). Tsanuo *et al*. (2003) managed to isolate an isoflavanone (uncinanone B) from *Desmodium uncinatum* (Jacq.) DC.which induced *S. hermonthica* seeds germination.

Conclusions

Growing Sorghum with *Cassia angustifolia*, *Acacia nilotica* and *Prosopis* spp (leaves and seeds) increased Sorghum growth and inhibied Striga emergence.

The allelopathy effects of different nine plants effectively some were induced Striga seeds germination and some plants suppressed and reduced Striga emergence.

Used different concentrations from different plants had clear effects on striga seeds germination. Addition of 50% concentration of plant extract displayed positive effect (stimulate) of striga germination than 100% concentration. It is negative affected (inhibited).

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APPENDICES

Analyses of variance (ANOVA) Table on plant height leaves number and chlorophyll content/plant during growth of sorghum (Sorghum bicolor) in invasion.

Source	D.F	**F. Value**								
		PH1	PH2	PH3	LN1	LN2	LN3	Ch1	Ch2	Ch3
Rep	3	-	-	-	-	-	-	-	-	-
Strata	1	0.07ns	0.13ns	1.77ns	0.00**	2.45ns	4.27ns	0.46ns	4.14ns	57.57**
Error A	3	-	-	-	-	-	-	-	-	-
Tre	6	4.05**	2.67**	4.32**	3.44**	0.62ns	0.19ns	3.22*	1.28ns	1.14ns
SXT	6	0.53**	0.25ns	1.10ns	0.20ns	1.58ns	0.96ns	1.16ns	1.78ns	1.26ns
Error B	36	-	-	-	-	-	-	-	-	-
Total	55	-	-	-	-	-	-	-	-	-
C.V	-	28.40	29.00	18.64	15.62	14.49	13.26	20.77	22.86	25.60
E.M.S	-	179.263	523.63	458.41	1.14	1.2068	0.867	22.16	66.461	93.385

*= significant
**= High significant
Ns= Non-significant

Analysis of variance (ANOVA). Table of sorghum shoots and roots fresh and dry weight (g) during growth of Sorghum (Sorghum bicolor) in invasion.

SOV	DF	F. value			
		Shoots fresh weight	Shoots dry weight	Roots fresh weight	Roots dry weight
Rep	3	-	-	-	-
Striga	1	2.65ns	0.96ns	0.36ns	1.57ns
Error A	3	-	-	-	-
Tre	6	1.38ns	1.01ns	1.72ns	1.47ns
SXT	6	0.59ns	1.13ns	0.87ns	1.37ns
Error B	36	-	-	-	-
Total	55	-	-	-	-
C.V	-	45.30	48.44	40.98	46.07
E.M.S	-	6958.9	1365.92	1951.32	182.213

*=significant

**=High significant

NS=Non- significant

Analyses of variance (ANOVA) Table of striga emergence/pot and striga fresh and dry weight (g).

SOV	D.F	F. value				
		Striga emergence/pot			Striga weight	
		30 DAS	45 DAS	60DAS	S. fresh weight	S. Dry weight
Rep	3	-	-	-	-	-
Tre	6	1.36ns	1.09ns	1.30ns	1.30ns	1.23ns
Error	18	-	-	-	-	-
Total	27	-	-	-	-	-
C.V	-	113.98	119.55	114.10	164.98	147.79
E.M.S	-	2.785	11.960	14.361	96.938	4.890

*=significant

**=High significant

NS=Non-significant

Analysis of variance (ANOVA). Table of striga germination rate and radical length after 24 hours and after 48 hours in the laboratory experiment.

SOV	D.F	F. value			
		Germination 24 hours	Germination 48 hours	Radical length 24 hours	Radical length 48 hours
Rep	3	1.02ns	0.79ns	5.46**	6.34**
Tre	6	35.82**	38.97**	15.90**	24.70**
Error	18	-	-	-	-
Total	27	-	-	-	-
C.V	-	67.05	56.62	42.29	29.52
E.M.S	-	11.541	15.410	0.0515	0.068

*=significant

**=High significant

NS=Non-significant

Plate No I Germination of striga seeds at 50% Cassia extract

Plate No 2 Germination of striga seeds at 50% Acacia extract

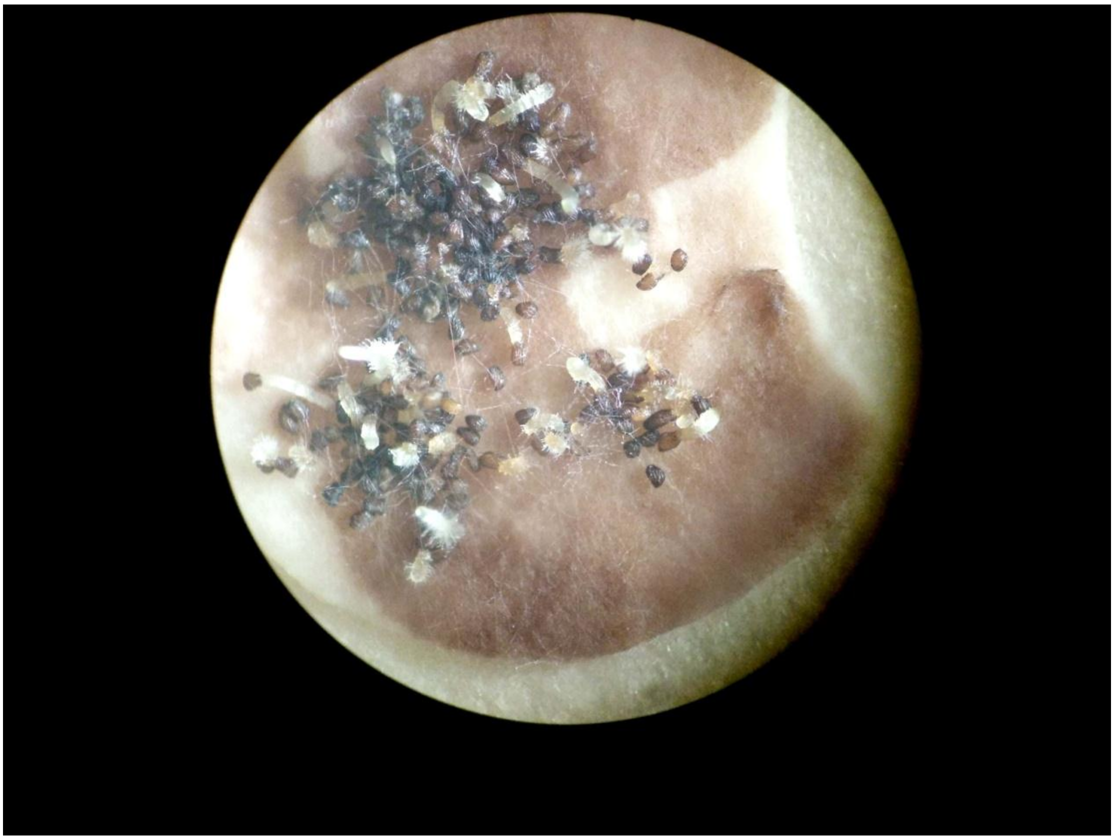

Plate No 3 Germination of striga seeds at 50% Prosopis extract

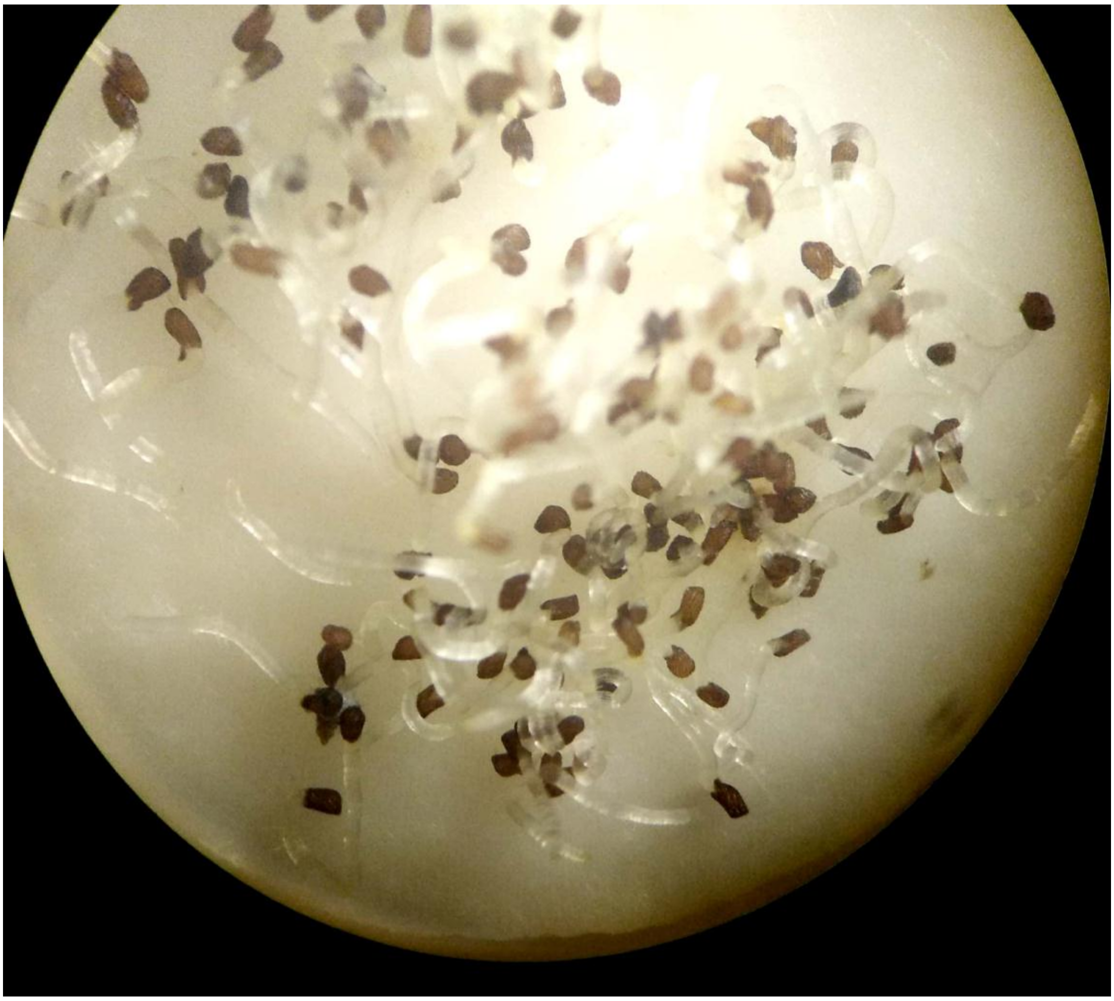

Plate No 4 Germination of striga seeds by GR24

Plate No 5 Sorghum growths with striga hermonthica treated by Acacia nilotica powder.

Plate No 5 Sorghum growths with striga hermonthica treated by Cassia angustifolia powder.