Effect of *Alectra vogelii* (Benth) Aqueous Extract on the Growth of Cowpea [*Vigna unguiculata* (L.) Walp] Varieties

BY

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DECLARATION

I declared that the work in thisDissertation entitled "Effect of *Alectra vogelii* (Benth) Aqueous Extract on the Growth of Cowpea (*Vigna unguiculata* (L.) Walp) Varieties" has been carried out by me in the Department of Biological Sciences, Faculty of Science, Ahmadu Bello University, Zariaunder the supervision of Professor S.O. Alonge and Dr. B.Y. Abubakar. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this project dissertation was previously presented for another degree or diploma in this or any other institution.

Basheer Abdullahi	**Signature**	**Date**

CERTIFICATION

This dissertation entitled“EFFECT OF *ALECTRA VOGELII*(BENTH) AQUEOUS EXTRACT ON THE GROWTH OFCOWPEA (*VIGNA UNGUICULATA*(L.) WALP) VARIETIES” by Basheer ABDULLAHI meets the regulations governing the Award of the Degree of Master of Science in Educational Biology, Ahmadu Bello University, Zaria and is approved for its contributions to knowledge and literary presentation.

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DEDICATION

I Basheer Abdullahi Rabah the author of this dissertation dedicated the write-up to my late father Alh. Abdullahi Bashiru Rabah and my lovely mother Hajia Safiyya Abubakar Atiku, my step mother Hajia Fatima Ibrahim, and my entire brothers and sisters. Finally, my dear wife Badiyya Murtada and my lovely son Abdulrahman.

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ABSTRACT

Experimentswere conducted to evaluate the effect of *Alectra vogelii* (Benth) aqueous extract on the growth of cowpea (*Vigna unguiculata* (L.) Walp) varieties. The laboratory screening experiment was conducted at the Deparment of Biological Sciences and the pot experiment was carried out at the Institute for Agricultural Research, Ahmadu Bell Univesity, Zaria. The qualitative and quantitative phytochemical screening of *Alectra vogelii* plants was conducted at National Research Institute and Chemical Technology, Zaria. The physico-chemical analysis of the soil used was carried out in the Department of Soil Science, Faculty of Agriculture, Ahmadu Bello University, Zaria. In the laboratory screening the effects of *Alectra vogelii*aqueous extract was evaluated at 0, 25, 50, 75 and 100 g/l. The parameters taken in the laboratory experiment include seed germination on daily basis for 10 days, shoot and root length (cm) and seedlings weight (g) of cowpea were taken 10 day after planting. In the pot experiment 0, 50, 100, 150 and 200 g/l of *Alectra vogelii* aqueous extract was tested. Parameters taken in the pot experiment include the number of leaves, plant height (cm), number of root nodules, shoot and root fresh and dry weight (g) of the cowpea at 5, 7 and 9 weeks after planting. The phytochemical composition of *Alectra vogelii* plant showed the presence of saponins with the highest percentage (46.50 %), followed by flavonoids (16.04 %), tannins (0.247 %), cyanogenic glycosides (0.212 %) and the least was alkaloids (0.08 %). *Alectra vogelii* aqueous extract at 25-100 g/l significantly reduced cowpea seeds germination, root and shoot lengths and seedling weight at 10 days afteqar planting in the laboratory screening test in all the cowpea varieties. In the pot experiment, *Alectra vogelii*aqueous extract treatments at 50 - 200 g/l reduced significantly all the growth parameters (root and shoot fresh and dry weight, plant height, number of leaves and root nodules) in cowpea varieties compared with the control. This reduction was concentration dependent and was highest at 200 g/l *Alectra* extract treatment. In some occasions, growth values under 50 g/l *Alectra* extract was comparable with that of the control and also that under 150 g/l comparable with that of 200 g/l *Alectra* extract treatment. In conclusion, the laboratory and pot experiments showed that,*Alectra vogelii*aqueous extract reduced seed germination and all the growth parameters of cowpea varieties. Therefore, it is necessary to remove *Alectra vogelii* residues from farms as they can inhibit the germination and growth of cowpea due to the allelochemicals that*Alectra vogelii* plant contains.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Classification of Cowpea

Cowpea (*Vigna unguiculata* (L.) Walp) It belongs to the Family Fabaceae, sub-family Faboiceae (Papillionoideae), Order Fabales, Genus *Vigna*, and Species*unguiculata*Ogunkanmi *et al*. (2006). It was reported by Karanja*et al*. (2010) that*unguiculata*is a Latin word for "with a small claw", which reflect the small stalks on the flower petals.All cultivated cowpeas are found within the universally accepted *Vigna unguiculata*, subspecies *unguiculata* classification, which is then commonly divided into four cultivar groups:*unguiculata*, biflora, textilis and *sesquipedalis* (Tarawali *et al*., 2002). Some of the common names for cultivated cowpeas include black-eye pea, southern pea,yard long bean, cat jang and crowder peas (Singh, 2004).

The first written reference using cowpea appeared in 1798 in USA (Rubiales *et al*., 2006).The name was most likely acquired due to their being used as fodder for cows (Ajeigbe, 2003).The common name for black-eye pea used for the *unguiculata* cultivar group, described the presence of the distinctive black spot at the hilum of the seeds. *Sesquipedalis* in Latin means "foot and a half long", and this subspecies characterized by unusually long pods, leading to the common names of yard-long bean, asparagus bean and Chinese long-bean (Girma *et al*., 2005). In West Africa, the plant is named 'niebe' (Igbo), 'wake' (Hausa) or 'ewa' (Yoruba).

1.2 History of Cowpea

The center of diversity of the cultivated cowpea is West Africa,leading to the current agreement that, this is likely the center of origin and place of early domestication(Ogunkanmi *et al*., 2006). In 2300 BC, cowpea is believed to make its way into south-east Asia where secondary domestication event mightoccur (Kamara*et al*., 2008).The first written reference to cowpea was in 300 BC and probably reached central and North America during slave trade from 17^{th} to early 19^{th} centuries(Carsky *et al.,* 2003)

The history of cowpea dates to ancient West African cereal farming, five to six thousand years ago, where it was closely associated with the cultivation of*Sorghum* and pearl millet in dry areas as intercrop (Rubiales, 2001).*Vigna unguiculata* is one of the most ancient human food source and has probably been used as a crop plant since Neolithic times (Van*et al*., 1997). A lack of archaeological evidence has resulted in contradicting views supporting Africa, Asia and South America as origin (Coulibaly *et al.,* 2002). According to Obadoni *et al.* (2000),some literature indicates that, cowpea was introduced from Africa to the Indian subcontinent approximately 2000 to 3500 years ago, at the same time as the introduction of *Sorghum*and millet, while others stated that, before 300 BC, cowpeas had reached Europe and possibly North Africa from Asia. Speculations are that, the Northern part of the Republic of South Africa (former Transvaal region) was the centre of speciation of *V. unguiculata*, owing to the presence of most primitive wild varieties (Kureh *et al*., 2005a). They further hypothesised that, the species moved northwards from the Transvaal to Mozambique and Tanzania, where the subspecies *Pubescens* evolved. Cowpea is now grown throughout the tropics and subtropics and has become a part of the diet of about 110 million people. Cowpea is believed to have originated from West Africa by

some workers, because both wild and cultivated species abound in the region (Kwaga, 2004). Others believe that it originated from Southern Africa. Its production has spread to East and Central Africa, India, Asia, South and Central America (MoAIFS, 2005).

1.3 Climatic and Soil Requirements of Cowpea

Cowpea is an important food security crop for over 43 million people in sub-Saharan Africa. It can be grown in stressful environments where many other crops fail, such as where rainfall is low, therefore cushioning farmers from its variability(Lagoke *et al.,* 1996b). It is also a nitrogen-fixing crop and contributes to improve soil fertility.

Cowpea on the other hand, can be grown under rain fed conditions as well as by using irrigation or residual moisture along river bank or lake flood plains during the dry season, provided that the range of minimum and maximum temperatures is between 28 and 30°C (night and day) during the growing season (ICRISAT/MAI, 2000). Cowpea performs well in agro ecological zones where the rainfall range is between 500 and 1200 mm/year. However, with the development of extra-early and early maturing cowpea varieties, the crop can thrive in the Sahel region where rainfall is less than 500 mm/year. It is tolerant of drought and well adapted to sandy and poor soils. However, best yields are obtained in well-drained sandy loam to clay loam soils with the pH between 6 and 7(Singh, 2006).

1.4 Production Level of Cowpea in the World

Most cowpeas are grown in the Africa continent, particularly in Nigeria and Niger Republic which together account for 72% of world cowpea production(Visser*et al*., 2004).It is estimated that the annual world cowpea crop is grown on 12.5 million ha, and the total grain production is 3.3 million tonnes annually, although only a small

proportion enters the international trade (IITA, 2001).About 64% that is produced in Africa, making it the leading cowpea producing region in the world, with estimated 3.3 million tonnes of cowpea seed produced annually. Nigeria is the world leading cowpea producing country with 37%, followed by Brazil with 29%. Other countries in Africa, including Niger republic, Senegal, Ghana, Mali, Burkina Faso and Cameroon are significant producers. The major production areas else where in the world are Asia (India, Myanmar) and the Americans (USA, Brazil, West Indies), and of the developed countries, only the USA is a substantial producer and exporter of cowpea (Singh and Ajeigbe, 2007). Cowpea is one of the mandate crops researched by the International Institute of Tropical Agriculture, Ibadan (IITA),(Fewsnet, 2007).

Singh *et al.* (2003) observed that, based on the available information from FAO and his personal correspondence with scientists in different countries, it is estimated that, globally cowpea is cultivated on about 14.5 million hectares with an annual production of over 4.5 million tonnes. However, the bulk of cowpea production comes from the drier regions of northern Nigeria (5 million ha and 2.3 million tonnes), Niger Republic (3 million ha and 0.4 million tonnes) and North East Brazil (about 1.9 million ha and 0.7 tonnes). In spite of its importance and wide cultivation, the overall productivity of cowpea is very low with an average yield particularly in Africa ranging from 100 to 400 kg/ha. This is due to several biotic, abiotic and physiological constraints.

Cowpea production was estimated at 2.7 million tonnes from 7.7 million ha. That not withstanding, based on information available from Food and Agricultural Organi-zation (IITA, 2004), it was estimated that more than 3.3 million tonnes of cowpeas wase produced worldwide in 2000 from at least 12.5 million/ ha. Its production is widely distributed throughout the tropics.However, West Africa accounted for more

than 64 % of the area with about 8 million/ ha, followed by about 2.4 million/ ha in Central and South America, 1.3 million/ ha in Asia and 0.80 million/ ha in EastAfrica (MoAIFS., 2008). The crop can be regarded as the fulcrum of sustainable farming in semi-arid lands. The area of cowpea production extends in a westerly direction from Cameroon through Senegal, lying mainly between 10°N and 15°N, covering the dry savannah (Northern Guinea and Sudan Savannahs) as well as Sahel zones. There are also a few additional pockets of production at more southerly latitudes, where the dry savannah agro-ecology penetrates closer into the West African coast, as in Ghana and Benin (IITA, 2003).

The amount of protein content of cowpea leafy parts consumed annually in Africa and Asia is equivalent to 5 millions tones of dry cowpea seeds, representing as much as 30% of the total food legumes production in the low land tropics (FOA, 2009).

1.5 Importance of Cowpea

Cowpea[*Vigna unguiculata* (L.) Walp] is one of the most important food legume crops in the semi-arid tropics covering Asia, Africa, Southern Europe and Central and Southern America. A drought tolerant and warm weather crop, cowpeas are well adopted to the drier regions of the tropics, where other food legumes fail or do not perform well. It also has the useful ability to fix the atmospheric nitrogen through its roots nodules and it grows well in poor soils with morethan 85% sand, and with less than 0.2% organic matter and low level of phosphorus(Kureh *et al*., 2005b). In addition, it is shade tolerance, so is compatible as an inter crop with maize, millet, *Sorghum*, sugar cane and cotton. This makes cowpea an important component of traditional inter cropping system, especially in the complex and elegant subsistence farming system of the dry savanna in sub Saharan Africa(Kureh *et al*., 2005a).In these system, the haulm (dried stalk)of cowpea is a valuable by-product used as animal

feeds. According to the USDA, food data base, the leaves of the cowpea plants have the highest percentage of calories from protein among vegetable foods(Omoigui *et al*., 2007).

Early maturing cowpea varieties provides the first food from the current harvest sooner than any other crop (in as few as 55 days after planting), thereby shortening the "hunger period" that often occurs just prior to harvest of the current season crop in farming communities in the developing world.

Cowpea is a major staple food crop in sub-Saharan Africa, especially in the dry savanna regions of West Africa. Cowpea is grown in rotation or mixed with cereals and tuber food crops, and also can be used as green manure or as cover crop in checking erosion (Dugje *etal.,*2009). The seeds are a major source of plant proteins and vitamins for man, livestock, and also a source of cash income. The young leaves and immature pods are eaten as vegetables. There exist a big market for the sale of cowpea grain and fodder in West Africa (IITA, I998). Farmers who cut and store cowpea fodder for sale at the peak of the dry season have been found to increase their annual income by 25 % (FAO, 2000). Cowpea also plays an important role in providing soil nitrogen to cereal crops (such as Maize, Millet, and Sorghum) when grown in rotation, especially in areas where poor soil fertility is a problem. It does not require a high rate of nitrogen fertilization; its roots have nodules in which soil bacteria,*Rhizobia* help to fix nitrogen from the air. IITA (2003) reported that, cowpea can be used at all stage of its growth as a vegetable crop, as spinach, snap beans, and the haulms are fed to livestock as a nutritious fodder.

Dry cowpea seeds are an important source of affordable protein, Vitamin. B, and minerals in the predominantly carbohydrate based diet of people in rural communities of Southern Africa (Riches *et al.,* 2002). Therefore, wider utilisation of cowpea in the

diet, presents a source of protein that is within the reach of most rural households, where protein-energy malnutrition remain a serious public health concern, with a 49% prevalence of stunting of children under five years of age (Singh and Ajeigbe, 2000). Inadequate in-take of protein in the diet is one of the factors that contribute to such high prevalence of malnutrition in developing countries (Joel, 2000).

1.6 Problem of Cowpea Production in Africa

In Africa, cowpea growth and yield are greatly reduced by a variety of bioticand abiotic factors (Omoigui *et al.*, 2012). The abiotic factors include erratic rainfall, high soil temperature, and low soil fertility. The biotic factors are insect pests, parasitic weeds such as *Alectra*, and diseases caused by various organisms such as bacteria, fungi, viruses and nematodes. Parasitic weeds such as *Alectra vogelii* constitute serious bottle neck in cowpea production resulting in low yield of cowpea and this is serious constraint to production (Obadoni *et al*., 2000).

A parasitic weed *Alectra vogelii* (Benth) commonly known as "Witchweed", is an obligate root-parasitic flowering plant of the family Scrophulariaceae, one of the major concerns in lowering cowpea growth.*Alectra vogelii* infestation greatly reduced the root and shoot dry weight of most cowpea varieties.Magani (1991) reported that *A. vogelii* problem is becoming more acute in sub-Saharan Africa as a result of increasing populations leading to intensified farming, shortening of the fallow period, deteriorating soil fertility, expansion of production land into marginal areas with little use of external inputs, and the increasing popularity of monoculture in place of traditional crop rotation and intercropping systems. Small-scale farmers suffer the most from parasitic weeds because they cannot afford to buy inputs and have little flexibility in their cropping system (Kabambe *et al*., 2008). *Alectra vogelii* plant is difficult to control as it produce thousands of small and light seeds per plant that are

easily and widely dispersed by wind, water, animals, and agricultural implements. Their seeds can lie dormant but still potentially active in the soil for many years. The germination of *Alectra vogelii* seeds takes about two days,*Alectra vogelii* has its greatest impact in low-input subsistence farming system, where farmers fields have being blighted (Alonge, 2000). When the flowers are in bloom, the plant is already firmly entrenched and thus above ground herbicide is ineffective as the damage occurs long before the weed is visible (Rambakudzibga *et al.*, 2002).In a study carried out between 1994 and 1995 to investigate cowpea reactions to *Striga gesnerioides*, it wasobserved that, irrespective of the sowing dates, there was greater reduction in the leaf area and root nodules of the susceptible than the resistance cowpea varieties (Alonge and Lagoke, 2002). Furthermore, the researchers observed that, *Striga gesnerioides* infestation reduced root nodulation and shoot dry weight of a host of cowpea varieties, especially in the late planted varieties (Alonge*et al.*,2001b).

Damage is inflicted on food and fodder plants by the parasitic members of family Scrophulariaceae. Among these are: *Alectra vogelii* and *Striga gesnerioides* which occur in West Africa, as serious pests of cowpea. These parasites divert the host nutrient into themselves through the haustorium that established contact with xylem and phloem tissues of the host (Karanja, 2009). Therefore, competition for water, organic ions and metabolites is the simplest explanation for losses in host production (Stewart and Press1990). The competitive success of theweedis usually ascribed to having a greater osmotic pressure than its host (Xie *et al*., 2008). According to Beck (2001), the osmotic potential was higher in both leaf and root of *Striga* than the leaf and root of *Sorghum*.

Alonge and Lagoke (2002) observed lower concentrations of nitrogen and phosphorus in the leaves of*Striga* and *Alectra*weed infected cowpea plants compared to the control plants, although, the differences were not significant. However, Kamara *et al.* (2007) reported no differences in leaf N concentration between *Striga*-infected and uninfected plants of *Sorghum*. Kwaga *et al*. (2004) reported that, *S. gesnerioides* was highly dependent on its host for carbon as well as for water and inorganic solutes. It was estimated that, 70% of the carbon transferred from host to parasite was used in respiration of parasites. Infected cowpea had a lower photosynthetic capacity. The loss of carbon from the host by export to parasite is more important than reduced photosynthetic capacity of the host accounting for the observed growth reduction. Lucky *et al.* (2012) found that, *Sorghum* on which there is a growing parasite accumulate less nitrogen from the soil than did non-parasitized *Sorghum.* However, they found that the parasite accumulated more N than did the host shoots per gramme on dry weight basis. Very little has been done in the tropics on the effect of *Striga* and *Alectra* infestation on cowpea seeds mineral element composition despite their devastating effects on cowpea crop production.

1.7 Statement of the ResearchProblem

*Alectra vogelii*and related parasitic weedsare presently among the most important biological constraints to food production in Africa. *Alectravogelii* can be a very serious parasite of cowpea causing chlorosis and then severe wilting and necrotic lesions. According to Alonge *et al.*(2001a), host plant growth and productivity was negatively affected by lower rates of photosynthesis, increased respiration, altered assimilate partitioning and early senescence of leaves of crop plants, that often collapse under drought stress leading to complete crop failure.

Thus, this makes the control of the parasite difficult.Moreover, each plant can produce up to half a million seeds that can remain dormant in the soil for decades (Kureh *et al.,* 2005b). The dormancy and intimate physiological interaction with the host plant are the main constrains that limit the development of successful measures that can be accepted and used by the subsistence farmers (Kroschel, 2001). Also, there is continuous deterioration in crop productivity year after year on field infested by these parasites. It is being suspected that, trace amount of unidentified organic compounds might be exported from the parasite to the host (Singh and Ajeigbe. 2000). This postulation suggests that, the devastating effect of *Alectra* species cannot be accounted for by the removal of host plant resources alone (Alonge *et al*., 2002). The production of toxic compounds by the parasite can also cause detrimental effect, which is an important ecological factor in plant species interactions (Lawan *et al*., 2010; Adeola *et al*., 2012). Also, there is a possibility that *Alectra* residue in the soil releases toxic chemicals that can adversely affect the germination and growth of crop plants (Karanja *et al*., 2012).

1.8 Justification

The devastating effect of *Alectra vogelii* on cowpea has became major biological constraint to food production in Nigeria, and Africa at large. Weed researchers have reported the loss of food product especially of cowpea and other legume crops due to the parasite (Alonge *et al*., 2001b;Singh, 2002; Cisse and Hall, 2003.).Thus, many researchers have largely examined the mechanism of parasitism and control measures (Alonge *et al*., 2001b;Ngwira, 2008). However, little is done on how the*Alectra vogelii* brings about such detrimental effect leading to poor growth, crop failure in some cases and total yield losses in fields that are heavily infested by the parasite (Alonge *et al*., 2001a; Okori, 2005).

There is a considerable interest in determining the effect of the residue of *Alectra* plants on the growth of crop plants. This will point to the possible effect of allelopathy between the parasite and the other crop plants (Dugje *et al*., 2009). Therefore, this experiment will provide information on the effect of *Alectra vogelii* aqueous extract on the growth of four different varieties of cowpea (*Vigna unguiculata*).

1.9 Aim of the Study

To determine the effect of *Alectra vogelii*(Benth) aqueous extract on the growth of cowpea (*Viga unguiculata* (L.) Walp) varieties.

1.10 Objectives of the Study

The Objectives of this study were to determine;

1) The phytochemical compounds present in *Alectra*whole plant aqueous extract.
2) The effect of *A. vogelii*aqueous extract on seed germination count of four cowpea varieties at different concentration levels.
3) The effect of *A. vogelii* aqueous extract on the growth of four cowpeavarieties.

1.11 Hypotheses

1.The phytochemical of*A. vogelii*whole plant aqueous extract is below detection level.

2. The different concentration of*Alectra vogelii* aqueous extract has no significant effect on the cowpea germination count of four cowpea varieties.

3. Thedifferent concentration of *Alectra vogelii* aqueous extract has no significant effect on the growth of four cowpea varieties.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

About 4,000 flowering plant species have adapted to parasitize other plants (Lagoke *et al*., 1996b). Unfortunately for farmers, a small number of these species have become weeds, posing severe constraints to major crops including grain and forage legumes (Boukar *et al*.,2004). The mosteconomically damaging on legumes are the broomrapes (*Orobanche* and *Phelipanche*). Other parasitic weeds such as *Striga gesnerioides* (Wild) Vatke, *Alectra* and the dodders (*Cuscuta spp*.) can also be damaging on some legumes (Joel *et al*.,2007). There is no single technology to control these parasitic weeds effectively (Rubiales*et al*.,2006). Large areas of new territory are at risk of invasion if care is not taken to limit the introduction of parasitic weed seeds and to educate farmers and others to be on alert for new infestations (Polniaszek *et al*.,2001). The only way to cope with parasitic weeds is through an integrated approach, employing a variety of measures in a concerted manner, starting with containment and sanitation, direct and indirect measures to prevent the damage caused by the parasites, and finally eradicating the parasite seedbank in soils.

Weed infestation has been a serious threat to crops production (Kabambe and Drennan, 2003). The menace of weeds can be more devastating and lead to drastic reduction in crop yield especially where parasitic weeds are prevalent for years (Lagoke*et al*., 1996b). *Alectra vogelii* is one of the parasitic weeds that threatens cowpea, groundnut, soybeanand bambaranutproduction in the northern and southern

guinea savannah of Nigeria (Kureh, 1999).Infestation caused by *A. vogelii* has been reported to cause dry matter and grain yield reduction in cowpea (Alonge, 2000).

Alectra vogelii Benth from the familyScrophulariaceaeis widely distributed as a parasite of legume crops in the dry savannah of sub-saharan Africa (Okori, 2005). The species is found on a number of legume hosts, most commonly in cowpea and locally as a significant problem in groundnut, bambara, soybean etc (Singh *et al*., 2011).

2.2 Biologyof *Alectra vogelii*

One of the most important parasitic weeds plants in the eastern, central, and western Africa is the genus *Alectra* and the species*vogelii*, is an *Angiospermous*root hemiparasite (obligate) of cultivated grain legumes in sub Saharan Africa which include cowpea (*Vigna unguiculata* L. Walp), Bambara (*Vigna subterranean*L. Verd), soybean (*Glycine max*. Merril), Mung bean (*Vigna radiate* L. Wilczek), Groundnut (*Arachis hypogaea* L.) and common bean (*Phaseolus vulgaris* L.) (Ajeigbe*et al*.,1991)

The seeds of *A. vogelii* are dormant and require a period of after-ripening in warm, dry storage, followed by conditioning in a warm, moist environment before they will respond to germination stimulants (Carsky, 2003).The length and effectiveness of after-ripening period may vary with humidity and other environmental factors. Before the seeds of the parasite will respond to germination stimulants, they require a period of conditioning subsequent to after-ripening. Seed coat permeability may increase during conditioning and or changes in the level or activities of endogenous germination promoters or inhibitors may occur. The duration of conditioning is dependent on certain factors such as like temperature, origin and age of the seeds.The period necessary for the conditioning ranges from several weeks to month.Prolonged

conditioning without subsequent germination induction by stimulants can cause secondary dormancy (Saginga *et al*.,2003).

Below ground, bright orange stems are attached to host root with a spherical haustorium of upto 2cm in diameter.This is composed of a mass of host and parasites tissue and the orange adventitious roots of the parasites. Plants grow to 30-45cm tall, often as a single stem but sometimes branching from near soil level. The stems and leaves which can be 1.5 - to-3.5cm long and extent of toothing along the edge lamina,vary considerably (Bationo *et al*., 2010).At the start of the rainy season, the seeds of *Alectra vogelii* will absorb water or moisture, but it is still unable to germinate. This condition last for about 5 - to-21 days at a suitable temperature of 23^0C –to-25^0C (Ajeigbe *et al*.,2001). Conditioned seeds are capable of germinating if triggered by stimulating substances produced by potential host roots. A system of chemical signaling between host and parasites is involved in the formulation of this attachment organ (Bationo *et al*., 2010).

Effective parasitism of *Alectravogelii* depends upon successful attachment to and penetration of the host root as well as the establishment of vascular connection (Chon *et al*., 2002). When the parasites make contact with the hosts root, it develops a root-like structure known as haustorium. The haustorium has three function; for attachment, for penetration of the host roots and for nutrition acquisition from the host (Rafiqulhoque *et al*.,2003). *Alectra vogelii* depends on the host for signal that will control their initial stages of development (Kim, 2000). Kureh*et al.*(2005b) reported, that the first signal induces germination of *Alectra vogelii*, which is the beginning of a brief free living state, radical elongation can be sustained for a few days.

Haustoria initial occurs in response to host derived signal which is the second signal stage.The direct connection of *A. vogelii* and that of host xylem can take several days

(Ajeigbe*et al*.,2006). When successful connections have been done with the host, the parasites can grow rapidly using water and nutrients taken from the host, thus causing inevitable negative effects on the hosts. After emergence, the parasites grow until its flowers, produce seeds and dies (Emechebe*et al*., 2004). The complete life cycle takes place within 10-15 weeks (Boukar *et al*., 2004). However, Rank*et al*. (2004), reported that, the growth process of *A. vogelii* on cowpea lasted from 5-6 weeks (i.e 3 weeks underground and 2-3 weeks after emergence).

2.3 Hosts of *Alectra vogelii*

Cowpea is the major crop host of *A. vogelii* throughout its range (Ntombi, 2003). Bambara, groundnuts, common bean, soyabean, mung bean, and tepary are also common hosts and there have been occasional reports of infestation of chickpea and runner bean. Pigeon pea is the only widely grown grain legume, which is not parasitized (Joel, 2000). Although,*A. vogelii* can attack the crops listed, there is clear geographic variation in the host range in different regions of Africa. Host range tests by Riches *et al*. (2002) indicated that populations from Mali, Nigeria and Cameroon can attack groundnut and cowpea. Samples from eastern Botswana and northern areas of Northern Province, South Africa attack mung bean in addition to cowpea and groundnut. Populations sampled from Kenya, Malawi and eastern areas of Northern Province of South Africa, parasitize Bambaranut as well as crops which are susceptible elsewhere.

2.4 Environmental Requirements for *Alectra vogelii*

Alectra vogelii is largely dependent on annual cropping, its environmental requirements mirror those of its major hosts: cowpea, Bambara, groundnut and soybean in sub-Saharan Africa. By and large these are found in semi-arid areas with a

short growing season of 4 to 6 months, below 1500 m altitude (Singh, 2006). The parasite is most commonly found in areas of mono-modal rainfall with a long dry season as in Botswana or the Guinea savannah of West Africa, but it is also a pest in bimodal rainfall areas as in north-west and coastal Tanzania (Kureh and Alabi, 2013).

2.5 Symptoms of *Alectra vogelii* Infection in Cowpea

The extent of physiological disorder caused by *A. vogelii* in cowpea which include drastic and extensive loss of carbohydrates from the host cowpea plant correlated with the size of the robust houstaria of the parasites which consists of phloem and other transport cells (Mugabe, 1983). The removal of organic compound mainly carbohydrates in large quantities result in extensive damage to the cowpea plant. Despite the relative small size of the parasite, the most common above ground symptoms observed in cowpea infested by *A. vogelii* in the field and screen house is intervenel chlorosis (Kwaga *et al*., 2010). On a heavily infected plant, an important symptom is foliar desiccation which may be preceeded by intervenal rusty brown to purplish spots. A few days later, the area around the spot suddenly desiccates to produce straw-coloured necrotic spot with water soaked margins.

Coalescence of several necrotic spots result in Oblighting of the lamina (Yohanna *et al*., 2010). A leaflet may be completely desiccated before the blight spreads to the rachis, resulting in necrosis which consequently results in the desiccation of the leaflets (Karanja *et al*., 2011). Desiccation later spreads from the petioles to their point of attachment to the stem which then dries up downwards and rarely upward of the stem. However, premature abscission of the leaf or leaflet prevents internode desiccation. In addition, a less severely infected plant may be stunted while mild chlorosis is symptomatic (Alonge *et al*., 2004).

2.6 Compositionof*Alectra vogelii*Plant

Alectra vogelii contains phytochemicals which includes alkaloids, saponin, glucosides, tannins, flavonoid, carbohydrates etc (Kureh and Alabi., 2003) produced and used by plants (weeds) for protection and repair processes within the natural environment, an example of adaptive defense mechanism (Alghali. 1991). The phytochemicals present anti herbivore defense system common to Scrophulariaceae(Rubiales, 2006).The presence of flavonoid has been reported to be medicinally important in animals when the leaves are eaten by the animals or extracted in curing animals liver. Also, anti inflammatory effect of *A. vogelii* has been suggested in traditional medicine, the powdered plant is sprinkled on wound or made into a paste with some fat and applied against swollen neck glands to reduce the inflammation (Sazada*et al*., 2009).

2.7 Effect of *Alectra vogelii*on Cowpea

A considerable damage is inflicted on food and fodder plants by wide spread occurrence of parasitic flowering plants. Parasitic plant species are plants that obtained their resources (assimilates, water, nutrients) partly or even completely from other plant species(Singh *et al*., 2005). *Alectra vogelii* and related parasitic weeds presently constitute the most important biological constraints to food production in Africa (Magani and Lagoke, 2009).

Alectra vogelii relatively affect the lives of about 300 million people (Bagnall,1991; Kim,2000), and it is considered by many experts to be the greatest obstacle to food production in Africa particularly in the semi arid region of rhe continent

(MoAIFS,2005). *Alectra vogelii*as a root parasitic weed with devastating effect on legume cropsis explained in the local Hausa name“wuta-wuta” literally meaning “fire-fire”. The devastating effect of *Alectra vogelii*is observed mostly in the Northern Guinea savanna of Nigeria (IITA, 2003).

Alectra vogelii infection in cowpea is more devastating in areas with sandy soil, low fertility and low rain fall (FAO,2009). Cowpea suffers considerable damage due to *A. vogelii*, and yield losses or reduction of upto 100% was reported in a susceptible cowpea variety (Olmstead *et al*.,2001). According to Seghatoleslami *et al.* (2012),the plant can be a serious parasite of cowpea causing chlorosis and then severe wilting, and necrotic lesions. Apart from this effect, host growth and productivity are negatively affected by lower rate of photosynthesis, increased respiration, altered assimilate, partitioning and early senescence of leaves. Crop plants often collapse under water stress leading to complete crop failure (Magani, 2004).

The severity of *A. vogelii* damage on host is influenced by a number of factors other than inherent susceptibility of the host, such as cultural practice, soil fertility, climate condition, and poor management of emerged*A. vogelii* plants and exogenousdormancy of *A. vogelii* seeds in the soil or environment (Joel *et al.*, 2007).

2.8 *Alectra vogelii* Infestation

Witch weeds infestation of the legume crops causes stunting, wilting and yield lost in crops.*Alectra vogelii* is more prevalent in the northern guinea savannah and southern part of Sudan savannah (Singh *et al*.,2011). Total yield lost is not uncommon in field that are heavily infested by the parasite, when susceptible cowpea variety is grown (Gbehounou, 1994).Grain yields reduction caused by *A. vogelii* infestation has been attributed to reduced root nodulation, shoot-root ratio and leaf area (Alonge *et*

al.,2001a).Yield losses of up to 100% in a susceptible cowpea variety and up to 90% in moderately resistant cowpea varieties was reported when *Alectra vogelii* shoot were over ten per plant (Alonge *et al.*2004). According to Rambakudzibga *et al.*(2002), *Alectrav vogelii* is a serious pest in cowpea production in Africa.

Other researches show that *A. vogelii* infestation caused delayed onset of flowering and reduced numbers of flowers (Ajeigbe *et al*., 2010), as well as reduced number of pods per plant, individual seeds weight and grain total soluble carbonhydrate (Singh *et al*., 2004). Fields infested by *A. vogelii* is difficult to clean out due to a large production of viable seeds (over 50,000 per plant) which can remain dormant in the soil for several years (IITA, 1998). Moreover, up to 75% of the crop damage is done before the emergence of the parasite from the ground, making it control more difficult (Singh and Ajeigbe, 2000).

Alectra vogelii was reported in Tanzania in causing yield losses of up to 50%, and in Kenya a total crop loss was reported (IITA, 2001). A*lectra vogelii* causes yield losses of 80 – 100% on cowpeas in Botswana. In soybeans, yield loss due to *A. vogelii* was estimated at 70-90 % (Magani., 2004;Emechebe *et al.*, 1983) and for farmers to effectively adopt any effective control measure; extension workers require knowledge on the existence of the weed, its biology and its management. Catch crops are susceptible species which are ploughed in or harvested after parasite attachment but before emergence and seed production. On the other hand trap crops are plants that are not hosts to *A. vogelii* but do stimulate germination of the *Alectra* seed(Emechebe and Lagoke, 2002).

2.9 Effect of Some Weeds Extract on Crops

Weeds residue left in the field or environment are known to exhibit allelopathy by releasing water- soluble allelochemicals from leaves, stems, roots, rhizomes, flowers,

fruits and seeds (Batish *et al*., 2007). Rice (1974) defined allelopathy as any direct or indirect harmful effect by one plant to another through the production of chemical compounds, which escape into the environment. Allelopathic substances are most commonly found in plant extracts and in plant residues on soil, some are found in live plant exudates and as volatile gases liberated from leaves and rhizomes (Agarwal *et al*., 2002). Theallelochemicals from the leaves, roots and stems of a plant mainly affect plants at seed emergence and seedling levels (Naseem *et al*., 2009). Batish *et al*. (2007) conducted experiment using residue of *Chenopodium murale* on the growth of chickpea and pea and found that, their root and shoot length significantly decreased. Hossain *et al*.(2003) found that, water extracts from 23 common weeds and crop residues inhibited germination and growth of wheat seedling. Field soil samples taken from areas of moderate and high leafy spurge densities or incorporation of leafy spurge leaves and roots into the soil inhibited seedling growth of tomato (*Lycopersicon esculentum*) and crabgrass (*Digitaria sanguinalis).* Inhibitory effect of *Euphorbia granulata* infested soil was further confirmed by Sadaqa *et al.* (2010) in Onion. Results similar to these findings were reported by Tanveer (2010) for wheat, chickpea and lentil with *Euphorbia helioscopia*. Allelopathic effect of these compounds is often observed to occur early in the life cycle causing inhibition of seed germination and/or seedling growth (MOAIFS, 2005). Evidence shows that, higher plants release a diversity of allelochemicals into the environment, which include Phenolic, Alkaloid, long - chain fatty acids, Terpenoid and Flavonoid (Kayode and Ayeni, 2009). In addition, the allelochemicals are important defense for certain plants against the interference of other plants of the same or different species, which can affect their growth and development (Hossain, 2008).

2.10 Allelopathic Effects of *Striga*/*Alectra*Extract on Field Crops

Several studies have been conducted on the phytotoxicity of *Striga*species aqueous extracts of stems, leaves and roots of *Striga*inhibited on Sorghums germination and seedling growth of maize, peas and several other species (Musniyi *et al*., 2012). Olorunmaiye and Ogunfolaji (2002) reported that, the detrimental effect of *Striga*residue in an environment where legume crop is planted.Leaves were more toxic than stems and roots (Musniyi *et al*., 2012) due to the present of secondary metabolites, which was confirmed later on by Selleck (1972). Variation in the allelopathic response of different plants depends upon the distribution and accumulation of allelochemicals in different parts of weeds. Reduction in seedling growth of maize, delayed germination, reduced chlorophyll and protein content of legume crops with aqueous extract of *Striga*at high concentration has been reported by Roman *et al*. (2010). The effect of *Striga*on maize was concentration dependent,at low concentration the damage is rare while at high concentration caused100 % loss of wheat (Jabeen andAhmad, 2009). Aqueous extract, decaying residues, root extract, leaf, stem and root extract and soil under *Striga*stands were inhibitory to seed germination, seedling growth and weight of *Vigna unguiculata* (Kumbhar andDabgar, 2011). Tanveer (2010) noted a detrimental effect of *Striga*extracton germination and early seedling growth of Soybean, groundnut and green gram.

2.11 *Alectra vogelii*Control Measures

Parasitic weeds are serious problems in much agricultural production system. Unlike normal weeds which merely compete with the crop plants for nutrients and harbor diseases, root parasitic weeds by haustorial induction with their host plant,

takenutrients and water from the host. They are especially hard to control because they can inflict much damage before emerging above the ground (Singh and Emechebe. 1997). The tremendous impact of parasitic plants on the world agriculture has prompted much research aimed at preventing infestation. Many potential control methods developed against these parasitic plants includes; physical, cultural, chemical and biological control (Joel, 2000). So far these methods however have only had a limited impact in controlling the menace of the parasites, and today there is no single control method that can effectively solve (Joel, 2000: Stewart and Press, 1990).

An integrated control approach utilizing several measures is considered as the best approach for control of witchweeds, as no single method may provide complete control (Hossain *et al.*, 2003). In light infestations, uprooting before flowering and timely destruction through drying in a pit and burning is recommended as well as avoiding contamination of grains at harvesting especially where farmers do not used certified cowpea seeds as planting material. Hygiene during harvest to avoid weed seeds in grain reduces further spread of the weed. Other control measures include use of catch crops and trap crops.

Currently the recommended *A. vogelii* preventive control methods have not been very effective and have therefore not been widely adopted. These methods include; ploughing *A. vogelii* plants before they flower, and burning them in a pit, as well as avoiding contamination of grains at harvesting especially where farmers do not use certified cowpea seeds as planting materials, Hand pulling, biological control, chemical control, germination stimulant, GR-24 and Nijmegan-1 control, resistance crop variety and integrated control approaches(Kabambe *et al*., 2008). Other control measures include:

2.11.1 Catch crops:Theseare host plants that are grown to stimulate germination of parasitic weeds but they are destroyed before flowering of the parasites and harvesting of the crop. Catch crops are effective in reducing the soil seeds bank but have not been effective as a viable control option for subsistence farmers, who consider it as a wasteful strategy (Stewart and Press., 1990). Catch crops have also proven to be ineffective because small *A. vogelii* infestations are capable of causing significant yield reduction since catch cropping is not able to deplete all the seeds reserves in the soil within a short period of time (one or two season).

2.11.2Trap crops:Are non host crops that are able to stimulate *A. vogelii* emergence but cannot support the attachment and the growth of the parasite on the host. Example of important trap crops for *Alectra vogelii* management includes; cereal crops like Sorghum (*Sorghum bicolor*), Maize(*Zea mays*), Pearl Millet (*Pennisetum glaucum*), Cotton (*Gossypium hirsutum*) (Olmstead and Rice., 1970), Sunflower (*Helianthus annuus* L.), Dolichos Beans (*Lablab pureus[L.]* Sweet), and Guar Bean (*Cyamopsistetr gonoloba[L.]Taub*)(Emechebe and Lagoke, 2002). Little has been done in establishment of *A. vogelii* resistant varieties in legumes in Malawi (MoAIFS, 2005).

2.11.3 Pesticide:The control of *A. vogelii* using herbicide seed dressing reported by Singh*et al.* (2003) and Riches (2001) has remain theoretical because the target farmers who are mostly resource poor farmers and have not shown interest in investing in the use of chemical control.

CHAPTER THREE

3.0 MATERIALS AND METHOD

3.1 Description of Experimental Sites

Thelaboratory experiment using petri dich was carried out inthe Department of Biological Sciences Laboratory, Faculty of Science and the pot experiment was carried out at the Department of Agronomy Orchard,Institute for Agricultural Research, Ahmadu Bello University, Samaru, which lies at latitude11^0 11^1N, longitude $07^0 38^1$E and 686m above sea level in the Northern guinea savannah ecological zone of Nigeria.

3.2 Experimental Materials

Seed of four cowpea varieties (SAMPEA 7,SAMPEA 9,SAMPEA 10 and IAR-00-1074) were obtained from Seeds Production Unit, Institute for Agricultural Research, Ahmadu Bello University, Samaru-Zaria.

3.3 Preparation of Plant Materials

The*Alectra vogelii*whole plantswere obtained from an infested field at theInstitute for Agricultural Research,Ahmadu Bello University, Samaru-Zaria. The plants werespread in a flat surface and air dried at room temperature, clean from dust particles. After drying they werecrushed usingmortar and pestle and kept.

3.4 Soil Collection

Top soil was collected from farm landsand sharp sandwas collected from a stream atarea BZ, Ahmadu Bello University, Samaru Zaria, and mixed together in 1:1 ratio.A 2 mm sieve was carefully used to remove stones, peebles and other woods particles from the soil in preparation for use. Eachpot was filled with equal volume (2 kg per

pot) of soil – sand mixture. The physicochemical properties of this soil-sand mixture was determined in Deprtment of Soil Science, Ahmadu Bello University, Zaria.

3.5 Preparation of*Alectra vogelii* Plant Aqueous Extract

From the powdered*Alectra vogelii*whole plant was weighed 25, 50, 75 and 100 g each into labelled big mouth bottle containing 500 ml of distilled water. These were placed on a shaker machine and was shaken for 3 hours. The solution was then filtered using a musling cloth to separate the aqueous extract from the residue. Distilled water was used for the control treatment. The prepared *Alectra vogelii* aqueous extract was placed in a cornical flask properly labelled and stored under room temperature of 20-22^{0}C in the absence of refrigerator. This same procedure was used to obtain 50, 100, 150 and 200 g of *Alectra vogelii* whole plant for the pot experiment.

3.6 Preparation of Petri-dishes and Pots

The experiment consisted of 480 open bagsused in place of pots in the field. In the laboratory experiment petri-dishes were arranged and labeled according to treatments: 0, 25, 50, 75 and 100 g/l*Alectra* extract.The pots were also filled with soil-sand mixture, thenlabeled and arranged according to treatments: 0, 50, 100, 150 and 200 g/l of *Alectra* extract.

3.7 Qualitative Phytochemical Screeningof *Alectra vogelii*whole plant

Ten grams of the dried powdered sample was soaked in 100 ml of distilled water contained in a 500 ml flask. The flask was covered with cotton plug and allowed to stand for 24 hours. After 24 hours, the suspension was shaken vigourously and filtered using muslin cloth and filter paper. Then the filtrate was then concentrated on a water bath set at 50^0 C. The concentrated extract was stored in airlight sample bottle until required.

3.8 Preparation of Extracts for Phytochemical Screening

One point zero gramme (1.0 g) of the aqueous extract was weighed on an electric weighing balance and dissolved in 10 ml of each solvent.

3.9 Preparation of Reagents for Phytochemical Screening

3.9.1 Mayer's Reagent

Mercury chloride (0.355 g) was dissolved in 60 ml of water and 5.0 g of potassium iodide was dissolved in 20 ml of water. The two solution was mixed in 100 ml volumetric flask to the mark with distilled water.

3.9.2 Ferric Chloride Solution

Ferric chloride (9 g) was dissolved in water in a 100 ml volumetric flask and made up to the mark.

3.10 Determination of Flavonoids presence

Sodium hydrochloride test: To 1.0 ml of the extract was dissolved in NaOH solution. The presence of yellow solution, which disappeared in addition of HCL, indicate the presence of flavonoids (Trease, 1984).

3.11 Determination of Alkaloids Presence

Mayer's test; Ten drops of Mayer's reagent were added to 0.5 ml of the extract in a test tube. Cream, yellow or white colouration indicate the presence of Alkaloids (Trease and Evans, 1996).

3.12 Test forTannins Presence

Ferric Chloride test: To 0.5 ml of the extract solution, 10 ml of distilled water and 1 to 2 drops of ferric chloride solution was added, observed for blue or green colouration (Harborne *et al*., 1973)

3.13 Test for Saponins Presence

Frothing test: To 0.5 ml of the extract were shaken with 10 ml of distilled water in a test tube for 5 minutes, the production of frothing which persisted on heating indicate the presence of saponins (Trease and Evans, 1996).

3.14 Test for Cyanogenic Glycosides Presence

Keller-killiani test: To 2 ml of the extract, 1 ml of glacial acetic acid and 5 % ferric chloride was added. Then 1 ml of concentrated sulphuric acid was added. A purple-brown ring was observed at the interphase. This indicates the presence of deoxy sugars and a pale green colour n the upper acetic layer indicate the presence of cardiac glycosides (Trease and Evans, 1996).

3.15Quantitative Phytohemical Screeningof *Alectra vogelii*Whole Plant

3.15.1 TanninsDetermination by Van-Burden and Robinson (1981)

In determining tannin using van-Burden and Robinson (1981) method, in which 500mg of the sample was weighed into a 50ml plastic bottle, and 50ml of the distilled water was added and shaken for 1 hour in a mechanical shaker. This was filtered into a 50ml volumetric flask and made upto the mark. Then 5 ml of the filtrate was pipetted out into a test tube and mixed with 2ml of 0.1m $FeCL_3$ in 0.1 NHCL and 0.008 M potassium ferrocynide. The absorbance was measured at 620 nm within 10 minutes.

3.15.2 Cyanogenic Glycosides Determination

The procedures used to test the amount of glycoside in *A. vogelii* plant wasas described by Akujobi *et al.* (2004). A 5gportion of sample was made into paste, and the paste was dissolved into 50ml distilled water. The extract was filtered and the filtrate was used for cyanide determination. To 1ml of sample filtrate, 4ml of alkaline pictrate was added and absorbance was recorded at 550nm and the cyanide content was extrapolated from a cyanide standard curve.

Cyanide (mg/100g) = Absorbance xGFx DF/sample weight
Where GF = gradient factor
DF = dilution factor

3.15.3 Saponins Determination

The method used here was that of Obadoni (2001). The sample was grounded and 20g of each were put into a conical flask and 100 mlat 20% aqueous ethanol were added. The samples were heated over a hot water bath for 4 hours, with continuous stirring at 55^0C. The mixture was filtered and the residue re-extracted with another 200ml of 20% ethanol. The combined extracts were reduced into 250ml over water bath at about 90^0C. The concentrate was transferred into a 250ml separatory funnel and 20ml of diethyl ether was added and shaken vigorously. The aqueous layer was recovered while the ether layer was discarded. The purification process was repeated and 60 ml of n-butanol was added. The combined n-butanol extracts were washed twice with 10ml of 5% aqueous sodium chloride. The remaining solution was heated in a water bath. After evaporation, the extract were dried in the oven to a constant weight, the saponins content was calculated as percentage.

Percentage saponins = weight of saponins / weight of sample x 100

3.15.4 AlkaloidsDetermination

The determination of the quantity of alkaloid was measured using Harbone method (1994). About 5g of the sample was weight into a 250ml beaker and 80ml of 10% acetic acid in ethanol was added, covered and allowed to stand for 4 hours. This was filtered and the extract was concentrated on a water bath to one quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until precipitation was complete. The whole solution was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and then filtered. The residue is the alkaloid, which was dried and weighed.

3.15.5 FlavonoidsDetermination

The quantity of flavonoides was determined using the method described by Bohm and kocipai-Abyazan (1984) and Parker and Riches (1993). About 10g of the plant sample was extracted and repeated with 100ml of 80% aqueous methanol at room temperature. The whole solution was filtered through whatman filter paper No. 42.The filtrate was later transferred into a crucible and evaporated into dryness over a water bath and weighed.

3.16 Planting of CowpeaSeeds

The seedsof the four cowpea varieties were dressed with Apron Plus (seed dressing chemical) at the rate of 5g per 2kg of seeds before planting. Four seeds of each cowpea variety were sown per bag to a depth of 2cm at the center of each bag filled with soil. Then 10mls of each of the prepared *A. vogelii* aqueous extract at 50, 100, 150, and 200g/l concentrations was applied at the designated pots on the spot where the seeds were sown or planted in each pot (the pots experiment). In the laboratory, the same dressed seeds(with Apron Plus) of the four varietieswere used. Ten seeds ofeach cowpea variety were sown in each petri-dish. Then 5mls of the prepared *A.*

vogelii aqueous extract at 25, 50, 75, and 100g/l concentration was applied immediately after sowing in the petri-dish. Distilled water was used only on the control treatment from both experiments (pot and laboratory experiment).

3.17 Spraying of Cowpea Plant

In the pot experiment,application of insecticides was carried out at 4weeks after planting (WAP), and subsequently whenever any insect was noticed and during flowing. Hand weeding and pulling started from 4 WAP whenever any weed was noticed from the pots.

3.18Sampling of Cowpea Varieties for Seed Germination andGrowth Parameters

In the laboratory experiment, cowpea seeds germination was observed on daily basis and the root and shoot length and seedling weight were determined at 10 days after planting (DAP). In the pot experiment, theplant height, root nodules, number of leaves, fresh and dry weight of shoot and root were determined at 5, 7 and 9 weeks after planting(WAP) the cowpea varieties.

3.18.1 Seed germination count

The seeds germination count of the cowpea was taken when the radicle of the seed emerges from the seed coat every day for 10 days after planting.

3.18.2 Root length

Root length of cowpea seedings in each petridish was measured from tip to end of the root.

3.18.3 Shoot length

Shoot length of cowpea seedling was measured from the tip of the leaf down to the interception between the root and the shoot, using three plant samples from each treatment.

3.18.4 Seedling weight

All the cowpea seedlings in the petridish were weighted and recorded.

3.18.5 Plant height

In the pot experiment,on each sampling dates, the plant height of cowpeaunder each treatment was measured and recorded.

In the pot experiment on each sampling date, cowpea plant in a pot from each treatment replicate was uprooted and washed in a running tap water thoroughly to separate the sand from the rootsand shoot, and further spread the plants on a clean table for the water to drain off.

3.18.6 Root nodules

The root nodules on each plant sampled were counted and recorded.

3.18.7Number of leaves

The functional leavesper plant of the cowpea was counted and recorded.

3.18.8 Fresh and dry weight of shoot and root

The root of three of the sampled cowpea plants were carefully cut off from the shoot and each part weighed. These were placed in labeled envelopes. The envelopes were placed in an oven set at 70^0C until a constant dry weight was attained and the dry weight recorded. This sampling was done at 5, 7 and 9 WAP.

3.19 Experimental design

Each treatment replicateconsisted of 8 potsfor each cowpea variety with a total of 480 pots for the experiment. The pots were placed 20 cm apart within rows and 30cm between columns. In the laboratory, the petridishes used were placed 5cm within colunms and 10cm between rows. The treatment were replicated thrice and laid out in a completely randomized design. The pots and petri-dishes were irrigated every day in the morning.

3.20 Dataanalysis

The data obtained on seed germination and growth parameters of cowpea varieties were subjected to one way analysis of variance (ANOVA) to test the significance of differences between treatment means using the F- test as described by Snedecor and Cochran (1967). Duncan multiple range test (DMRT) was used to separate the treatment means where significant differences occur(Duncan, 1955).

CHAPTER FOUR

4.0 RESULTS

4.1 Physical andChemical Properties of the Soil

The physico-chemical analysis of the soil used in the experiment showed that the silt component was higher in percentage than thesand and clay components.The soil used in the experiment was silty loam. The physico-chemical properties of the soil are presented in Table 4.1. The chemical property of the soil indicates that it contains of Calcium(6.06 meq/100 g soil) and Nitrogen (2.03 meq/100 g soil) Phosphorus,Organic carbon, Mg, K, and had pH 5.80 (Table 4.1)

4.2 Phytochemical Component of *Alectra* plant extract

The qualitative phytochemical screening result of *Alectra vogelii* plant extract is shown in (Table 4.2).The quantitative phytochemical propertiesof *Alectra vogelii* plant extract showed that it had low Alkaloids (0.08 %), Tannins (0.247 %) and Cyanogenic Glycosides (0.212 %) but high inSaponins (46.50 %)and Flavonoids (16.04 %) contents(Table 4.3)

4.3 Growth Parameters of Cowpea Varieties

The effect of *Alectra vogelii* aqueous extract on the germination and growth parameters of the four cowpea varieties are presented in Tables 4.4 to 4.21.

LABORATORY EXPERIMENT

4.3.1 Cowpea seed germination percentage.

The effects of cowpea variety and *Alectra vogelii* aqueous extract levels on seeds germination percentage are presented in Table 4.4.

The control treatment resulted in the highest seed germination percentage in each variety on each sampling date. The 100 g/l *Alectra*aqueous extract resulted in the

Table 4.1: Physical and Chemical Properties of the Soil

Soil Properties	Value
Sand(%)	28.30
Silt(%)	55.68
Clay(%)	16.02
Textural class	Silt loam
pH 1:2:5 in water	5.80
Available Phosphorous (ppm)	3.2
Organic Carbon (%)	1.08
Exchangeable Cation (meq/100g soil)	
Ca(ppm)	6.06
Mg(ppm)	2.50
K(ppm)	2.86
N (%)	2.03

ppm = part per million
% = percentage
M eq = meter per equal square

Table 4.2: QualitatlvePhytochemical Analysis of *Alectra vogelii*Whole Plant

Constituents	Inference
Flavonoids	positive (+)
Phytate	negative (-)
Phenol	negative (-)
Alkaloids	positive (+)
Oxalate	negative (-)
Saponins	positive (+)
Tannins	positive (+)
Terpenoids / Steriods	negative (-)
Trypsin	negative (-)
Cyanogenic Glycosides	positive (+)
Cardiac glycoside	negative (-)
Carbohydrate	negative (-)

Present(+)
Absent(-)

Table 4.3: QuantitativePhytochemical Propertiesof *Alectra vogelii* Whole Plant

Chemical Component	Quantity (%)
Alkaloids	0.08
Cyanogenic Glycosides	0.212
Flavonoids	16.04
Saponins	46.50
Tannins	0.247

Table 4.4: Effect of *Alectra vogelii*Aqueous Extract on Seed Germination Percentage of Cowpea Varieties

Variety	*Alectra* Extract (g/l)	Seed Germination (%) Days After Planting (DAP)		
		234		
SAMPEA 7	0	58.00[a]	83.33[a]	86.00[a]
	25	24.00[b]	57.33[b]	69.33[a]
	50	10.67[c]	44.00[bc]	50.00[b]
	75	2.67[d]	30.67[c]	44.00[b]
	100	0.00[d]	14.00[d]	24.00[c]
	Mean	**19.07**	**45.87**	**54.67**
	SE±	**2.35**	**4.48**	**5.43**
SAMPEA 9	0	58.00[a]	64.67[a]	81.33[a]
	25	24.00[b]	40.00[b]	57.33[b]
	50	8.67[c]	12.00[c]	37.33[c]
	75	2.00[c]	6.00[c]	29.33[cd]
	100	0.67[c]	3.33[c]	20.00[d]
	Mean	**18.67**	**25.20**	**45.07**
	SE±	**3.34**	**2.77**	**4.49**
SAMPEA 10	0	23.33[a]	75.33[a]	93.33[a]
	25	17.33[a]	60.00[ab]	74.67[b]
	50	17.33[a]	42.67[bc]	56.67[c]
	75	17.33[a]	34.67[c]	49.33[cd]
	100	10.00[a]	28.67[c]	38.67[d]
	Mean	**17.07**	**48.27**	**62.53**
	SE±	**9.28**	**7.68**	**4.79**
IAR-00-1074	0	12.33[a]	72.67[a]	78.67[a]
	25	19.00[a]	46.00[b]	62.67[b]
	50	10.67[a]	50.67[b]	51.33[b]
	75	0.00[a]	24.00[c]	24.67[c]
	100	0.00[a]	12.00[c]	12.00[c]
	Mean	**8.40**	**41.07**	**45.87**
	SE±	**7.05**	**6.65**	**4.72**

Means with the same superscript along each column, under each varietyare not significantly different ($P<0.05$), using DMRT.

lowest seed percentage of each cowpea variety on each sampling date (Table 4.4). *Alectra*aqueous extract reduced the seed number or percentage of cowpea varieties and this reduction increased with extract concentration. The seed germination percentage of the cowpea varieties increased with increase in days after planting (DAP) (Table 4.4).

SAMPEA 7: The highest seed germination percentage in SAMPEA 7 due to the control treatment (0g/l) was significantly higher than that due to all the other treatments on each day after planting (DAP). This was followed by that due to 50 and 75 g/l *Alectra*aqueous extract.On the other hand, the lowest seed germination percentage in SAMPEA 7 due to 100g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments, exceptat 2 DAP.

SAMPEA 9: The highest seed germination percentage in SAMPEA 9 due to the control treatment (0g/l) of *Alectra*aqueous extract was significantly higher than that due to all the other treatments. The lowest seed germination percentage in SAMPEA 9 due to 100g/l was comparable to that due to50 and 75 g/l *Alectra*aqueous extract at 2 and 3 DAP, but only similar to that due to 75 g/l *Alectra* extract at 4 DAP (Table 4.4).

SAMPEA 10: Thecontrol treatment resulted in thehighest seed germination percentage number of *Alectra*aqueous extract which was significantly higher than that due to all the other treatment at all ages, except at 2 DAP when it was significantly similar to that due to 25, 50 and 75 g/l *Alectra*aqueous extract.However, at 3 DAP, the highest percentage germination due to the control was only similar to that due to 25 g/l *Alectra* extract.The lowest seed germination percentage in SAMPEA 10 due to 100g/l wassimilar to all other treatments at 2 DAP, but at 3 DAP it was similar to 50 and 75g/l *Alectra*aqueous extracts.

IAR-00-1074: The highest seed germination percentage of cowpea in IAR-00-1074 due to the control treatment (0g/l) significantly higher than that due to all the other treatments at 3 and 4 DAP. This was followed by that due to 25 and 50g/l *Alectra*aqueous extract. On the other hand, the lowest seed germination percentage of cowpea inIAR-00-1074 due to 100g/l was similar to that due to 75g/l *Alectra* aqueous extract on each sampling date except at 2 DAP.

The combined ANOVA of the data on seeds germination percentage showed that, the *Alectra vogelii* aqueous extract treatments reduced the percentage seed germination compared with the control treatment in all the cowpea varieties. This reduction increased as the extract concentration increases. The lowest seed germination percentage was observed at 100g/l *Alectra*aqueous extract on each sampling date (Table 4.5).The highest seedgermination percentage of the cowpea varieties observed from the control treatment each day after planting was significantly higher than that of all the other treatments. This was followed by that due to 25 and 50 g/l *Alectra*aqueous extract. However, the lowest seed percentage due to 100g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments at 3 and 4 DAP.

4.3.2 Root length

SAMPEA 7: The longest root of cowpea variety SAMPEA 7 due to the control treatment (0g/l) was significan tly longer than that due to all the other treatments. This was followed by that due to 25 and 50 g/l *Alectra* extract. However, the shortest root in SAMPEA 7 due to 100g/l *Alectra*aqueous extract was only similar to that due to 75g/l *Alectra* extract (Table 4.6).

SAMPEA 9: The longest root of cowpea in SAMPEA 9 due to the control treatment (0g/l) was significantly longer than that due to all the other treatments. This was

Table 4.5 Effect of *Alectra vogelii*Aqueous Extract on Seeds Germination Percentage of CowpeaBased onCombined ANOVA

***Alectra*Extract (g/l)**	**Seed Germination (%) Days After Planting (DAP) 234**		
0	37.83[a]	74.00[a]	84.83[a]
25	21.17[b]	51.00[b]	66.00[b]
50	11.83[c]	37.17[c]	48.83[c]
75	5.50[c]	23.83[d]	36.83[d]
100	2.67[c]	14.50[e]	23.67[e]
Mean	**15.80**	**40.10**	**52.03**
SE±	**3.09**	**2.86**	**2.83**

Means with the same superscript along each column, are not significantly different (P<0.05), using DMRT.

Table 4.6: Effect of *Alectra vogelii*Aqueous Extract onRoot and Shoot Lengths and Seedling Weight of Cowpea Varieties

Variety	***Alectra*** Extract (g/l)	Root Length (cm)	Shoot Length (cm)	Seedling Weight (g)
SAMPEA7	0	3.21^{a}	10.66^{a}	$4,43^{a}$
	25	2.60^{b}	7.26^{b}	4.21^{ab}
	50	1.20^{c}	4.45^{c}	3.93^{bc}
	75	1.15^{d}	2.44^{d}	3.67^{c}
	100	1.10^{d}	2.20^{d}	3.04^{d}
	Mean	**2.01**	**5.40**	**3.86**
	SE±	**0.17**	**0.57**	**0.11**
SAMPEA 9	0	2.23^{a}	4.86^{a}	3.76^{a}
	25	1.76^{b}	4.09^{a}	3.72^{a}
	50	1.07^{c}	2.57^{b}	3.60^{a}
	75	0.91^{cd}	1.99^{bc}	3.32^{a}
	100	0.63^{d}	1.53^{c}	3.35^{a}
	Mean	**1.32**	**3.01**	**3.55**
	SE±	**0.13**	**0.26**	**0.18**
SAMPEA 10	0	2.67^{a}	6.59^{a}	4.18^{a}
	25	2.17^{ab}	4.26^{b}	3.93^{ab}
	50	1.33^{bc}	3.13^{bc}	3.61^{bc}
	75	1.17^{c}	2.16^{cd}	3.34^{c}
	100	0.78^{c}	1.48^{d}	2.87^{d}
	Mean	**1.62**	**3.52**	**3.59**
	SE±	**0.27**	**0.44**	**0.12**
IAR-00-1074	0	1.90^{a}	5.60^{a}	4.39^{a}
	25	1.76^{a}	4.66^{b}	4.23^{ab}
	50	1.45^{a}	3.58^{c}	4.05^{b}
	75	0.61^{b}	1.39^{d}	3.50^{c}
	100	0.23^{b}	0.62^{d}	3.49^{c}
	Mean	**1.19**	**3.17**	**3.93**
	SE±	**0.15**	**0.26**	**0.08**

Means with the same superscript along each column, under each variety are not significantly different ($P<0.05$), using DMRT.

followed by that due to 25 and 50g/l *Alectra*aqueous extract treatments. However, the shortest root in SAMPEA 9 due to 100g/l *Alectra*aqueous extract was only similar to that due to 75 g/l *Alectra*aqueous extract.

SAMPEA 10: The longest root in SAMPEA 10 due to the control treatment (0g/l) was significantly longer than that due to all the other treatments, except being similar to that due to 25g/l *Alectra*aqueous extract. However, the shortest root in SAMPEA 10 due to 100g/l *Alectra*aqueous extract was signifcantly similar to that due to 50 and 75 g/l *Alectra*aqueous extracts.

IAR-00-1074: The longest root in IAR-00-1074 due to the control treatment was significantly longer than that due to all the other treatments, except being similar to that due to 25 and 50 g/l *Alectra*aqueous extract teeatments. However, the shortest root in IAR-00-1074 due to 100 g/l *Alectra*aqueous extract was only similar to that due to 75g/l *Alectra*aqueous extract (Table 4.6).

4.3.3 Shoot length

SAMPEA 7: The tallest shoot of cowpea in SAMPEA 7 due to the control treatment was significantly taller than that due to all the other treatments. This was followed by that due to 25 and 50 g/l *Alectra*aqueous extract treatments. However, the shortest shoot in SAMPEA 7 due to 100g/l *Alectra*aqueous extract was only similar to that due to 75g/l *Alectra*aqueous extract.

SAMPEA 9: The tallest shoot in SAMPEA 9 due to the control treatment of *Alectra* extract was similar to that due to 25 g/l *Alectra*aqueousextract. However, the shortest shoot in SAMPEA 9 due to 100g/l *Alectra*aqueous extract was only similar to that due to 75g/l *Alectra*aqueous extract.

SAMPEA 10: The tallest shoot in SAMPEA 10 due to the control treatment was significantly taller than that due to all the other treatments. This was followed by that

due to 25 and 50 g/l *Alectra*aqueousextract.The shortest shoot in SAMPEA 10 due to 100g/l *Alectra*aqueous extract was similar to that due to 75 g/l *Alectra*aqueous extract.

IAR-00-1074: The tallest shootin IAR-00-1074 due to the control treatment was significantly taller than that due to all the other treatments. This was followed by that due to 25 and 50 g/l *Alectra*aqueous extract treatments. However, the shortest shoot in IAR-00-1074 due to 100g/l *Alectra*aqueous extract was only similar to that due to 75 g/l *Alectra*aqueous extract (Table 4.6).

4.3.4 Seedling weight

SAMPEA 7: The highest seedling weight in SAMPEA 7 due to the control treatment was only similar to that due to 25 g/l *Alectra*aqueous extract. The least seedling weight in SAMPEA 7 due to 100g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments.

SAMPEA 9: The highest seedling weight in SAMPEA 9 due to the control treatment was similar to that due to all the other treatments (Table 4.6).

SAMPEA 10: The highest seedling weight in SAMPEA 10 due to 0g/l *Alectra*aqueous extract was only similar to that due to 25 g/l *Alectra*aqueous extract. Heeowever, the lowest seedling weight in SAMPEA 10 due to 100 g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments (Table 4.6).

IAR-00-1074: The highest seedling weight in IAR-00-1074 due to control treatment of *Alectra*aqueous extract was only similar to that due to 25 g/l *Alectra*aqueous extract. On the other hand, the lowest seedling weight in IAR-00-1074 due to 100 g/l *Alectra*aqueous extract was only similar to that due to 75 g/l *Alectra*aqueous extract.

The combined ANOVA of the data on root and shoot length and seedling weight showed that, the *Alectra vogelii*aqueous extract treatments reduced the root and shoot length and seedling weight in the cowpea varieties. This increased as the aqueous

extract concentration increases. The shortest root and shoot was observed at 100g/l *Alectra* aqueous extract (Table 4.7).The longest root and shoot observed in the cowpea varieties at 0g/l *Alectra*aqueous extract was significantly higher than that due to all the other treatments. However, the shortest root due to 100g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments. However, the shortest shoot due to 100g/l *Alectra*aqueous extract was only similar to that due to 75 g/l *Alectra* extract treatments. The control treatments had the highest seedling weight, while the lowest weight was observed at 100 g/l *Alectra* aqueous extract treatments.

POT EXPERIMENT

4.3.5 Number of Leaves

The 0 g/l *Alectra vogelii* aqueous extract (control) resulted in the highest leaf number in each variety on each sampling date. The 200 g/l *Alectra*aqueous extract resulted in the lowest number of leaves in each cowpea variety on each sampling date (Table 4.8). *Alectra*aqueous extract reduced the number of leaves in each cowpea varieties and this reduction increased with concentration of the aqueous extract. The number of leaves in the cowpea varieties increased with increase in age (Table 4.8).

SAMPEA 7: The highest number of leaves in SAMPEA 7 at 5 WAP due to the control treatment was only significantly higher than the lowest due to the 200 g/l *Alectra*aqueous extract.At 7 WAP, the highest number of leaves in SAMPEA 7 due to the control treatment was only similar to that due to 50 g/l *Alectra*aqueous extract. On the other hand, the lowest leaf number in SAMPEA 7 at 7 WAP due to the 200 g/l

Table 4.7: Effect of *Alectra vogelii*Aqueous Extract Based on (Combined ANOVA) on Shoot and Root Length and Seedling Weight on Cowpea Varieties

Alectra/ Extract (g/L)	Root Length(cm)	Shoot Length(cm)	Seedling Weight(g)
0	2.50[a]	6.93[a]	4.19[a]

25	2.07[b]	5.07[b]	4.02[a]
50	1.46[c]	3.43[c]	3.80[b]
75	0.96[d]	1.20[d]	3.46[c]
100	0.69[e]	1.46[d]	3.19[d]
Mean	**1.54**	**3.78**	**3.73**
SE±	**0.09**	**0.20**	**0.06**

Means followed by the same letter(s) in each column, are not significantly different (P<0.05), using DMRT.

Table 4.8: Effect of *Alectra vogelii* Aqueous Extract on Number of Leaves of Cowpea Varieties

Variety	*Alectra* Extract (g/l)	Number of Leaves Plants Age (WAP)		
		5	7	9

SAMPEA 7	**0**	4.33[a]	9.67[a]	13.33[a]
	50	4.00[ab]	8.67[ab]	10.33[b]
	100	3.67[ab]	7.33[bc]	8.33[c]
	150	3.33[ab]	7.00[cd]	7.67[c]
	200	3.00[b]	5.67[d]	6.67[c]
	Mean	**3.67**	**7.67**	**9.27**
	SE±	**0.37**	**0.47**	**0.62**
SAMPEA 9	0	5.00[a]	11.67[a]	14.33[a]
	50	4.00[ab]	10.00[b]	11.00[b]
	100	4.00[ab]	8.00[c]	8.67[c]
	150	3.67[b]	6.67[cd]	7.67[c]
	200	3.67[b]	5.67[d]	7.67[c]
	Mean	**7.07**	**8.40**	**9.87**
	SE±	**0.33**	**0.45**	**0.62**
SAMPEA 10	0	4.00[a]	10.67[a]	13.67[a]
	50	4.00[a]	8.33[b]	9.00[b]
	100	3.67[a]	7.33[bc]	9.00[b]
	150	3.33[a]	6.00[c]	7.00[b]
	200	3.00[a]	6.00[c]	4.00[c]
	Mean	**3.60**	**7.67**	**8.53**
	SE±	**0.33**	**0.63**	**0.94**
IAR-00-1074	0	4.33[a]	12.00[a]	13.67[a]
	50	4.33[a]	7.33[b]	9.67[b]
	100	3.67[ab]	6.67[b]	8.67[bc]
	150	3.33[ab]	6.00[b]	7.00[c]
	200	3.00[b]	5.67[b]	6.33[c]
	Mean	**3.73**	**7.53**	**9.07**
	SE±	**0.30**	**0.82**	**0.79**

Means with the same superscript along each column, under each variety are not significantly different (P<0.05), using DMRT.
WAP = Week After Planting

*Alectra*aqueous extract was only similar to that due the 150 g/l *Aletra vogelii*aqueousextract (Table 4.8).The highest number of leaves in SAMPEA 7 due to the control at 9 WAP was significantly higher than that due to all the other

treatments.The lowest leaf number in SAMPEA 7 at 9 WAP due to 200 g/l *Alectra*aqueous treatment was significantly lower than that due to 0 and 50 g/l *Alectra*aqueous extract (Table 4.8).

SAMPEA 9: At 5 WAP, the lowest number of leaves in SAMPEA 9 due to the 200g/l *Alectra*aqueous extract was significantly lower than the highest due to the control treatment (Table 4.8).At 7 WAP, the control treatment produced significantly higher number of leaves in SAMPEA 9 than that due to the all other treatments. This was followed by that due to 50 g/l *Alectra*aqueous extract. The lowest leaf number in SAMPEA 9 at 7 WAP due to 200 g/l *Alectra*aqueous extract was only similar to that due to 100 and 150 g/l *Alectra*aqueous extract.The highest number of leaves in SAMPEA 9 at 9 WAP due to the control treatment was significantly higher than that due to all other treatments. This was followed by that due to 50 g/l *Alectra*aqueous extract. The lowest number of leaves in SAMPEA 9 at 9 WAP due to 200g/l *Alectra*aqueous extract was significantly lower than that due to the 0 and 50 g/l *Alectra*aqueous extract (Table 4.8).

SAMPEA 10: At 5 WAP, the highest number of leaves in SAMPEA 10 due to the control treatment was not significantly higher than the lowest due to 200 g/l *Alectra*aqueous extract (Table 4.8).The highest number of leaves in SAMPEA 10 at 7 WAP due to the control treatment was significantly higher than that due to the all other treatments. At 7 WAP, the least number of leaves in SAMPEA 10 due to 200 g/l *Alectra*aqueous extract was only significantly lower than that due to 0 and 50 g/l *Alectra*aqueous extract. At 9 WAP, the highest number of leaves in SAMPEA 10 due to the control was significantly higher than that of the other treatments. However, at 9 WAP, the lowest leaf number in SAMPEA 10 due to 200 g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments (Table 4.8).

IAR-00-1074: The highest number of leaf in IAR-00-1074 at 7 and 9 WAP due to the control was significantly higher than that due to all the other treatments at each age.At 5 WAP, the highest leaf number in IAR-00-1074 due to the control was only significantly higher than the lowest due to 200 g/l *Alectra*aqueous extract. However, at 7WAP, the lowest number of leaf in IAR-00-1074 due to 200 g/l *Alectra*aqueous extract was only significantly lower than the highest due to control treatment (Table 4.8).The lowest leaf number at 9 WAP in IAR-00-1074 due to 200 g/l *Alectra*aqueous extract was significantly lower than that due to 0 and 50 g/l *Alectra*aqueous extract.

The combined ANOVA of the data on number of leaves showed that, *Alectra vogelii*aqueous extract treatment reduced the number of leaves compared with the control treatment in all the cowpea varieties. This reduction increased as the aqueous extract concentration increased. The lowest number of leaves was observed at 200 g/l *Alectra*aqueous extract on each sampling date (Table 4.9).

At 5 WAP, the highest number of leaves observed in the cowpea varieties at 0 g/l *Alectra*aqueous extract was similar to that due to 50 g/l *Alectra*aqueous extract treatment. The least number of leaves due to 200 g/l *Alectra*aqueous extract treatment was similar to that due to 150 g/l *Alectra*aqueous extract at 5 WAP. At 7 and 9 WAP, the highest leaf number due to the control treatment was followed by that due to 50 and 100 g/l *Alectra*aqueous extract treatments. The lowest number of leaves at 7 and 9 WAP due to 200 g/l *Alectra*aqueous extract was similar to that due to 150 g/l *Alectra* aqueous extract at 7 WAP, but lower than that of all other treatments at 9 WAP (Table 4.9).

Table 4.9: Effect of *Alectra vogelii* Aqueous Extract (Based on Combined ANOVA)onLeaves Number of Cowpea Varieties

***Alectra* Extract (g/l)**	**Number of leaves Plant Age (WAP)**

	5	7	9
0	4.42[a]	11.00[a]	13.75[a]
50	4.08[ab]	8.58[b]	10.00[b]
100	3.75[bc]	7.33[c]	8.67[c]
150	3.42[cd]	6.17[d]	7.33[d]
200	3.17[d]	6.00[d]	6.17[e]
Mean	**3.77**	**7.82**	**9.18**
SE±	**0.17**	**0.31**	**0.37**

Means with the same superscript along each column, are not significantly different (P<0.05), using DMRT.
WAP =Weeks After Planting

4.3.6 Number of Root Nodules

The *Alectra vogelii* aqueous extract reduced the number of root nodules in all the cowpea varieties on each sampling date and this reduction increased with the concentration of the aqueous extract.

SAMPEA 7: The highest number of root nodules in SAMPEA 7 at 5, 7 and 9 WAP due to the control treatment was significantly higher than that due to all the other treatments at each age (Table 4.10). This was followed by that due to 50 and 100 g/l *Alectra*aqueous extract.The lowest number of root nodules at 5 WAP due to the 200 g/l *Alectra*aqueous extract was significantly lower than that due to the all other treatments, but similar to that due to 150 g/l *Alectra*aqueous extract at 7 and 9 WAP.

SAMPEA 9: In SAMPEA 9, the highest number of root nodules at 5, 7 and 9 WAP due to the control treatment was significantly higher than that due to all the other treatments. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract.On the other hand, the lowest number of root nodules in SAMPEA 9 at 5, 7 and 9 WAP was due to 200 g/l *Alectra*aqueous extract and this was significantly lower than that due to all the other treatments at 5 and 7 WAP, but similar to that due to 150 g/l *Alectra*aqueous extract at 9 WAP.

SAMPEA 10: The highest number of root nodules in SAMPEA 10 at 5, 7, and 9 WAP due to the control treatment was significantly higher than that due to all the other treatments, except 50 g/l *Alectra*aqueous extract at 7 WAP. This was followed by that due to 50 and 100 g/l *Alectra*aqueous extract.At 5 and 7 WAP, the lowest number of root nodules due to 200 g/l *Alectra*aqueous extract was only similar to that due to 150 g/l *Alectra*aqueous extract.At 9 WAP, the lowest number of root nodules in SAMPEA 10 due to 200g/l *Alectra*aqueous treatment was significantly lower than that due to all the other treatments (Table 4.10).

Table 4.10: Effect of *Alectra vogelii*Aqueous Extrcact on Number of Root Nodules ofCowpea Varieties

Variety	*Alectra*Extract (g/l)	Number of Root Nodules Plants Age (WAP)		
		579		
SAMPEA 7	0	59.00[a]	95.67[a]	113.33[a]
	50	47.67[b]	70.33[b]	91.00[b]

	100	33.33^{c}	60.00^{bc}	85.33^{b}
	150	29.00^{c}	49.33^{cd}	61.67^{c}
	200	23.00^{d}	37.67^{d}	49.00^{c}
	Mean	**38.40**	**62.60**	**80.07**
	SE±.	**1.57**	**4.15**	**4.89**
SAMPEA 9	0	53.33^{a}	92.00^{a}	111.00^{a}
	50	45.00^{b}	74.33^{b}	97.33^{b}
	100	32.00^{c}	56.33^{c}	91.33^{b}
	150	27.33^{c}	46.33^{d}	57.00^{c}
	200	18.00^{d}	33.67^{e}	48.33^{c}
	Mean	**36.13**	**60.53**	**81.00**
	SE±.	**2.53**	**2.70**	**3.13**
SAMPEA 10	0	57.00^{a}	83.33^{a}	122.33^{a}
	50	41.00^{b}	73.67^{ab}	9433^{b}
	100	31.00^{c}	61.00^{bc}	85.67^{bc}
	150	26.67^{cd}	46.33^{cd}	72.67^{c}
	200	22.33^{d}	34.00^{d}	46.00^{d}
	Mean	**35.60**	**59.67**	**84.20**
	SE±	**2.38**	**4.96**	**4.52**
IAR-00-1074	0	53.00^{a}	80.67^{a}	125.33^{a}
	50	41.00^{b}	73.00^{ab}	94.00^{b}
	100	30.00^{c}	61.67^{b}	86.00^{b}
	150	26.33^{c}	44.33^{c}	80.33^{b}
	200	18.00^{d}	36.00^{c}	46.00^{c}
	Mean	**32.57**	**59.13**	**86.33**
	SE±	**1.70**	**3.83**	**5.00**

Means with the same superscript along each column, under each variety are not significantly different (P<0.05), using DMRT.
WAP = Week After Planting

IAR-00-1074: The highest number of root nodules in IAR-00-1074 at 5, 7 and 9 WAP due to the control treatment was significantly higher than that due to all the other treatments. This was followed by that due 50 and 100 g/l *Alectra*aqueous extract. On

the other hand, the least number of root nodules due to 200 g/l *Alectra*aqueous extract in IAR-00-1074 at 5 and 9 WAP was significantly lower than that due to the all other treatments.

The combined ANOVA of the data on the number of root nodules showed that, *Alectra* vogelii aqueous extract treatment reduced the number of root nodules in all the cowpea varieties. This reduction increased as the aqueous extract concentration increased. The lowest number of root nodules was observed at 200 g/l *Alectra*aqueous extract on each sampling date (Table 4.11). At 5, 7 and 9 WAP, the highest number of root nodules observed in the cowpea varieties due to the control treatment was significantly higher than that of other treatments. This was followed by that due to 50 and 100 g/l *Alectra*aqueous extract.The lowest root nodules observed in the cowpea varieties due to 200 g/l *Alectra*aqueous extract was significantly lower than that of other treatments at 5, 7 and 9 WAP (Table 4.11).

4.3.7 Plant Height

SAMPEA 7: In SAMPEA 7 at 5, 7, and 9 WAP the highest plant height due to the control treatment was significantly higher than that due to all the other treatments on most of the sampling dates. This was followed by that due to 50 and 100 g/l *Alectra*aqueousextract (Table 4.12). The lowest plant height in SAMPEA 7 at 5, 7 and 9 WAP due to 200 g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments, except being similar to that due to 150 g/l *Alectra* aqueous extract at 7 WAP.

Table 4.11: Effect of *Alectra* vogelii Aqueous Extract (Based on Combined ANOVA) on Number of Root Nodules of Cowpea Varieties

***Alectra* Extract (g/l)**	**Number of Root Nodules**		
	Plants Age (WAP)		
	5	**7**	**9**

0	56.88[a]	87.92[a]	118.00[a]
50	42.42[b]	72.83[b]	94.17[b]
100	31.58[c]	59.75[c]	87.08[c]
150	27.33[d]	46.58[d]	67.92[d]
200	20.33[e]	35.33[e]	47.33[e]
Mean	**35.70**	**60.48**	**82.90**
SE±	**1.04**	**2.00**	**2.22**

NB: Means with the same superscript along each column, are not significantly different (P<0.05), using DMRT.
WAP = weeks after planting

Table 4.12: Effect of *Alectra vogelii*Aqueous Extract on Plant Height of Cowpea Varieties

Variety	*Alectra* Extract (g/l)	Plant Height (cm) Plant Age (WAP)		
		5	**7**	**9**
SAMPEA 7	0	23.33[a]	35.33[a]	41.00[a]
	50	20.00[b]	30.00[b]	37.33[b]
	100	18.33[b]	27.67[bc]	31.67[c]
	150	16.33[c]	25.67[cd]	29.33[c]
	200	14.00[d]	23.00[d]	24.33[d]
	Mean	**18.40**	**28.33**	**32.73**
	SE±	**0.63**	**1,18**	**1,14**
SAMPEA 9	0	22.33[a]	34.00[a]	42.67[a]
	50	20.33[ab]	29.67[b]	36.33[b]
	100	18.67[b]	27.33[b]	31.00[c]
	150	15.33[c]	24.67[c]	26.67[cd]
	200	14.33[c]	22.67[c]	24.33[d]
	Mean	**18.20**	**27.67**	**32.20**
	SE±	**0.67**	**0.79**	**1.51**
SAMPEA 10	0	21.33[a]	31.00[a]	40.00[a]
	50	19.33[ab]	29.00[b]	36.67[a]
	100	20.00[ab]	26.33[c]	31.33[b]
	150	15.67[bc]	24.00[d]	25.67[c]
	200	13.00[c]	21.00[e]	24.00[c]
		17.87	**26.27**	**31.53**
	Mean	**0.67**	**0.60**	**1.07**
IAR-00-1074	**SE±**	21.00[a]	30.33[a]	42.33[a]
	50	18.67[b]	28.67[a]	37.67[b]
	100	16.67[c]	26.00[b]	28.67[c]
	150	15.67[cd]	24.33[b]	26.00[c]
	200	15.33[d]	19.00[c]	21.67[d]
	Mean	**17.47**	**25.67**	**31.27**
	SE±	**0.39**	**0.73**	**1.33**

NB: Means with the same superscript along each column, under each variety are not significantly different (P<0.05), using DMRT.
WAP = Week After Planting

SAMPEA 9: The highest plant height in SAMPEA 9 at 5, 7 and 9 WAP due to the control treatment (0 g/l) was significantly higher than that due to the other treatments, except at 5 WAP when it was similar to that due to 50 g/l *Alectra*aqueous extract. This was followed by that due to 50 and 100 g/l *Alectra*aqueous treatment on each sampling date. The lowest plant height in SAMPEA 9 at 5, 7 and 9 WAP due to 200 g/l *Alectra*aqueous extract was only similar to that due to 150 g/l *Alectra*aqueous extract treatment (Table 4.12).

SAMPEA 10: The height of SAMPEA 10 on each sampling date was lower in plants under *Alectra*aqueous extract treatment compared with the control treatment.The highest plant height in SAMPEA 10 at 5 WAP due to the control treatment was only similar to that due to 50 and 100 g/l *Alectra*aqueousextract. The lowest plant height at 5 WAP in SAMPEA 10 due to 200 g/l *Alectra* aqueous extract was only similar to that due to the 150 g/l *Alectra*extract. At 7 WAP, the highest plant height in SAMPEA 10 due to the control treatment was significantly higher than that of the other treatments. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract. The lowest plant height in SAMPEA 10 at 7 WAP due to 200g/l *Alectra*aqueous extract was significantly lower than that of the other treatments (Table 4.12). At 9 WAP, in SAMPEA 10, the highest plants height due to the control treatment was only similar to that due to 50g/l *Alectra*aqueous extract.On the other hand, the lowest plant height in SAMPEA 10 due to 200g/l *Alectra*aqueous extract was only similar to that due to 150g/l *Alectra* aqueous extract treatment (Table 4.12).

IAR-00-1074: The highest plant height in IAR-00-1074 at 5 WAP due to the control treatment was significantly higher than that due to the other treatments. The lowest plant height due to the 200 g/l *Alectra*aqueous extract was only similar to that due to 150 g/l *Alectra* aqueous extract (Table 4.12).At 7 WAP, the highest plant height in

IAR-00-1074 due to the control treatment was only similar to that due to 50g/l *Alectra*aqueous extract. On the other hand, the lowest plant height due to 200g/l was significantly lower than that due to the other treatments. In IAR-00-1074 at 9 WAP, the highest plant height due to the control treatment was significantly higher than that due to all the other treatments. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract. The lowest plant height in IAR-00-1074 at 9 WAP due to 200g/l *Alectra*aqueous extract was significantly lower than that due to other treatments (Table 4.12).

The combined ANOVA of the data on plant height showed that,*Alectra vogelii*aqueous extract treatment reduced the plant height in all the cowpea varieties. This reduction increased as the concentration of the *Alectra*aqueous extract increased. The lowest plant height was observed at 200 g/l *Alectra* treatment on each sampling date (Table 4.13).

At 5, 7 and 9 WAP the highest plant height was observed in all the cowpea varieties at the control treatment (0g/l *Alectra vogelii* aqueous extract). This was followed by that due to 50 and 100 g/l*Alectra*aqueous extract treatments. The lowest plant height at 5, 7 and 9 WAP in the cowpea varieties due to 200g/l *Alectra*aqueous extract was significantly lower than that of the other treatments (Table 4.13).

4.3.8 Shoot Fresh Weight

The 0 g/l *Alectra vogelii* aqueous extract (control treatment) resulted in the highest shoot fresh weight, while 200 g/l *Alectra* aqueous extract resulted in the lowest shoot fresh weight in each cowpea variety. *Alectra* aqueous extract reduced shoot fresh weight in cowpea varieties and this reduction increased with the concentration of the

Table 4.13: Effect of *Alectra vogelii*Aqueous Extract (Based on Combined ANOVA) on Plant Height in Cowpea Varieites

Alectra Extract (g/l)	Plant Height (cm) Plants Age (WAP)		
	579		
0	22.00[a]	32.67[a]	41.50[a]
50	19.58[b]	29.33[b]	37.00[b]
100	17.33[c]	26.83[c]	30.67[c]
150	16.33[c]	24.67[d]	26.72[d]
200	14.17[d]	21.42[e]	23.58[e]
Mean	**17.98**	**26.98**	**31.93**
SE±	**0.45**	**0.43**	**0.64**

Means with the same superscript along each column, are not significantly different (P<0.05), using DMRT.
WAP = weeks after planting

Table 4.14:Effect of *Alectra vogeli*AqueousExtract on Shoot Fresh Weight of Cowpea Varieties

Varieties	*Alectra* Extract (g/L)	Shoot Fresh Weight (g) Plant Age (WAP)		
5	**79**			
SAMPEA 7	0	12.23[a]	17.00[a]	29.60[a]
	50	11.33[b]	16.17[ab]	28.80[a]
	100	10.80[b]	15.27[b]	26.13[b]
	150	7.67[c]	12.50[c]	21.50[c]
	200	5.97[d]	9.83[d]	16.70[d]
	Mean	**9.60**	**14.15**	**24.55**
	SE±.	**0.25**	**0.43**	**0.30**
SAMPEA 9	0	12.20[a]	17.27[a]	28.80[a]
	50	11.00[b]	15.73[b]	28.43[a]
	100	10.47[b]	14.93[c]	25.50[b]
	150	7.27[c]	11.70[d]	21.37[c]
	200	5.40[d]	9.20[e]	16.76[d]
	Mean	**9.27**	**13.77**	**24.17**
	SE±.	**0.26**	**0.23**	**0.46**
SAMPEA 10	0	12.10[a]	17.83[a]	29.70[a]
	50	11.23[b]	15.77[b]	27.40[b]
	100	8.93[c]	13.70[c]	23.40[c]
	150	6.77[d]	10.67[d]	20.03[d]
	200	5.07[e]	8.73[e]	17.63[e]
	Mean	**8.82**	**13.34**	**23.63**
	SE±.	**0.18**	**0.27**	**0.42**
IAR-00-1074	0	11.93[a]	16.87[a]	29.20[a]
	50	10.90[b]	15.40[b]	27.30[b]
	100	7.83[c]	13.07[c]	25.37[c]
	150	5.77[d]	9.60[d]	19.10[d]
	200	4.87[e]	8.87[e]	17.20[e]
	Mean	**8.26**	**12.76**	**23.63**
	SE±.	**0.25**	**0.18**	**0.43**

Means with the same superscript along each column, under each variety are not significantly different ($P<0.05$), using DMRT.
WAP = Week After Planting

extract. The shoot fresh weight of cowpea vareities increased with increase in plant age (Table 4.14).

SAMPEA 7: At 5, 7 and 9 WAP, the highest shoot fresh weight in SAMPEA 7 due to the control treatment was significantly higher than that due to the all the other treatmentsexcept being only similar to that due to 50 g/l *Alectra* aqueous extract at 7 and 9 WAP. The lowest shoot fresh weight in SAMPEA 7 at 5, 7 and 9 WAP due to the 200 g/l *Alectra* aqueous extract was significantly lower than that due to all the other treatments (Table 4.14).

SAMPEA 9: The highest shoot fresh weight in SAMPEA 9 at 5, 7 and 9 WAP due to the control treatment was significantly higher than that due to all the other treatments, except at 9WAP when it was only similar to that due to 50 g/l *Alectra* aqueous extract. The lowest shoot fresh weight in SAMPEA 9 at 5, 7 and 9 WAP due to 200g/l *Alectra* aqueous extract was significantly lower than that due to all the other treatment.

SAMPEA 10: The highest shoot freshweight at 5, 7 and 9 WAP in SAMPEA 10 due to the control treatment was significantly higher than that due to all the other treatments. This was followed by that due to 50 and 100 g/l *Alectra*aqueous extract (Table 4.14).The lowest shoot fresh weight in SAMPEA 7 at 5, 7 and 9 WAP due to 200 g/l *Alectra* aqueous extract was significantly lower than that due to all the other treatment.

IAR-00-1074: The highestshoot fresh weight at 5, 7 and 9 WAP in IAR-00-1074 due to the control treatment (0 g/l) was significantly higher than that due to all the other treatments. This was also followed by that due to 50 and 100 g/l *Alectra*aqueous extract treatments (Table 4.14).On the other hand, the lowest shoot fresh weight in

IAR-00-1074 at 5, 7 and 9 WAP due to 200g/l *Alectra* aqueous extract was significantly lower than that due to all the other treatments.

The combined ANOVA of the data on shoot fresh weight showed that,*Alectra vogelii*aqueous extract treatment reduced the shoot fresh weight compared with the control in all the varieties. This reduction increased as the aqueous extract concentration increased. The lowest shoot fresh weight observed at 200 g/l *Alectra* aqueous extract on each sampling date was significantly lower than that of other treatment (Table 4.15).

4.3.9 Shoot dry weight

At 5, 7 and 9 WAP, the highest shoot dry weight due to the control treatment was followed by that due to the 50 and 100 g/l *Alectra* aqueous extract treatments (4.16).

The lowest shoot dry weight at 5, 7 and 9 WAP due to the 200g/l *Alectra* aqueous extract was significantly lower than that of all the other treatments.The 0g/l *Alectra vogelii* aqueous extract (control treatment) resulted in the highest weight of dry stem, while 200 g/l *Alectra*aqueous extract resulted in the lowest weight of dry stem in each cowpea varieties. *Alectra*aqueous extract reduced shoot dry weight in cowpea varieities and this reduction increased with concentration of the extract. The shoot dry weight of cowpea varieties increased with increase in plant age (Table 4.16).

SAMPEA 7: The control treatment resulted in thehighest shoot dry weight in SAMPEA 7 at 5, 7 and 9 WAP which was significantly higher than that due to other treatments at 5 WAP but similar to that of 50 g/l at 7 and 9 WAP. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract treatments.On the other hand, the lowest shoot dry weight in SAMPEA 7 at 5, 7 and 9 WAP due to 200g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments,

Table 4.15: Effect of *Alectra vogelii*Aqueous Extract (Based on Combined ANOVA) on Shoot Fresh Weight of Cowpea Varieties

***Alectra* Extract (g/l)**	**Shoot Fresh Weight(g) Plant Age (WAP)**		
	5	**7**	**9**
0	12.12[a]	17.24[a]	29.33[a]
50	11.12[b]	15.77[b]	27.98[b]
100	9.51[c]	14.24[c]	25.10[c]
150	6.87[d]	11.12[d]	20.50[d]
200	5.33[e]	9.16[c]	17.08[e]
Mean	**8.99**	**13.51**	**24.00**
SE±	**0.12**	**0.15**	**0.20**

Means with the same superscript along each column, are not significantly different (P<0.05), using DMRT.
WAP = weeks after planting

Table 4.16: Effect of *Alectra vogelii* AqueousExtract on Shoot Dry Weightof Cowpea Varieties

Varieties	*Alectra* Extract (g	Shoot Dry Weight(g) Plant Age (WAP)		
		5	7	9
SAMPEA 7	0	0.50[a]	0.83[a]	1.40[a]
	50	0.37[b]	0.77[a]	1.20[ab]
	100	0.30[bc]	0.60[b]	1.00[bc]
	150	0.23[c]	0.53[b]	0.80[c]
	200	0.20[c]	0.40[c]	0.63[c]
	Mean	**2.54**	**2.97**	**3.41**
	SE±	**0.16**	**0.12**	**0.15**
SAMPEA 9	0	0.60[a]	1.07[a]	1.97[a]
	50	0.43[b]	0.83[b]	1.83[a]
	100	0.27[c]	0.80[bc]	1.83[a]
	150	0.23[c]	0.73[c]	1,43[b]
	200	0.20[c]	0.53[d]	1.03[c]
	Mean	**2.45**	**2.95**	**3.32**
	SE±	**0.15**	**0.18**	**0.17**
SAMPEA 10	0	2.67[a]	4.07[a]	4.77[a]
	50	2.60[a]	3.37[b]	3.80[b]
	100	2.30[b]	2.63[c]	2.93[c]
	150	2.03[c]	2.43[c]	2.77[c]
	200	1.80[d]	2.03[d]	2.53[c]
	Mean	**2.28**	**2.91**	**3.36**
	SE±	**0.06**	**0.11**	**0.13**
IAR-00-1074	0	3.53[a]	4.03[a]	4.70[a]
	50	2.47[b]	3.20[b]	3.30[b]
	100	2.13[c]	2.67[c]	3.03[bc]
	150	2.07[c]	2.43[cd]	2.73[cd]
	200	1.73[d]	2.00[d]	2.20[d]
	Mean	**2.39**	**2.87**	**3.19**
	SE±	**0.07**	**0.16**	**0.17**

Means with the same superscript along each column, under each variety are not significantly different (P<0.05), using DMRT.
WAP = weeks after planting

except being similar to that due to 100 and 150 g/l *Alectra*aqueous extract treatments at 5 WAP.

SAMPEA 9: The highest shoot dry weight in SAMPEA 9 at 5, 7 and 9 WAP due to the control treatment (0 g/l) *Alectra*aqueous extract was significantly higher than that due to all the other treatments except being similar to that of 50 and 100 g/l at 9 WAP. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract. However, the lowest shoot dry weight in SAMPEA 9 at 5, 7 and 9 WAP due to 200 g/l *Alectra*aqueous extract was only similar to that due to 100 and 150 g/l *Alectra*aqueous extract at 5 WAP (Table 4.16).

SAMPEA 10: The highest shoot dry weight at 5, 7 and 9 WAP in SAMPEA 10 due to the control treatment (0 g/l) was significantly higher than that due to all the other treatments, except at 5 WAP when it was similar to that due to 50g/l *Alectra*aqueous extract. On the other hand, the lowest shoot dry weight in SAMPEA 10 at 5, 7 and 9 WAP due to 200 g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments, except being similar to that due to 100 and 150g/l *Alectra*aqueous extract at 9 WAP (Table 4.16).

IAR-00-1074: The highest shoot dry weight in IAR-00-1074 at 5, 7 and 9 WAP due to the control treatment (0 g/l) *Alectra*aqueous extract was significantly higher than that due to all the other treatments. This was followed by that due to 50 and 100 g/l *Alectra*aqueous extract.The lowest shoot dry weight of 5, 7 and 9 WAP in IAR-00-1074 due to 200g/l *Alectra*aqueous extract was significantly lower than that due to the all other treatments at 5 WAP, but similar to that due to 150g/l *Alectra*aqueous extract at 7 and 9 WAP (Table 4.16).

The combined ANOVA of the data on shoot dry weight showed that, the *Alectra vogelii*aqueous extract treatments reduced the shoot dry weight in the cowpea varieties, and this reduction increased as the extract concentration increased. The lowest shoot dry weight observed at 200 g/l *Alectra*aqueous extract on each sampling date (Table 4.17).

The highest shoot dry weight at 5, 7 and 9 WAP on each sampling date, due to control treatment was significantly higher than that due to all the other treatments. This was followed by that due to 50 and 100 g/l *Alectra*aqueous extract treatments. However, the lowest shoot dry weight at 5, 7 and 9 WAP due to 200 g/l *Alectra*aqueous extract was significantly lower than that due to the other treatments.

4.3.10 Root fresh weight

The 0 g/l *Alectra vogelii* aqueous extract (control treatment) resulted in the highest root fresh weight, while 200 g/l *Alectra*aqueous extract resulted in the lowest root fresh weight in each cowpea variety. *Alectra*aqueous extract reduced root fresh weight of cowpea varieties and this reduction increased with extract concentration. The root fresh weight of the cowpea varieties increased with increase in plant age (Table 4.18)

SAMPEA 7: The highest root fresh weight in SAMPEA 7 at 5, 7 and 9 WAP due to the control treatment (0 g/l) of *Alectra*aqueous extract was significantly higher than that due to all the other treatments at 9 WAP, but similar to that of 50 g/l at 5 WAP, and 50 and 100 g/l at 7 WAP. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract treatments.The lowest root fresh weight in SAMPEA 7 at 5, 7 and 9 WAP due to the 200 g/l *Alectra*aqueous extract treatments was significantly lower than that due to all the other treatments at 5 WAP, but similar to that due to 150g/l *Alectra*aqueous extract at 7 and 9 WAP (Table 4.18).

Table; 4.17: Effect of *Alectra vogelii*Aqueous Extract (Based on Combined

ANOVA) on Shoot Dry Weight of Cowpea Varieties

Alectra Extract (g/L)	Shoot Dry Weight**(g)** Plant Age (WAP)		
	5	7	9
0	3.23[a]	4.05[a]	4.72[a]
50	2.62[b]	3.42[b]	3.72[b]
100	2.31[c]	2.69[c]	3.06[c]
150	2.11[d]	2.41[d]	2.72[d]
200	1.81[e]	2.06[e]	2.40[e]
Mean	**2.41**	**2.93**	**3.32**
SE±	**0.06**	**0.07**	**0.08**

Means with the same superscript along each column, are not significantly different ($P<0.05$), using DMRT.
WAP = weeks after planting

Table 4.18:Effect of *Alectra vogelii*AqueousExtract on Root Fresh Weight of

Cowpea Varieties

Variety	*Alectra* Extract (g/l)	Root Fresh Weight (g) Plant Age (WAP)		
				579
SAMPEA 7	0	1.27[a]	2.37[a]	3.70[a]
	50	1.17[ab]	2.30[a]	2.97[b]
	100	1.07[b]	2.27[a]	2.53[bc]
	150	0.90[c]	1.80[b]	2.27[cd]
	200	0.73[d]	1.43[b]	1.77[d]
	Mean	**1.03**	**2.03**	**2.65**
	SE±	**0.04**	**0.13**	**0.16**
SAMPEA 9	0	1.27[a]	2.67[a]	3.63[a]
	50	1.17[ab]	2.07[b]	3.23[b]
	100	1.07[b]	1.83[bc]	2.63[c]
	150	0.80[c]	1.43[cd]	1.67[d]
	200	0.70[c]	1.23[d]	1.50[d]
	Mean	**1.00**	**1.85**	**2.53**
	SE±	**0.04**	**0.14**	**0.12**
SAMPEA 10	0	1.27[a]	2.80[a]	3.27[a]
	50	1.17[a]	2.50[b]	3.20[a]
	100	0.97[b]	2.20[c]	2.83[b]
	150	0.80[c]	1.83[d]	2.10[c]
	200	0.73[c]	1.63[d]	2.00[c]
	Mean	**0.99**	**2.19**	**2.68**
	SE±	**0.05**	**0.08**	**0.11**
IAR-00-1074	0	1.30[a]	2.63[a]	3.43[a]
	50	1.17[a]	2.40[a]	3-10[b]
	100	0.87[b]	2.37[ab]	2.87[b]
	150	0.80[b]	2.03[bc]	2.53[c]
	200	0.87[b]	1.87[c]	2.27[c]
	Mean	**1.00**	**2.26**	**2.84**
	SE±	**0.05**	**0.11**	**0.10**

Means with the same superscript along each column, under each variety are not significantly different (P<0.05), using DMRT.
WAP = weeks after planting

SAMPEA 9: The highest root fresh weight in SAMPEA 9 at 5, 7 and 9 WAP due to the control treatment (0 g/l) of *Alectra*aqueous extract was significantly higher than that due to all the other treatments at 7 and 9 WAP, but similar to that due to 50 g/l *Alectra*aqueous extract at 5 WAP. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract treatments.The lowest root fresh weight in SAMPEA 9 at 5, 7 and 9 WAP due to the 200 g/l *Alectra*aqueous extract was only similar to that due to 150 g/l *Alectra*aqueous extract on each sampling date (Table 4.18).

SAMPEA 10: The highest root fresh weight in SAMPEA 10 at 5, 7 and 9 WAP due to the control treatment (0 g/l) was significantly higher than that due to all the other treatments at 7 WAP, but similar to that due to 50 g/l *Alectra*aqueous extract at 5 and 9 WAP.The lowest root fresh weight in SAMPEA 10 at 5, 7 and 9 WAP due to the 200 g/l *Alectra*aqueous extract was only similar to that due to 150g/l *Alectra*aqueous extract on each sampling date.

IAR-00-1074: The highest root fresh weight in IAR-00-1074 at 5, 7 and 9 WAP due to the control treatment was significantly higher than that due to all the other treatments at 9 WAP, but similar to that due to 50 g/l *Alectra*aqueous extract at 5 and 7 WAP. This was followed by that due to 50 and 100 g/l *Alectra*aqueous extract treatments.The lowest root fresh weight in IAR-00-1074 at 5, 7 and 9 WAP due to the 200 g/l *Alectra*aqueous extract was similar to that due to 150 g/l *Alectra*aqueous extract on each sampling dates.

The combined ANOVA of the data on root fresh weight showed that, the *Alectra vogelii*aqueous extract treatments reduced the root fresh weight of the cowpea variety. This reduction increased as the aqueous extract concentration increased. The lowest root fresh weight was observed at 200 g/l *Alectra*aqueous extract on each sampling date (Table 4.19).

Table 4.19: Effect of *Alectra*Aqueous Extract(Based on Combined ANOVA) on Root Fresh WeightCowpea Varieties

***Alectra*Extract (g/l)**	**Root Fresh Weight(g) Plant Age (WAP)**		
	5	**7**	**9**
0	3.23[a]	4.05[a]	4.72[a]
50	2.62[b]	3.42[b]	3.72[b]
100	2.31[c]	2.69[c]	3.06[c]
150	2.11[d]	2.41[d]	2.72[d]
200	1.81[e]	2.06[e]	2.40[e]
Mean	**1.00**	**2.08**	**2.68**
SE±	**0.02**	**0.05**	**0.06**

Means with the same superscript along each column, are not significantly different (P<0.05), using DMRT.
WAP = weeks after planting

The highest root fresh weight at 5, 7 and 9 WAP due to the control was significantly higher than that due to all the other treatments. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract. However, the lowest root fresh weight at 5, 7 and 9 WAP due to 200g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments.

4.3.11 Root Dry Weight

The 0g/l *Alectra vogelii* aqueous extract (control treatment) resulted in the highest root dry weight, while 200 g/l *Alectra*aqueous extract resulted in the lowest in each cowpea variety. *Alectra*aqueous extract reduced root dry weight in cowpea varieties and thisreduction increased with concentration of the extract. The root dry weight of the cowpea varieties increased with the plant age (Table 4.20).

SAMPEA 7: The highest root dry weight in SAMPEA 7 at 5, 7 and 9 WAP due to the control treatment was significantly higher than that due to all the other treatments at 5 WAP, but, at 7 and 9 WAP it was similar to that due to 50g/l *Alectra*aqueous extract. On the other hand, the lowest root dry weight at 5, 7 and 9 WAP in SAMPE 7 due to 200 g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments at 7 WAP, but similar to that due to 150 g/l *Alectra* aqueous extract at 5 and 9 WAP.

SAMPEA 9: The highest root dry weight at 5, 7 and 9 WAP in SAMPEA 9 due to the control treatment *Alectra*aqueous extract was significantly higher than that due to all the other treatments, except at 9 WAP when it was only similar to that due to 50 and 100g/l *Alectra*aqueous extract.This was followed by that due to 50 and 100 g/l *Alectra*aqueous extract treatments on all the sampling dates.On the other hand, the lowest root dry weight at 5, 7 and 9 WAP in SAMPEA 9 due to 200g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments, except being similar to that due to 100 and 150g/l *Alectra*aqueous extract at 5 WAP (Table 4.20).

Table 4.20: Effect of *Alectra vogelii*AqueousExtract on Root Dry Weightof Cowpea Varieties

Variety	*Alectra* Extract (g/l)	Root Dry Weight(g) Plant Age (WAP)		
		579		
SAMPEA 7	0	0.50[a]	0.83[a]	1.40[a]
	50	0.37[b]	0.77[a]	1.20[ab]
	100	0.30[bc]	0.60[b]	1.00[bc]
	150	0.23[c]	0.53[b]	0.80[c]
	200	0.20[c]	0.40[c]	0.63[c]
	Mean	**0.32**	**0.63**	**1.01**
	SE±	**0.03**	**0.04**	**0.11**
SAMPEA 9	0	0.60[a]	1.07[a]	1.97[a]
	50	0.43[b]	0.83[b]	1.83[a]
	100	0.27[c]	0.80b[c]	1.83[a]
	150	0.23[c]	0.73[c]	1.43[b]
	200	0.20[c]	0.53[d]	1.03[c]
	Mean	**0.35**	**0.79**	**1.62**
	SE±	**0.04**	**0.03**	**0.05**
SAMPEA 10	0	0.47[a]	1.00[a]	2.07[a]
	50	0.40[b]	0.97[a]	2.00[a]
	100	0.30[c]	0.73[b]	1.67[b]
	150	0.20[d]	0.63[b]	1.40[c]
	200	0.20[d]	0.40[c]	1.00[d]
	Mean	**0.31**	**0.75**	**1.63**
	SE±	**0.01**	**0.05**	**0.07**
IAR-00-1074	0	0.50[a]	0.93[a]	2.00[a]
	50	0.43[b]	0.97[a]	1.83[a]
	100	0.27[c]	0.67[b]	1.83[a]
	150	0.20[c]	0.53[c]	1.13[b]
	200	0.20[c]	0.47[c]	0.90[c]
	Mean	**0.32**	**0.71**	**1.54**
	SE±	**0.02**	**0.03**	**0.06**

Means with the same superscript along each column, under each variety are not significantly different (P<0.05), using DMRT.
WAP = weeks after planting

SAMPEA 10: The highest root dry weight at 5, 7 and 9 WAP in SAMPEA 10 due to the control treatment was significantly higher than that due to all the other treatments at 5 WAP, but similar to that due to 50 g/l *Alectra*aqueous extract at 7 and 9 WAP.This was followed by that due to 100 and 150g/l *Alectra*aqueous extract which are only similar 200 g/l at 5 WAP, and significantly higher than 200 g/l *Alectra*aqueoustreatments at 7 and 9 WAP.The lowest root dry weight at 5, 7 and 9 WAP in SAMPEA 10 due to 200g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments, except being similar to that due to 150g/l *Alectra* extract at 5 WAP.

IAR-00-1074: The highest root dry weight at 5, 7 and 9 WAP in IAR-00-1074 due to the control treatment *Alectra*aqueous extract was significantly higher than that due to all the other treatments at 5 WAP, but at 7 and 9 WAP it was similar to that due to 50g/l *Alectra*aqueous extract.The lowest root dry weight at 5, 7 and 9 WAP in IAR-00-1074 due to 200g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments at 9 WAP, but similar to that due to 150g/l *Alectra* aqueous extract at 5 and 7 WAP (Table 4.20).

The combined ANOVA of the data on root dry weight showed that, the *Alectra vogelii*aqueous extract treatments reduced the root dry weight in the cowpea varieties. This reduction increased as the concentration increased. The lowest root dry weight was observed at 200 g/l *Alectra*aqueous extract on each sampling date (Table 4.21).

The highest root dry weight at 5, 7 and 9 WAP due to the control treatment was significantly higher than that due to all the other treatments. This was followed by that due to 50 and 100g/l *Alectra*aqueous extract. However, the lowest root dry weight at 5, 7, and 9 WAP due to 200g/l *Alectra*aqueous extract was significantly lower than that due to all the other treatments.

Table 4.21: Effect of *Alectra*Aqueous Extract (Based onCombined ANOVA) on Root Dry Weight of Cowpea Varieties

Alectra/ Extract (g/l)	Root Dry Weight(g) Plant Age (WAP)		
	579		
0	3.23[a]	4.05[a]	4.72[a]
50	2.62[b]	3.42[b]	3.72[b]
100	2.31[c]	2.69[c]	3.06[c]
150	2.11[d]	2.41[d]	2.72[d]
200	1.81[e]	2.06[e]	2.40[e]
Mean	**0.33**	**0.72**	**1.45**
SE±	**0.01**	**0.02**	**0.04**

Means with the same superscript along each column, are not significantly different (P<0.05), using DMRT.
WAP = Week After Planting

CHAPTER FIVE

5.0 DISCUSSION

The phyhtochemical screening of*Alectra vogelii*showed that, it contains alkaloids, cyanogenic glycosides, flavonoids, saponins and tannins. The release of such phytochemicals into the environment or field can surpress and depress the growth of cowpea and in some cases, not allowing the seeds to germinate. Theexperiment revealed that, different concentrations of *Alectra vogelii* aqueous extracts reduced cowpea seed germination.It was observed that,the inhibitory effect of *Alectra vogelii*aqueous extract on seed germination and seedling growth was dependent on the extract concentration, that is, inhibition increased as the extract concentration increased. These findings is similar to the report of Lawan *et al*.(2010) and Sazada *et al*.(2009) who reported that, allelopathy of phenonyl group is concentration dependent phenomenon.The reduced cowpea seed germination and the root and shoot length of plant seedlings under laboratory conditions indicatedthe accumulation of the toxic substances (Allelopathic potentials) of*Alectra* plant extract. This finding correlated with the reports of Rafinqulhoque *et al*. (2003). Ashrati *et al*. (2007), and Lawan (2011)that indicated that, many weeds and some plants species contain secondary plant products (metabolites) that have allelopathic potentials which resulted to reduce in germination and growth of*Tithonia diversifoli* seedlings.This result is also similar to the findings of Bano *et al*. (2012) and Musniyi*et al*. (2012) who reported the inhibitory effect of neem leaf extracts on root growth of wild Oat seedlings and the growth of *Cleane gyandra* and paddy, respectively.

Among the four cowpea varieties used in this study, the control treatment significantly had the highest germination than all*Alectra* extract treatments. Thisindicates that *Alectra vogelii*plants extractinhibited the germination and growth of cowpea seedlings. This can have serious negetive effects on the growth of crops in a field infested with the witchweed. It was observed that, reduction in seed germination percentage increased with increase in the extract concentration. This is in agreement with the findings of Chon *et al*. (2002) and Jayakumar and Manikandan (2008), that reported the inhibitory effect of leaf extract of *Eucalyptus*(hybrid) on the germination of certain food crops.

In the laboratory experiment, the control produced the highest root and shoot length in the four cowpea varieties used, to indicate that,*Alectra* extract reduced seedling growth, and the peak of this was at100g/l *Alectra* extract treatments. This could have been due to increase in the*Alectra* extract concentration which led to higher reduction in cowpea growth. The seedling weight of the cowpea under the control treatment was observed to have the highest weight over all the other treatments, except being only similar to 50 g/l *Alectra* extract.The results obtained showed that,*Alectra vogelii* aqueous extract reduced the fresh and dry weight of shoot and root, leaf number of the cowpea plants. This will invariably lead to poor crop growth. Furthermore, there was a highly significant reduction in root nodules number in all the cowpea varieties particularly at higher concentration compared with the control treatment. This may be due to the phytochemicals present in the*Alectra* plants extract that inhibited cowpea plants root nodule formation. Rice(1974) reported that, the phytochemicals are potential inhibitors of *Rhizobium* which may lead to reduced root nodulation. The plant used in the study had lessroot nodules compared to the control treatment plant. Thus, increase in*Alectra* infestation in a field or environment led to the decrease in the

number of nodules.The inhibitory effect of the *Alectra* extract may be as a result of the presence of toxic chemicals in the weed plant.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 SUMMARY

The *Alectra vogelii* plant used in this study containedSaponins (46.50 %),flavonoids (16.04 %), tannins (0.247 %), cyanogenic glycosides(0.212 %) and alkaloids(0.08 %).The experiment revealed that, different concentration of *Alectra vogelii* aqueous extracts reduced seed germination with the highest effect at the highest concentration (200 g/l).The control treatmenthad the highest root and shoot length among the four cowpea varieties used to indicate that *Alectra* extract at all concentrations investigated reduced cowpea seedling growth. The control treatment had the highest number of leaves compared to the other treatments. There was highly significant reduction in the number of root nodules in all the plant at the higher concentration (200 g/l) as compared with the control treatment. The*Alectra* extract reduced the shoot and root fresh and dry weight observed at 150 and 200 g/l extract concentration. The result obtained in the experiment show the phytochemicals present in the *Alectra* extract whichconsequently led to the reduction in the plant growth.In conclusion, the experiment revealed that,*Alectra* extract contain certain toxins or phytochemicals which could be released into the soil and inhibit the seeds germination and plant growth.

6.2 CONCLUSION

The laboratory and pot experiments showed that,*Alectra vogelii* aqueous extract reduced the germination and growth of the four cowpea varieties used in the study. It was discovered that, *Alectra vogelii* plant contains allelochemical that include,

alkaloids, cyanogenic glycosides, flavonoids, saponins and tannins. Therefore, it is necessary not to allow *Alectra vogelii* and other related parasitic weeds plants and their residues in the field, even after being removed from an infected crops.

6.3 RECOMMENDATION

Thefinding showed that,*Alectra vogelii*plants that areleft in the field or farm landcontained allelochemicals (phytotoxins) that are inhibitory to cowpea seed germination and growth (production). Therefore, *Alectra* plants must be uprooted and removed from the fields to avoid allelopathic influence on succeeding crops.Agricultural Extention agents should educate farmers on how to properly discard*Alectra vogelii* residue removed from the fields or farms.

REFERENCES

Adeola, S.S., Folorunso, S.T., Gana, E.N., Amadu, M.Y., and Owolabi, J.O. (2012). Productivity and Profitability Analysis of Productivity of Cowpea in Kaduna State. *Advanced Applied Science Research*, **2**(4): 72-78

Agarwal, A., Gahlot, A., Verma, R, and Rao, P. (2002).Effects of weed extracts on Seedling Growth of some varieties of wheat. *Journal of Environmental Biology*, **23**: 19-23.

Ajeigbe, H. A., Ekeleme, F., and Chikoye, D. (2010). Final project report: Gatsby improved CropLivestock project (Project Number: GAT2833). *Improved crop–livestock system for enhanced food security and income generation in West Africa*. International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. 50 pp.

Ajeigbe, H. A., Mohammed, S. G., Singh, B. B, and Tarawali, S. A. (2001). Crop–livestock integration for sustainable agricultural production in sub-Saharan Africa–a prognosis. *Journal of Sustainable Tropical Agricultural Research,***1**:1–9.

Ajeigbe, H. A., Oseni, T.O. and Singh, B.B. (2006).Effect of planting pattern, crop variety, and insecticide on the productivity of cowpea–cereal systems in Northern Guinea Savanna of Nigeria.*Journal of FoodAgriculture and Environment,***4**(1):145–150.

Ajeigbe, H. A., Singh, B. B., and Oseni, T. O. (1991). Cowpea–cereal intercrop Productivity in the Sudan savanna zone of Nigeria as affected by planting pattern, crop variety and pest management. *African Crop Science Journal*, **13**(4):269–279.

Akujobi, C., Anyanwa, B.N., Onyeze,C., and Ibekwe, V.I. (2004). Antibacterial Activities and Preliminary phytochemical screening of four medical plants.*Journal of Applied Science,***7(3**): 4328-4338.

Alghali, A. M. (1991). The effect of plant spacings on cowpea (*Vigna unguiculata* (L). Walp), insect pest and yields in two sites in Nigeria. *Inter-science and its Application***12**(5 - 6): 707 – 711.

Alonge, S.O. (2000). Effect of *Alectra vogelii* Benth and *Striga gesnerioides* Vatkes on the growth, yield and grain chemicalcomposition of cowpea (*Vigna unguiculata* (L) Walp) varieties. Ph. D. Thesis, submitted to Department of Biological Sciences, Ahmadu Bello University, Zaria. 321 pp.

Alonge, S. O., and Lagoke, S.T.O. (2002). Parasitism of cowpea varieties by *Alectra vogelli* and *Striga gesneriodes. Nigeria Journal of Weed Science*, **15**:39-46.

Alonge, S.O., Lagoke, S.T.O., and Ajakaiye, C.O. (2001a). Cowpea reaction to *Alectra vogelii* I: Effect on growth. *Crop Protection*, **20**: 283-290.

Alonge, S.O., Lagoke, S.T.O., and Ajakaiye, C.O. (2001b). Cowpea reaction to *Alectra vogelii* II: Effect on grain, yield and chemical composition. *Crop Protection,***20**: 291-296.

Alonge, S.O., Oladipo, M.O.A., Dim, L.A., and Ewa, I.O.B. (2004). Effect of *Alectra vogelii* on the mineral element concentration of tolerant cowpea varieties in guinea savanna zone of Nigeria. *Zuma Journal of Basic and Applied Science*,**6**: 103–108.

Alonge, S. O, Tehatchoua, D. and Musa, S. D (2002). Effect of *Alectra vogelii* on the nutrient composition of cowpea varieties, *Nigeria Journal of. Weed Science,* **15**: 31-37.

Ashrati, Z., Mashhadi, H. R., and Sadeghi, S. (2007). Allelopathic effects of Barley (*Hordeum vulgare*) on Germination and Growth of Wild Barley (*Hordeum spontaneum*). *Pakistan Journal of Weed Science Research,***13**(1-2): 99-112

Bagnall-Oakeley, H. (1991). The incidence and control of *Alectra vogelii*, in Embu district, Kenya. In: Ransom J. K, Musselman L. J, Worsham A. D and Parker C. (Eds.), *Proceedings of the 5th International Symposium on ParasiticWeeds*, Nairobi, Kenya

Bano, S., Ullah, M.A., Khaliq, A., Abbasi, K.H., and Khanum, S. (2012). Effect of aqueous extract of sun-dried Neem (*Azadirachta indica* A.) leaf on wheat and wheat weeds (wild Oat and Dumbi sitti) *in vitro*.*International ResearchJournal of Plant Science*, **3**(4): 69-73.

Bationo, A., Boaz, W., Okeyo, J. M., Maina, F., Kihara, J., and Mokwunye, U., (Eds.)(2010). Fighting Poverty in sub-Saharan Africa: *the multiple roles of legumes in integrated soil fertility management.* Springer, Dortdrecht, the Netherlands. Pp. 117–150.

Batish, D. R., Lavanya, K., Singh, H. P., and Kohli, R.K.(2007).Root-mediated Allelopathic Interference of nettle-leaved goosefoot (*Chenopodium murale*) on wheat (*Triticum aestivum). Journal of Agronomy and Crop Science* **193**: 37–44.

Beck, B. D. W. (2001). The effect of *Alectra vogelii* Benth on the yield of njigo beans (*Vigna subterranean* (L.) Verdc.). In: Chr. Weber, H., and Forstreuter, W. (Eds.). *Parasitic Flowering Plant*,Phillips University, Marburg, Gemarny. pp.79-82.

Bohm, O. I. and Kocipoi-Abyzan, S. (1984). Plant phytochemical screening guide to Plants Analysis, *Journal of Plant Science*.**9**: 14 - 19.

Boukar, O. Kong, L. Singh, B.B., Murdock, I., and Ohm, H. W. (2004). AFLP and AFLP-derived SCAR markers associated with *Striga gesnerioides* resistance in Cowpea {*Vigna unguiculata* (L.) Walp.}. *Crop Science,* 44:1259-1264.

Carsky, R. J. (2003). Cowpea grain yield from resistance to *Striga gesnerioides* parasitism in southern Benin. *Experimental Agriculture*. **9**(2): 73-75.

Carsky, R. J., Vanlauwe, B., and Lyasse, O. (2000). Cowpea rotation as a resource management technology for cereal-based systems in the savannas of West Africa. In: Fatokun, C. A, Tarawali, S. A., Singh, B. B., Kormawa, P. M, Tamo, M. (Eds.). Challenges and Opportunities for Enhancing Sustainable Cowpea Production. International Institute of Tropical Agriculture, Ibadan, Nigeria, pp. 252–266.

Carsky, R. J., Akakpo, C., Singh, B. B. and Detongnon, J. (2003). Cowpea grain yield from resistance to *Striga gesnerioides* parasitism in Southern Benin. *Experimental Agriculture,* **39**(3): 327-333.

Chon,S.U., Jung, S.D., Piyo,B.S., and Kims, M. (2002).Effect of Alfalfa leaf extract and phenolics allelochemicals on early seedling growth of barnyard grass. *Crop bbbbbbbbbbbbxzxvczzxProtection*,**5**:107-138.

Cisse, N., and Hall, A. E., (2003). *Traditional Cowpea in Senegal*. www.FAO.org /ag/AGP/AGPC/doc/publicat/cowpea_cisse/cowpea-cisse.htm. Retrieved 2014

Coulibaly O., Lowenberg-Deboer J., and Jim, U. (2002): The economics of cowpea in West Africa. Pp. 351-366. In: Fatokun, C.A., S.A. Tarawali. B.B. Singh., P.M. Komawa, and M. Tamo. (Eds). Challenges and opportunities for enhancing sustainable cowpea production.*Proceedings of the World Cowpea comference III*,held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 4-8 September, 2000. IITA, Ibadan, Nigeria.

Dugje, I.Y., L.O. Omoigui, F. Ekeleme, A.Y.Kamara, and H.A. Ajeigbe. (2009). Farmers` guide to cowpea production in West Africa. IITA, Ibadan, Nigeria. 22 – 24 March, 2009. 20.

Duncan, D. W. (1955). Muliple range and multiple 'F' test *Biometrics,* 11; 1-42.

Emechebe, A. M., Ellis-Jones, J., Schulz, S., Chikoye, D., Douthwaite, B., Kureh, I., Tarawali, G., Hussaini, M. A., Kormawa, P., and Sanni, A. (2004). Farmers' perception of the *Striga* problem and its control in northern Nigeria. *Experimental Agriculture*, **40**:215–232.

Emechebe A.M., and Lagoke S.T.O. (2002). Recent advances in research on cowpea diseases. Pp. 94-123. In: Fatokun, C.A., S.A. Tarawali, B.B. Singh, P.M. Komawa, and M. Tamo. (Eds.). Challenges and opportunities for enhancing sustainable cowpea production. *Proceedings of the World Cowpea Conference III* held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 4-8 September, 2000. IITA, Ibadan, Nigeria.

Emechebe, A.M., Leleji, I. O. and Salako, E.A. (1983). Control of root parasitic weeds in Cowpea and groundnut.Paper presented at Institute for Agricultural Research Symposium on *Striga* and its control, 23 May, 1983. Institute for Agricultural Research, Samaru – Zaria, Nigeria.

F.A.O. (2000). FAOSTAT Database. http://apps.fao.org Food and Agriculture Organisation of the United Nations, Rome, Italy. Accessed June, 2000.

FAO-STAT (2009). Food and Agriculture Organization Statistical Database. http://www.fao.org/faostat.

Farnsworth, N.R. (1966). Biological and Phytochemical Screening of Plants. *Journal of Pharmacological Sciences*,**55**:225-276

FEWSNET (2007). Farming and Early Warning System Network. Summary of crop production estimates, Lilongwe, Malawi.*African Journal of General Agriulture*, **6**(1); 26-28.

Gbehounou, G.(1994). Infestation of crop fields by *Striga*species in the savannah zones of northern Nigeria. *Agriculture, Ecosystems and Environment*, **116**: 251-254.

Girma, A., Girefes S., Abdel-Rahman, M. and Tawaha, A.L. (2005). Evaluation of potential trap crops on *Orobanche* soil seed bank and Tomato yield in the central Rift Valley of Ethiopia. *World Journal of Agricultural Sciences* **1**(2):148-151.

Harbone, N.V. (1994). *Phytochemical method. A guide to Modern Technique of Plants Analysis* (2nd Edition), Chapman and Hall, London.425 pp.

Hossain, A. K. M. M. (2008). Allelopathic effects of five selected weed species on seed Germination and seedling growth of corn. *Journal of Soil Nature,* **2** (2):13-18.

Hossain, M.K., R.R. Ahamed, and M.B. B. Uddin (2003).Growth inhibitory effect of *Albizia lebbeck* on some agricultural crops. Institute of Forestry and Environmental Sciences. Chittagong. Bangladesh.pp.308-311.

ICRISAT/MAI (2000). Cost-effective soil fertility management options forsmallholder farmers in Malawi. Bulawayo, Zimbabwe: ICRISAT; and Lilongwe, Malawi: Ministry of Agriculture and Irrigation. Crop Production in Tropical Africa. Directorate General for International Co-operation (DGIC), Ministry of Foreign Affairs, External Trade and International Co-orperation, Brussels, Belgium. pp. 809-828.

International Institute of Tropical Agriculture (IITA) (1998).International Institute of Tropical Agriculture. Dry Season Cowpea. 1993, Annual Report, IITA, Ibadan, Nigeria.

International Institute of Tropical Agriculture (IITA). (2001). Crop Improvement in Sustainable Food Production in Sub-saharan Africa. Annual Report, IITA, Ibadan, Nigeria. 65-73 pp.

International Institute of Tropical Agriculture (IITA).(2003). IPM Research Brief No. 1. (IITA), Cotonou, Benin. www.spipm.cgiar.org.

IITA. (2004). Problems of *Orobanche*and *Striga*. *Weed Problems Council Symposium on Parasitic Weeds. Proceeding of a Workshop,* IITA, Ibadan, Nigeria. Pp.18-20.

Jabeen, N., and Ahmad, M. (2009). Possible Allelopathic Effects of Three Different Weeds on Germination and Growth of Maize (*Zea mays* L.) Cultivars. *Pakistan Journal of Botany*,**41**(4): 1677-1683.

Jayakumar, M. and Manikandan,M. (2008). Allelopathic potentials of *Acacia leucopholea* on germination and growth of groundnut and Sorghum. *Allelopathy Journal*,**15**: 123-127.

Joel, D. M.**(**2000). The long-term approach to parasitic weeds control: manipulation ofspecific developmental mechanisms of the parasite. *Crop Protection*,**19**, 753-758.

Joel, D. M, Hershenhorn, J., Eizenberg, H., Aly, R., Ejeta, G., Rich, P. J., Ransom, J. K., Sauerborn, J., and Rubiales, D. (2007).*Biology and Management of Weedy Root Parasites*. Horticulture Revolution.**33**:267–349

Kabambe, V. H and Drennan, D. S. H. (2003). Control of *Striga asiatica* in maize by means of crop rotation and intercropping in Malawi. In: Mloza- Banda, H. R., Salanje, G. F. (Eds.). *Proceedings of the 19th Biennial Weed Science Society Conference for Eastern Africa*. Lilongwe, WSSEA, 105-111 pp.

Kabambe, V., Katunga, L., Kapewa, T., and Ngwira, A. R. (2008). Screening Legumes for Integrated Management of Witchweeds (*Alectra vogelii* and *Striga asiatica*) in Malawi. *African Journal of Agriculture Research,***13**:708-715.

Kamara, A.Y., Chikoye, D., Ekeleme, F., Omoigui,L. O. and Dugje, I. Y. (2008): Field Performance of improved cowpeavarieties under conditions of natural infestation by theParasitic Weed *Striga gesneroides*. *International Journal of Pest Management*, 54: 189-195.

Kamara, A. Y., Menkir, A., Chikoye, D., Omoigu, L. O. and Ekeleme, F. (2007). Cultivar and Nitrogen Fertilization effect on *Striga* infestation and grain yield on early maturing tropical maize. *Maydica, Pest Management Journal*, **52**: 415-423.

Karanja, J. K., Nguluu, S. N, and Gatheru, M. (2010). Farm yard manure reduces the virulence of *Alectra vogelii* (Benth) on cowpea (*Vigna unguiculata).* Paper presented at Bondo University College conference, February. Kenya.

Karanja, J., Nguluu, S., and Gatheru, M. (2012). Farm yard manure reduces the virulence of *Alectra vogelii* (Benth) on cowpea (*Vigna unguiculata*).*African Journal of Plant Science.***6**(3): 130-136).

Karanja, J., Nguluu, S. N., and Mwangi, G. (2011). The reaction of cowpea (*Vigna unguiculata*) to *Alectra vogelii* (Benth.) parasitism as influenced by Nitrogen and Phosphorus fertilization KASAL.End of Programme Conference and Exhibition, August, 2011. http://www.kari.org/kasal

.

Kayode, J and Ayeni, J.(2009). Allelopathic effects of some crop residues on the Germination and growth of maize (*Zea mays* L.). *Pacific Journal of Science and Technology,* **10**(1): 345-349.

Kimiti, J. M., Odee, D. W., and Vanlauwe, B. (2009). Area under grain legumecultivation and problems faced by small holder farmers in legumeproduction in the semi-arid, Eastern Kenya. *Journal of SustainableDevelopment in Africa*, **11**(4): 104-107.

Kim, S. K. (2000). Horizontal resistance, misunderstanding, approach and importance. In: Kim, S. K., Robinson, K., Atkinson, V. O., Adetimirin, C., and Salle, G. (Eds.) Combating *Striga* parasitic weeds through horizontal resistance. *Proceedings of International Workshop on Horizontal Resistance for Controlling Parasitic Weeds*. Held at Hotel President World Center, Brussel, Belgium.

Kroschel, J. (2001). *A tropical manual for parasitic weed research and extention*. Kluwer Academic Publishers, Dordrecht, the Netherland. 256pp.

Kumbhar, B. A.and Dabgar, Y. B. (2011) Allelopathic effects of aqueous extracts of *Euphorbia thiamifolia* on germination and seedling growth of *Cajanus cajan*(L.)*Journal of Bioscience Research*, **2**(2): 62-66.

Kureh,I. (1999), Reaction of soybean varieties to Preconditioning and concentration of seed inoculum of *Alectra vogelii* (Benth). *Science Forum, Journal of Pure and Applied Science,***2,** (1): 116- 124.

Kureh, I. and Alabi, S. O.(2003). The parasitic angiosperm *Alectra vogelii* (Benth.) can influence the growth and nodulation of host soybean(*Glycine max* (L.) Merrill). *Crop Protection,***22**:361-367.

Kureh, I., Alabi, S. O. and Kamara A. Y. (2005a). Response of Soyabean Genotype to *Alectra vogelii* Infestation under Natural Field conditions. *Tropicultura*, **23**(3): 183-189.

Kureh, I., Segun, A., Lagoke S. T. O. and Mohammed, S. (2005b). Host Plant resistant and anti-transpirant for the control of *Alectra vogelii* in soyabean bean. *Journal of Food Agriculture and Environment*. **3**(2):176-180.

Kwaga, Y.M. (2004). Effect of genotype, N,P and herbicide treatment on the reaction (*Arachis hypogaea* L.) to *Alectra vogeili* (Benth). Doctor of Philosophy Thesis Department of Agronomy, Ahmadu Bello University, Zaria. Pp.74 – 146

Kwaga, Y. M., Olufajo, O. O., Tanimu, B., Shebayan, J. A. Y., and Lagoke, S. T. O. (2010). The reaction of groundnuts (*Arachi hypgaea* L.) to *Alectra*parasitism, as influenced by nitrogen and phosphorus fertilization atSamaru, Nigeria. *American-EurasiaJournal of Agriculture and Environment Science,***7**(6): 628-633.

Lagoke,S.T.O., Singh, B.B., Odion, C., Alahira, C.C., Alabi, O., Shebayan, J., and Magani, I. (1996b)**;** Host-plant resistance for the management of *Striga gesneriodes* (Wild.) Votke and *Alectra vogelii*in cowpea (*Vigna unguiculata* (L.) Walp) in Nigeria. In; Integrated *Striga* Management Technologies: from research to farmers in sub-saharan Africa. *Proceedings. Fourth General Workshop. Pan-Africa; Striga Control Network* (PASCON) (In Press) Bamako- Mali, 28 October- 1 November, 1996.

Langyintuo, A. S., Lowenberg-DeBoer, J., Faye, M., Lamber, D. and Ibro, G. (2003). Cowpea supply a demand in West Africa. *Field Crops Research,***82**:215–231.

Lawan, S. A. (2011): Suppressing effect of *Chenopodium album*(L.) water extracts on some *Amaranthus* species. *Biological and Environmental Science Journal for the Tropics,* **8**(1): 23-26.

Lawan, S.A., Iortsuun, D.N., Alonge, S.O. and Yahya, S.U. (2010). Evaluation of allelopathic influence of *Acacia sieberiana* and *Eucalyptus camaldulensis* on maize and cowpea. *Biological and Environmental Science Journal ofthe Tropics,***7**(2): 26-30.

Lucky, O. Omoigui, B., Ousmane, K. and A. Kamara. (2012). integrated *Striga* and *Alectra* management in Africa (ISAM): Progress on Cowpea Variety Improvement in Nigeria. *Annual Review and Planning Meeting,International Conference*, May, 2012.

Magani, I.E. (1991). Reaction of cowpea varieties to *Alectra* in Northern Guinea Savanna. *Paper presented at the 19 Annual Conference of the Weed Science Society of Nigeria.* ABU, Zaria, Nigeria, 1-10.

Magani, E. I. (2004). Effect of fertilizers and herbicides on the reaction of cowpea varieties (*Vigna unguiculata* (L.) Walp) to *Alectra vogelii* Benth; Doctor of philosophy Thesis, Department of Agronomy, Ahmadu Bello University, Zaria. 138 pp.

Magani, I. E., and Lagoke, S. T. O. (2009). Mechanism of reaction of cowpeavarieties to *Alectra vogelii* (Benth) and its control. *Journal of Applied Bioscience,***14**: 775 – 781.

Ministry of Agriculture, Irrigation and Food Security MOAIFS (2005). A Guide toAgriculture and Natural Resources Management in Malawi. Agricultural Extension Branch. Lilongwe, Malawi. *African Journal of General Agriculture,***6**(1):708-715.

Ministry of Agriculture and Food Security (MoAFS) (2008). Agricultural Production Estimates, 2007/08 season. Planning Department. (MoAFS). Lilongwe. Ministry of Agriculture and Food Security.

Mugabe,E.I. (1983). Effect of *Alectra vogelii* Benth on Cowpea (*Vigna unguiculata* (L.) Walp) I. Some aspects on reproductionof cowpea. *Zimbabwe Journal of Agricultural Research,***21** (2): 135-147.

Musniyi, D.M., Kahihu, S.W., Buyela. D.K and Sikuku, P.A. (2012). Allelopathic effects of Mexican Sunflower [*Tithonia diversifolia* (Hemsl) A. Gray] on Germination and Growth of Spiderplant (*Cleome gynandra* L.). *Journal of Biodeversity and Environmental Sciences,***2**(8): 26-35.

Naseem, H., Aslam, M., Ansar, M. and Azhar, M. (2009)**.** Allelopathic effects of sunflower water extract on weed control and wheat productivity. *Pakistan Journal of Weed Science Research,* **15**(1): 107-116.

Naseem, H., Neuenschwander, P., Borgemeister, C., Langewald, J.(Eds.). (2003). *Biological control in IPM systems in Africa*. CABI Publishing, Wallingford, UK.

Ngwira, A.R. (2008). Scaling out best fit Legume Technologies for Soil Fertility Enhancement among smallholder farmers in Malawi.*African Journal of Agricultural Research,***7**(6):918-928.

Ntombi, R. M. (2003). Effect of *Alectra vogelii* on Cowpea. *Zimbabwe Journal of Agricultural Research,***21**:146-148.

Obadoni, K. (2001). Dormancy and Viability of Witch Weed Seeds as Affected by Temperature Relative Humidity.*Weeds*.**11**:247-248.

Obadoni, K., Obi,V.I., and Omuoha, C. (2000). *Extraction and characterization method of plant and plants product*. In: Ogbulie, J.N. and O.J. Ojiako (Eds.). Biological and Agricultural Techniques. WebsmediaPublication, Owerri, 271- 286 pp.

Ogunkanmi, H.,Olson, B. E., and Wallander, R. T. (2006). Effects of Invasive Forb Litter on Seed Germination, Seedling Growth and Survival. *Basic Applied Ecology*,**3**(4): 309-317 pp.

Okori, P. (2005). Food Security and Sustainability. *Journal of Agriculture*. *South-East Nigeria*. **1** (2):124-136.-

Olmstead, C.E. and Rice, E.L. (1970). Relative effects of known plant inhibitors on Species from first stages of old-field succession. *Nature,***15**: 165-173.

Olmstead, R. G., dePamphilis, C. W., Wolfe, A. D., Young, N. D., Elisons, W. J. and Reeves, P. A. (2001). Disintegration of the Scrophulariaceae. *American Journal of Botany.* **88**:348-361.

Olorunmaiye, K. S. and Ogunfolaji, R. T. (2002) Effect of density and duration of *Euphorbia heterophylla* (L) on the Performance of Cowpea (*Vigna unguiculata* (L.) Walp). *Journal of Environmental Biology*, **2**(1):17-22.

Omoigui, L. O., Kamara, A. Y., Ishiyaku, M. F, and Boukar, O. (2012). Comparative responses of cowpea breeding lines to *Striga* and *Alectra* in the dry savanna of North-East Nigeria. *African Journal of Agricultural Research*, **7**(5):747-754.

Omoigui, L.O., Kamara, A.Y., Massawe, F.S., Ishiyaku, M.F., Boukar, O., Alabi, S.O. and Ekeleme, F. (2007). Evaluation of Cowpea Genotypes for their Reaction *to Striga gesnerioides* in the dry savanna of North-East Nigeria. *Africa Crop Science Conference Proceedings***8**:273-278.

Parker, C., and Riches, C. R. (1993). *Parasitic Weeds of the World. Biology and Control*. CAB International. Oxon, UK. 332 pp.

Parkinson, V. (1997). *Trap crops as a Cultural Measure in Striga Control in Africa.* FAO Plant Protection Bulletin,**35**: 51-54.

Polniaszek, T. I., Parker, C., and Riches, C. R 2001). Variation in virulence of *Alectra vogelii* populations on cowpea. *Tropical Pest Management*,**37**:152– 154

Rafiqulhoque, A.T.M., Romel, A., Mohammad, B.U. and Hossain, M.K. (2003). Inhibition of germination and growth behavior of some agricultural crops through application of *Albizia saman* leaf water extracts. *Pakistan Journal of Biological Sciences,* **6**(7): 707-711.

Rambakudzibga, A. M, Manschadi, A. M. and Sauerborn, J. (2002). Host-parasite relations between cowpea and *Alectra vogelii*. *European Weed Research Society*, **42**:249-256.

Rank, C; Rasmussen, L.S., Jensen, S.R., Pierce, S., Press, M.C., and Scholes, J.D. (2004).Cytotoxicconstituents of *Alectra* and *Striga* species. *Weed Research,***44**: 265-270.

Riches, C. R. (2001). *Alectra vogelii* Benth. – A Constraint to Cowpea Production in Southern Africa. In: Mgonja, M. A. (Eds.).*StrigaResearch in Southern Africa and Strategies for Regionalized Control Options*. International Crops Research Institute for the Semi-arid Tropics,Bulawayo, Zimbabwe. 89–91 pp.

Riches, C. R., Hamilton, K., and Parker, C. (2002). Parasitism of grain legumes by *Alectra* species (Scrophulariaceae). *Annual of Applied Biology*.**121**:361–370 pp.

Riches, C. R., Shaxson, L. J., and Munthali, D.C.(2000). Parasitic weed problems in southernMalawi and use of farmer knowledge in the design of control measures.In: Kumwenda, J. D. T, and Kisyombe, F. (Eds.).*Conference on Agricultural Research for Development*,Organised by the Soil Pests Project (University of Malawi) and theMalawi Maize Research Team, Ministry of Agriculture. Mangochi,Malawi, 7-11 June 1993. Munthali, D.C., J.D.T. Kumwenda, and F.Kisyombe. (Eds.). 165-174 pp.

Rice, E. L, (1974).*Allelopathy*. Academic Press, New York.

Romman, S. A., Shatnawi, M., and Shibli, R. (2010) Allelopathic effects of spurge (*Euphorbia hierosolymitana*) on wheat (*Triticum durum*).*Journal of Agricultural Environment Science*, **7**(3):298-302 pp.

Rubiales, D**. (**2001). Parasitic plants: an increasing threat. *Grain Legumes*,**33**, 10-11.

Rubiales, D., Perez, D., Luque, A., Fernandez-Aparica, M., Sillero, J. C., Roman, B., Kharrat, M., Khalil, S., Joel, D. M., and Riches, C. R. (2006). Screening techniques and sources of resistance to parasitic weeds in grain legumes.*Euphytica*, **147**: 187-199.

Sadaqa, E. A., Bawazir, A. A., and Qasem, J. R. (2010). Allelopathic activity of some common Weeds species in Onion fields. *Allelopathy Journal*. **26**(2): 175-184 pp.

Salehi-sumaghi, M.H., Aynehchi, Y., Amin,G.H., and Mahmoodi, Z. (1992).Survey of Iranian plants for Saponnin, Alkaloids, Flavonoides, and Tannins. *Journal of Indian plant.* **2**:281-91.

Sanginga, N., Dashiell, K., Diels, J., Vanlauwe, B., Lyasse, O., Carsky, R. J., Tarawali, S., Asafo-Adjei, B., Menkir, A., Schulz, S., Singh, B. B., Chikoye, D., Keatinge, D., and Rodomiro O.(2003). Sustainable resource management coupled to resilient germplasm to provide new intensive cereal–grain legume– livestock systems in the dry savanna. *Agriculture Ecosystems and Environment***100**:305–314.

Seghatoleslami, M.J., Mousavi, G.R. and Akbari, H. (2012). Studying the allelopathic Effects of shoot and root water extracts of hoary dress (*Cardaria draba* L.) on germination and seedling growth of wheat. *Pakistan Journal of Weed Science Research.***18**: 565-568.

Selleck, G. W.(1972). The antibiotic effect of plants in laboratory and field. *Weed Science*, **20**(2): 189-194.

Sikwesa, M., Mloza-Banda, H.R., Kabambe, V.H. and Phombeya, H.K. (2003). The potential of multipurpose tree species in the integrated management of *Striga asiatica* in maize field in Malawi. *Africa. Crop Science Conference Proceedings*, **6**; 133-137.

Sazada, S., Ruchi, Y., Kavita, Y., Feroze, A.W., Mukesh, K.M., Sudarshana, S. and Farah, J. (2009). Allelopathic potentialities of different concentration of aqueous leaf extracts of some Arable trees on germination and radical growth of *Cicer arietinum* Var.-C-235. *Global Journal of Molecular Sciences*,**4**(2): 91-95.

Singh, B. B. (2002). Breeding cowpea varieties for resistance to *Striga gesnerioides* and *Alectra vogelii.* pp. 154 – 166. In:Fatokan, C. A., S. A. Tarawali, B. B. Singh., P. M. Kormawa, and M. Tamo. (Eds). *Challenges and opportunities for enhancing sustainable cowpea production.* IITA, Ibadan, Nigeria.

Singh, B. B. (2006). Cowpea [*Vigna unguiculata* (L.) Walp]. In: *Genetic Resources, chromosome engineering and crop Improvement*. R.J.S.and P.P. Jauhar, (Eds.) (Boca Raton).117-162 pp.

Singh, B. B, and Ajeigbe, H. A. (2000). Improving cowpea–cereal based cropping systems in the dry savannas of West Africa. In: Fatokun, C. A., Tarawali, S. A., Singh, B. B., Kormawa, P. M. and M. Tamò.(Eds.). Challenges and opportunities for enhancing sustainable cowpea production. *Proceedings of the World Cowpea Conference III* held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 4–8 September, 2000, IITA, Ibadan, Nigeria. 278–286 pp.

Singh, B.B. and H.A. Ajeigbe. (2007). Improved cowpea–cereals based cropping systems for household food security and poverty reduction in West Africa. *Journal of CropImprovement*, **19** (1/2): 157–172.

Singh, B.B., H.A. Ajeigbe., C.Endondo., I.B. Mohammed., and O.O. Olufajo. (2004). An improved planting pattern for cowpea-based intercrops in West Africa. Pages 67–68 In: *Proceedings of Fifth European Conference on Grain Legumes and Second International Conference on Legume Genomics and Genetics* held at Dijon, France, 7–11 June 2004. European Association for Grain Legume Research (AEP), Paris, France.

Singh, B.B., Ajeigbe, H. A., Tarawali, S. A., Fernandez-Rivera, S, and Abubakar, M. (2003). Improving the production and utilization of cowpea as food and as fodder. *Field Crops Research*,**84**:169–177.

Singh, B. B, and Emechebe, A. M. (1997). Advances in research on cowpea *Striga* and *Alectra*. Pp. 215-224. In: Singh, B.B., D.R., Mohan Raj, K.E. Dashiell, and L. E. N. Jackai (Eds.) *Advances in Cowpea Research*. Copublication of International Institute of Tropical Agriculture (IITA) and Japan International Research Center for Agricultural Sciences (JIRCAS).

Singh, B. B., Musa, A., Ajeigbe, H. A. and Tarawali, S. (2011). Effect of feeding crop residues of Different cereals and legumes on weight grain of Yankassa rams. *InternationalJournal of Livestock Production*, **2**(2):17–23.

Singh, B.B., Olufajo, O.O., Ishiyaku, M.F., Adeleke, R.A., andAjeigbe, H. A. (2005). Registration of six improved germplasm lines of cowpea with combined resistance to *Striga gesnerioides* and *Alectra vogelii*. *Crop Science*,**46**: 2332-2333.

Snedecor, G. W. and W. G. Cochran (1967). Statistical methods the Lowa State University Press. Ames. Lowa. USA, 507 pp.

Sofowora, E. A. (1993). *Medicinal Plants and Traditional Medicine in Africa*. Department of Pharmacognosy, Obafemi Awolowo University, Ile Ife, Nigeria. 89-102 pp.

Stewart, G. R., and Press M. C. (1990). The physiology and biochemistry of parasitic angiosperms. *Annual Review Plant Physiology and Plant Molecular Biology*. **41**: 127–151.

Tanveer, A.(2010). Allelopathic potential of *Euphorbia helioscopia*(L.) against wheat (*Triticum aestivum* L.), chickpea (*Cicer erietinum* L.) and lentil (*Lens culinaris* Medic.). *Turkey Journal of Agriculture and Forestry*, **34**,(1):75-81,

Tarawali, S. A., Singh, B. B., Gupta, S. C., Tabo, R., Harris, F., Nokoe, S., Fernández-Rivera, S., Bationo, A., Manyong, V. M., Makinde, K., and Odion, E. C. (2002). Cowpea as a key factor for a new approach to integrated crop–livestock systems research in the dry savanna of West Africa. In: Fatokun, C. A., Tarawali, S. A., Singh, B. B., Kormawa, P. M. and Tamo, M. (Eds.). Challenges and Opportunities for enhancing Sustainable Cowpea Production. International Institute of Tropical Agriculture, Ibadan, Nigeria, 233–251pp

Trease, G.E. and Evans, W. C. (1989). *Pharmacognosy*. Barlrene Tindal, Easbourne. Pp. 306-409

Van Burden and Robinson. A. I. (1981). Biological and phytochemical screening of plants. *Journal of Pharmacological Sciences*,**3**:25-36

Van, E. K., Geftmod, A.,Henriet, J., Blade,S.F., and Singh,B.B. (1997). Quantitative assessment of Traditional cropping systems in the Sudan savanna of northern Nigeria. II. Management and productivity of major cropping systems. *SamaruJournal of Agricultural Research*, **14**: 47-60.

Visser, J.H., (2006). Germination stimulants of *Alectra vogelii* (Benth). Seed. *Zeitschrift Für Pflanzenphysiologie*, **74**: 464-469.

Visser, J.H., Dörr, I., and Kollmann, R**. (**2004). The "hyaline body" of the root parasite *Alectraorobanchoides* Benth. (Scrophulariaceae) – Its anatomy, ultrastructure andhistochemistry. *Protoplasma,***121:** 146-156.

Xie, X., Yoneyama, K., Kusumoto, D., Yamada, Y., Yokota, T., Takeuchi, Y. and Yoneýama, K., (2008).Isolation and Identification of *Alectrol* as (+) -*Orobanchyl* Acetate, a Novel Germination Stimulant for Root Parasitic Plants. *Phytochemistry*,**69**: 427-431.

Yohanna, M.K., Olussoji, O., Balarabe, T., Shebayan, J., and Lagoke, S.T.O. (2010). Genotype Effect on the Reaction of Groundnuts to *Alectra vogelii* (Benth.) Infestation in a Sub-humid Environment. *Journal of Weed Science,***6**:10-13.