BIO-CONTROL OF *CERCOSPORA* LEAF SPOT DISEASE OF GROUNDNUT (*Arachis hypogeae*) USING EXTRACTS OF *Moringa oleifera* LAM. AND *Jatropha curcas* L.

BY

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CERTIFICATION

This is to certify that this research work was carried out by Baushe, Mohammed Mohammed in the Department of Crop Science and Technology, School of Agriculture and Agricultural Technology, Federal University of Technology, Owerri.

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DEDICATION

This thesis is dedicated to my mother Hajia Ummakaltume Ibrahim Khalil; my primary school class mate Late Sadiya Haruna, my brother Hassan M. Sabo and all my relatives and friends.

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ABSTRACT

The study was conducted in the School of Agriculture and Agricultural Technology (SAAT) research farm. The Experiment was laid out in a RCBD form. Extracts from roots and seeds of *Moringa oleifera* and *Jatropha curcas* were tested at 10% concentration and sprayed after 2,3 and 4 weeks in three different growing periods of groundnut; 2, 3 and 4 weeks. Some plant extrated were mixed with 3ml of an emulsifier made from castor oil known as RIMULGAN and then separately added to each of the 150ml of the four different plant extracts. Neem oil at 0.6ml, hexaconazole material (6% EC) at 0.3ml and mancozeb (80% WP) at 0.4g/plot were equally used. The test materials significantly reduced the disease severity at 2, 4 and 6 Weeks spray in two, three and four weeks After Sowing (WAS) plots when compared with untreated plots. When the plots were treated after 2 weeks, all the plots showed no severity of the disease (0.00), except plots sprayed with Hexaconazole 6% E.C (0.333), Neem oil (0.667) and RIMULGAN alone which recorded highest severity of the disease (1.00). In three weeks after sowing plots, all the treated groundnuts showed no severity of the disease (0.00), except Hexaconazole 6% E.C and Mancozeb 80% WP (0.333) and untreated plot (0.667), while plot treated with RIMULGAN alone recorded the highest severity of the disease (1.00). In four weeks after sowing plots, the untreated plot recorded highest severity of the disease (1.333), while the groundnuts in other treated plots recorded the same severity of the disease (1.00). At 4WAS, plot treated with RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *M. oleifera* root extract, RIMULGAN + *J. curcas* seed extract, RIMULGAN + *J. curcas* root extract and Neem oil recorded lowest incidence of the disease (0.00%) after two weeks spray, followed by Mancozeb 80% WP (0.333%), while untreated plot recorded the highest (1.667%). In three weeks after sowing, the test materials showed no significant differences on severity of *Cercospora* disease of groundnut after 4 and 6 weeks spray when compared with untreated plot. In four weeks after sowing,

untreated plots (control) recorded highest severity of the disease (2.333) followed by RIMULGAN (2.00). While plots treated with Neem oil and Mancozeb 80% WP recorded lowest (0.333). After 6 weeks spray, plot treated with RIMULGAN + *J. curcas* root extract recorded lowest incidence of the disease (0.00%) in two weeks after sowing, followed by RIMULGAN + *J. curcas* seed extract and Neem oil (0.333%), and while plot treated with RIMULGAN and untreated plot recorded highest (2.00%). In four weeks spray, plots treated with RIMULGAN and control recorded the highest severity of the disease (2.333), followed by *M. oleifera* seed extract (2.00) while groundnut in plots sprayed with Neem oil and Mancozeb 80% WP recorded the least (0.333). Treatment materials showed significant differences on *Cercospora* disease incidence at 2, 4 and 6WAS. It also showed significant differences on overall seed yield and on incidence and severity of non *Cercospora* diseases (late leaf spot, rust, *Alternaria* leaf disease and anthracnose diseases) at 2 and 6 weeks after spray, in two, three and four weeks after sowing when compared with the untreated plot. The summary of this study shows that the plant extracts were able to control both the *Cercospora* and other folia diseases of groundnut. However, the RIMULGAN + seed extracts (*Jatropha* and *Moringa*) were more effective and comparable with Neem oil and synthetic fungicides (Hexaconazole 6% E.C and Mancozob 80% WP) than the root extracts and spray test plant after 2 WAS gave a better result than 3 and 4 WAS.

***Key words*:** Groundnut, *Moringa oleifera*, *Jatropha curcas*, *Cercospora*, Neem oil. RIMULGAN, Mancozob, Hexaconazole

CHAPTER ONE

3.0 Introduction

Plant diseases need to be controlled to maintain the quality and abundance of food, feed, and fiber produced by growers around the world. Different approaches may be used to prevent, mitigate or control plant diseases. Beyond good agronomic and horticultural practices, growers often rely heavily on chemical fertilizers and pesticides (Kerr, 1980). Such inputs to agriculture have contributed significantly to the spectacular improvement in crop production and quality over the past 100 years. However, the environmental pollution caused by excessive use and misuse of agrochemicals by some opponents of pesticides, has led to considerable changes in people's attitude towards the use of pesticides in agriculture (Sandra *et al.,* 2001). Some pest management researchers have focused their efforts on developing pesticide alternatives to synthetic chemicals for controlling insect pests and diseases. Among these alternatives are those referred to as biopesticides (Pal and Gardener, 2006).

The term "biological control" and its abbreviated synonym "biocontrol" have been used in different fields of biology, especially entomology and plant pathology. In entomology, it has been used to describe the use of live predatory insects, entomopathogenic nematodes, or microbial pathogens used to suppress populations of different insect pests (Pal and Gardener, 2006). In plant pathology, the term applies to the use of microbial antagonists to suppress plant diseases caused by fungi as well as the use of host specific pathogens to control weed populations. In both fields, the organism that suppresses the insect pest or pathogen is referred to as the biological control agent (BCA) (Koumoutsi *et al*., 2004). Also, the term biological control has been applied to the use of the natural products extracted or fermented from various sources (Pal and Gardener, 2006).These formulations may be very

simple mixtures of natural ingredients with specific activities or complex mixtures with multiple effects on the host plant as well as the target insect pest or pathogenic organism. In its narrow technical souce, biological control refers to the of introduction of resident living organisms, other than disease resistant host plants in to plants, to suppress the activities and populations of one or more plant pathogenic organisms. A variety of biological control measures are available for use. More than 2400 plant species belonging to 235 families have been identified to possess pest control properties. They range from tiny mosses and lichens to giant trees; from grasses and sedges to legumes and from desert cacti and other succulent plants to forest trees and shrubs. The family Asteraceae contains as many as 261 species (Pal and Gardener, 2006). The plant kingdom therefore offers a diverse array of complex chemical structures and biological activity. These plants are only biodegradable but economical and readly available to synthetic pesticides alternatives (Pal and Gardener, 2006).

Pasteuria penetrans an obligate bacterial pathogen of root-knot nematodes has been used as a BCA (Koumoutsi *et al*., 2004). Hypoviruses as a hyperparasites have been used to infect *Cryphonectria parasitica*, a fungus causing chestnut blight, which causes hypovirulence, a reduction in disease-producing capacity of the fungal pathogen (Milgroom and Cortesi, 2004). Some Bio control agents (BCA) exhibit predatory behavior under nutrient-limited conditions. For example, some species of *Trichoderma* produce a range of enzymes that affect the cell walls of fungi (Benhamou and Chet, 1997).

Antibiotics are microbial toxins that can, at low concentrations, poison or kill other microorganisms. Most microbes produce and secrete one or more compounds with antibiotic activity. *Pseudomonas fluorescens* F113 that produced 2, 4-diacetylphloroglucinol controlled the growth of *Pythium spp.* causing damping off of cowpea (Shanahan *et. al*.,

1992). Agrocin 84 produced by *Agrobacterium radiobacter* kills *Agrobacterium tumefaciens* causing Crown gall disease on some cereals (Kerr, 1980). Bacillomycin D produced by *Bacillus subtilis* AU195 kills *Aspergillus flavus* causing Aflatoxin contamination (Moyne *et al.,* 2001).

Bacillomycin and fengycin produced by *Bacillus amyloliquefaciens* FZB42 affected the growth of *Fusarium oxysporum* causing wilt of groundnut (Koumoutsi *et al.,* 2004). Gliotoxin produced by *Trichoderma virens* infects *Rhizoctonia solani* causing root rots disease of cowpea (Wilhite *et al.,* 2001). Herbicolin produced by *Pantoea agglomerans* C9-1 kills *Erwinia amylovora* causing fire blight disease of wheat (Sandra *et. al*., 2001).

Diverse microorganisms secrete and excrete other metabolites that can interfere with growth of pathogen and/or its activities. Many microorganisms produce and release lytic enzymes that can hydrolyze a wide variety of polymeric compounds, including chitin, proteins, cellulose, hemicellulose, and DNA. Expression and secretion of these enzymes by different microbes can sometimes result in the suppression of activities of plant pathogen directly. For example, control of plant diseases caused by *Sclerotium rolfsii* using *Serratia marcescens* was atributed to enzyme chitinase (Ordentlich *et al.,* 1988). The biocontrol activities of *Lysobacter enzymogenes* strain C3 has been atributed to b-1, 3-glucanase (Palumbo *et al.,* 2005). *Lysobacter* and *Myxobacteria* Spp. are known to produce lytic enzymes, and some isolates have been shown to be effective at suppressing fungal plant pathogens (Bull *et al.,* 2002). Some products of lytic enzyme activity have been reported to suppress disease. For example, oligosaccharides derived from fungal cell walls are known to be potent inducers of plant host defenses. Interestingly, *Lysobacter enzymogenes* strain C3 has been shown to induce plant host resistance to disease (Kilic-Ekici and Yuen 2003). in postharvest disease control, addition of chitosan can stimulate microbial degradation of pathogens similar to that of an applied hyperparasite (Benhamou, 2004). Chitosan is a non-

toxic and biodegradable polymer of beta-1,4-glucosamine produced from chitin by alkaline deacylation. Amendment of plant nutrient with chitosan suppressed the root rot disease caused by *Fusarium oxysporum* f. sp. *radicis-lycopersici* in tomato (Lafontaine and Benhamou, 1996). Hydrogen cyanide (HCN) effectively blocks the cytochrome oxidase pathway and is highly toxic to all aerobic microorganisms. The production of HCN by certain fluorescent pseudomonades is believed to be involved in the suppression of pathogens (Voisard *et. al*., 1989). Howell *et. al*., (1988) reported that volatile compounds such as ammonia produced by *Enterobacter cloacae* were involved in the suppression of *Pythium ultimum*-induced damping-off of cotton. Genetic work of Anderson *et. al*., (1988) revealed that production of a particular plant glycoprotein called agglutinin was correlated with potential of *P. putida* to colonize the root system. *P. putida* mutants deficient in this ability exhibited reduced capacity to colonize the rhizosphere and a corresponding reduction in Fusarium wilt suppression in cucumber (Tari and Anderson, 1988). Plants actively respond to a variety of chemical and environmental stimuli, including gravity, light, temperature, physical stress, water and nutrient availability. Such stimuli can either induce or condition plant host defenses through biochemical changes that enhance resistance against subsequent infection by a variety of pathogens. A number of strains of root-colonizing microbes have been identified as potential elicitors of plant host defenses. Some biocontrol strains of *Pseudomonas* sp. and *Trichoderma* sp. are known to strongly induce plant host defenses (Haas and Defago, 2005). In several instances, inoculations with plant-growth-promoting rhizobacteria (PGPR) were effective in controlling multiple diseases caused by different pathogens, including anthracnose (*Colletotrichum lagenarium*), angular leaf spot (*Pseudomonas syringae* pv. *lachrymans* and bacterial wilt (*Erwinia tracheiphila*) (Van Loon *et. al*., 1998, Ongena *et al*. 2004, Ryu *et. al.,* 2004). The amino acids produced by plants have been reported to help them to resist some parasites (Voisard *et al.,* 1989).

Another natural product for plant care is liverwort. Liverwort extract is rapidly biodegradable and leaves no residue in the soil. It is nontoxic to humans and animals, and effective against bacteria and fungi (Sandra *et. al*., 2001). Plant strengtheners, such as stone-cutter horror mildew strengthen the resilience of plants, thereby making them less likely to be infested by pests and fungi (Milgroom and Cortesi, 2004).

Jatropha curcas plant is one of the important plants with varying biological activities. It contains alkaloids, lignans, cyclic peptides, and terpenes which have shown a wide range of biological activities, such as insecticidal, and fungicidal activities (Makkar, 1993).The seed extract have also been found to inhibit and control maize weevil (*Sitophilus zeamais*) in storage. Adebowale and Adedire, (2006) reported that *J. curcas* oil offered 12-wk protection for treated cowpea seeds against *C. maculatus*. In another study, when J. *curcas* oil was used as an emulsifiable concentrate (JEC) it produced toxicity toward *S. zeamais* (on corn) and *Callosobruchus chinensis* (on mung bean), inhibiting their oviposition when sprayed on them.The methanol extract of J. *curcas* oil containing phorbol esters was also found to exert potent insecticidal effects against *Busseola fusca* and *Sesamia calamistis* larvae (Makkar and

Becker, 1997). Pounded leaves are applied near horses' eyes to repel flies in India. HCN (Hydrogen cyanide) is present in the leaves. The extracts of the plants are dangerous to use but water can easily wash it over if too much extract is applied not applied (Duke, 1985).

Chomnong, 1990 and Aiyelaagbe *et al*., (2007), reported that *J. curcas* and *J. podagrica* roots were found to have cytotoxic and insecticidal activities respectively. The seeds are considered anthelemintic in Brazil. They are ground with palm oil and used as rat poison in Gabon. Aqueous extract to leaves is reported to have insecticidal properties. In Ghana, the leaves are for fumigating houses against bed bugs. The ether extract shows antibiotic

activity against Staphylococcus aureus and Escherichia coli (Makkar and Becker, 1997). The juice of the whole plant is used for stupefying fish in Philippines.

Moringa oleifera Lam possess antibiotic compound found in its flowers and root (pterygospermin) which has powerful antimicrobial and fungicical effects (Duke, 1985). Ojiako and Adesiyun (2008) had reported that *M.oleifera s*eed powder compared favourably with Actellic dust (2%) in the control of *C. maculatus* on stored cowpea and had no effect on viability and organoleptic characteristics of the stored seeds. Soil incorporation of *Moringa* leaves have been known to prevent seedling damping off. While evaluating the effect of four planting materials and fernazzan D on the mycelial growth of *Aspergillus flavus* isolated from stored maize grains. Balogun *et. al*., (2004), found that *M. oleifera* compared most favourably with Fernazan D (synthetic fungicide), by inhibiting completely the radial growth of the fungus after 48 hours inoculation. Ojiako and Adesiyun, (2008) have reported that *M. oleifera* seed powder compared favourably with Actellic dust (2%) in the control of *Callosobruchus maculatus* on stored cowpea which had no adverse effect on its viability, physical properties, nutritional and organoleptic characteristic of the stored seeds (Duke, 1985).

1.1 OBJECTIVES OF THE STUDY

i) To determine the effects of extracts of *J. curcas* and *M. oleifera* seeds and roots on *Cercospora* leaf spot and other foliar diseases of groundnut (*Arachis hypogeae*).

ii) To determine appropriate time of application of the plant extracts against the leaf spot disease (*Cercospora arachidicola*) of groundnut (*Arachis hypogeae*). and

iii) To assess the effect of an emulsifier (RIMULGAN) alone and in combination with the extracts of *J. curcas* and *M. oleifera* on disease incidence and severity, growth and yield of groundnut.

CHAPTER TWO

4.0 LITRATURE REVIEW

2.1 Groundnut Production:

The peanut, or groundnut (*Arachis hypogaea*), is a species in the legume or "bean" family (Fabaceae). It originated in South America but first grown by the Inca of ancient Peru. It was first introduced by the Portuguese slave traders who took them to Africa and elsewhere around the world. African slaves then brought them to the US, which explains why the first names used were of the Congo origin (pindar and goober). But it was not until early in the 20th century that the popularity of the peanut began to soar (David *et al.,* 2003).

Groundnut is the sixth most important oilseed crop in the world. It contains 48-50% oil and 26-28% protein, and is a rich source of dietary fiber, minerals, and vitamins. Groundnut is grown on 26.4 million ha worldwide with a total production of 37.1 million metric tonne and an average productivity of 1.4 metric t/ha (Kerry, 2000). The production of groundnut is concentrated in Asia and Africa with 56% and 40% of the global area and 68% and 25% of the global production, respectively (Kerry, 2000). Cultivated groundnut (*Arachis hypogaea*

L.) belongs to genus *Arachis* in sub tribe *Stylosanthinae* of tribe *Aeschynomenea* of family *Leguminosae*. It is a self-pollinated, tropical annual legume. At locations where bee activity is high, some cross-pollination can occur (Nigam *et al.,* 1983).

Cultivated groundnut has two subspecies, *hypogaea* and *fastigiata*, which in turn have two botanical varieties (var, *hypogaea* and var. *aequatoriana*). Each of these botanical varieties has different plant, pod and seed characteristics (Krapovickas and Gregory, 1994). However, most of the commercially cultivated varieties belong to the *hypogaea* (common name/market type: Spp. or runner), *fastigiata* (valencia), and *vulgaris* (Spanish) botanical variety groups.

The characteristics of these three botanical varieties are described below;
Hypogaea: No floral axes or branches on main stem; alternating pairs of vegetative and reproductive axes on branches (alternate branching); inflorescence simple; vegetative branches moderate to profuse; primary branches longer than main stem; growth habit spreading, intermediate, or erect; usually two seeds per pod; pod beak not very prominent; seed size medium (runner market type) to large (Sp Virginia market type); testa color generally tan (red, white, purple, or variegated also exist); cured seed dormancy moderate; maturity medium to late (Krapovickas and Gregory, 1994).

Fastigiata: floral axes on main stem; irregular pattern of vegetative and productive branches with reproductive branches predominating on branches (sequential branching); inflorescence usually simple; vegetative branches sparse; primary branches shorter than main stem; growth habit upright; two to four seeds per pod; pod beak absent, slight, or prominent; seed size small to medium; testa color tan, red, white, yellow, purple, or variegated; cured seed dormancy little (Krapovickas and Gregory, 1994).

Vulgaris: floral axes on main stem; irregular pattern of vegetative and productive branches with reproductive branches predominating, primary branches shorter than main stem; growth habit upright; mostly two seeds per pod (three seeds are rare); beak may or may not be present; seed size small to medium; testa color tan, red, white, or purple; cured seed dormancy limited (Krapovickas and Gregory, 1994).

2.2 Soil selection

Groundnut requires well-drained sandy loamy soil that facilitate penetration of the pegs after pollination, and easy digging without much pod loss. Groundnut plants are sensitive to salinity, and high soil acidity (pH<5) could induce magnesium or aluminum toxicity. In this type of soil, calcium should be added to maintain the pH above 6 (McSpadden and Fravel,

2002).

2.3 Climatic conditions

The optimum temperature for growing groundnut, range from 25°C to 35°C. Cooler temperatures, especially at night, prolong the growing cycle. Groundnuts are slightly sensitive to photoperiod. Although groundnut is drought tolerant, good performance is strongly linked to adequate soil water content at sowing time, followed by well-distributed rainfall. Early maturing small-seeded varieties require 300-500 mm while the medium to late maturing large-seeded varieties need 1000-1200 mm rainfall (Kerry, 2000).

2.4 Land preparation

Removal of crop residues that spread diseases and harbour pests is important. For light soils, the cleaning should be followed by a shallow raking after the first light rains (Nigam *et al.,* 1983). This eliminates early weeds and breaks up the soil surface. In wetter areas or areas with heavier soils, fields must be ploughed at the beginning of the season to suppress weeds

and break up the soil, which must then be refined by harrowing and raising beds to limit runoff or water logging. If groundnut is to be grown on ridges, they should be made at or just before sowing, and should be flat-topped. If the soil is dry when the ridges are being made, a light rolling after ridging will help make the seedbed firm (McSpadden and Fravel, 2002).

2.5 Fertilizer application

A reasonable level of organic matter must be maintained in the light, weakly structured, tropical soils where groundnuts are grown. The groundnut plant has an extensive root system that allows it to explore a large volume of soil and therefore benefit from organic manure residues from the preceding crop (cereal). Groundnuts can be cultivated with a balanced fertilizer (N-P-K). Calcium must be added to slightly acidic soils to correct the pH and improve the quality of the seeds (McSpadden and Fravel, 2002). The recommended fertilizer rate depends on soil type and varies between 200 to 600 kg/ha of gypsum for large-seeded varieties (Nigam *et al.,* 2004).

2.6 Sowing and spacing

***Sowing*:** planting date is linked to rainfall distribution in a given area and length of the crop season. Soil moisture must be sufficient to guarantee good germination. Seeds must not be sown immediately after heavy rains since they will imbibe too much water, which may cause rotting (Kerry, 2000). This also may result in excessive soil compaction, which may hinder germination. In general early sowing improves yields where as significant delay in sowing can reduce yield by 50% and seed quality (Nigam *et al.,* 2004).

***Plant spacing and seed rate*:** spacing depends on the growth habit and the variety. Small seeded Spanish types are spaced at 60 cm between rows and 10 cm between stations. This gives an optimum plant population of 167,000 per hectare. The large-seeded Virginia types are spaced at 75 cm between rows and 15 cm between stations, giving an optimum plant population of 89,000 per hectare. Under irrigation, plant population can be as high as 250,000 plants/ha. With manual sowing, individual seeds are sown 3-5 cm deep. Mechanized sowing is widely practiced in some countries like Senegal. This is done using a single row planter, generally drawn by a horse or donkey. In this way, one hectare can be sown in 8 hours (Nigam *et al.,* 2004).

2.7.0 Crop maintenance

2.7.1 Weed control

Groundnut cannot compete effectively with weeds, particularly at the early stages of development (3-6 weeks after sowing). Early removal of weeds reduces this competition. Crop rotation may reduce certain species of weeds. Pre- and post-emergence herbicides may be used to eradicate weeds but they are too expensive for most small-scale farmers (Kerry, 2000). Once pegging begins, soil disturbance should be avoided or kept to a minimum, so as not to interfere with the developing pods. Instead weeds at this stage can be controlled by hand-picking (Nigam *et al.,* 1983).

2.7.2 Irrigation

Although groundnut is a rustic plant, high yield can be guaranteed using irrigation. Irrigation also allows off-season groundnut production, which accelerates seed multiplication (Nigam *et al.,* 2004; Baker, 1987).

2.8.0 Pest control

2.8.1 Insect Pests of Groundnut and their control

Pest of groundnut ranges from mammals (ruminant farm animals) and birds to minute winged and wingless insects. These pests mainly feed on groundnut. Most groundnut insect pests are sporadic in occurrence and distribution. In general, insects cause 10-20% crop loss. However, there are instances of total crop loss caused by a single insect species like red hairy caterpillar (FAO, 2003). Virus transmitting insects like jassids, thrips etc. cause losses in yield indirectly by spreading the virus diseases. Soil insects also damage groundnut at low populations, and they are difficult to detect before the damage occurs (Baker, 1987). Other examples of insect pests of groundnut include; Bihar hairy caterpillar (*Spilosoma (Diacrisia) obliqua*), Tobacco caterpillar (*Spodoptera litura*), Red Hairy caterpillars (*Amsacta albistriga*), Gram pod borer (*Helicoverpa armigera*), Aphids (*Aphis craccivora*), Jassids (*Empoasca kerri Bachlucha spp*), Thrips (*Scirtothrips dorsalis, Thrips palmi*), Jewel beetle (*Sphenoptera indica*), Termites (*Odontotermes spp*), White grubs (*Holotrichia consanguinea, Holotrichia serrata*),

Groundnut bruchid (*Empoasca kerri Bachlucha spp*), etc (Nigam *et al.,* 2004).

2.8.1.1 Insect Pest Control

***Cultural Control*:** Deep ploughing (two/three times) will expose the hibernating pupae to sunlight and predatory birds. Removal and destruction of alternate hosts which harbour the hairy caterpillars and growing of trap crops like cowpea, castor and *Jatropha* on field bunds

attract the caterpillars. Irrigating once to avoid prolonged mid season drought prevents preharvest infestation (Kerry, 2000).

***Mechanical Control*:** Setting up bonfires on field bunds during night. Mass collection and destruction of eggs and emerged caterpillars (Jones and Prusky, 2002).

***Biological Control*:** use of natural bio-control agents like spiders, long horned grasshoppers, praying mantid, robar fly, ants, green lace wing, damsel flies/dragon flies, flower bugs, shield bugs, lady bird beetles, ground beetle, predatory cricket, earwig, braconids, trichogrammatids, NPV, green muscular fungus. Use of NPV (nuclear polyhedrosis virus) on cloudy days at 500 LE/ha have reported to be effective. Spraying of *Bacillus thuringiensis* at 1 kg/ha where mulberry is not grown and use of the barconids as parasites to insect pest have been reported (Kerry, 2000).

***Chemical Control*:** Application of insecticides such as dust Lindan (1.3%) or Fanvalerate (0.4%) at 15.20 kg/ha at the early stage of the infestation in a deep furrow trench around the field and dusting with two per cent methyl parathion to prevent the mass migration of hairy caterpillars have been reported. Spraying of quinalphos 25 EC (2 ml/lit), or chlorpyriphos 20 EC (2.5 ml/lit) or endosulfan 35 EC (2.0 ml/lit) are recommended when the caterpillars are younger (Kerry, 2000).

2.8.2 Diseases of Groundnut

2.8.2.1 Early leaf spot

The disease is caused by *Cercospora arachidicola*. Infection starts about 1 month after sowing. Small chlorotic spots appear on leaflets, with time they enlarge and turn brown to

black and assume sub circular shape on upper leaf surface. On lower surface of leaves light brown colouration is seen. Lesions also appear on petioles, stems and stipules (Krapovickas and Gregory, 1994).

In severe cases several lesions coalesce and result in premature senescence of the infected leaves. Sole cropping of groundnut, low temp (25^{o}C), long periods of high relative humidity and rainfall favour the disease (Krapovickas and Gregory, 1994).

Disease Control

***Cultural Control*:** Resistant varieties can be grown wherever early leaf spot is severe. Intercropping with millet or sorghum (1: 3) and crop rotation with non-host crops preferably cereals have been found to be useful in reducing the intensity of early leaf spot.

(Krapovickas and Gregory, 1994).

***Mechanical Control*:** Deep burying of crop residues in the soil, and removal of volunteer groundnut plants are important measures to reduce the primary source of infection (Jones and Prusky, 2002).

***Biological Control*:** Foliar application of aqueous neem leaf extract (2-5%) or 5% neem seed kernel extract at 2 weeks interval 3 times starting from 4 weeks after planting have been recommended (Nigam *et al.,* 1983, Krapovickas and Gregory, 1994, Nigam *et al.,* 2004). ***Chemical Control*:** Spray carbendazim 0.1% or mancozeb 0.2% or chlorothalonil 0.2%

(Krapovickas and Gregory, 1994).

2.8.2.2 Late leaf spot

This fungal disease is caused *Phaeoisariopsis personatum.* Infection starts around 55-57 days after sowing in Kharif and 42-46 days after sowing in Rabi. Black and nearly circular spots appear on the lower surface of the leaflets. Lesions are rough in appearance (Krapovickas and Gregory, 1994). In extreme cases many lesions coalesce resulting in premature senescence and shedding of the leaflets. Temperature of 18-30^{o}C, leaf wetness and a total wetness and a late wet spell, magnesium deficiency and heavy application of nitrogen and phosphorus fertilizers favour the development of disease (Nigam *et al.,* 1983).

Disease Control

***Cultural Control*:** Same as early leaf spot (3.8.3.1).

***Mechanical Control*:** Deep burying of crop residues in the soil, removal of volunteer groundnut plants are important measures in reducing the primary source of infection (Jones and Prusky, 2002).

***Biological Control*:** Foliar application of aqueous neem leaf extract (2-5%) or 5% neem seed kernel extract at 2 weeks' interval 3 times starting from 4 weeks after planting have been recommended (Kessel *et al.,* 2005).

***Chemical Control*:** Spray carbendazim 0.1% or mancozeb 0.2% or chlorothalonil 0.2% (Krapovickas and Gregory, 1994).

2.8.2.3 Rust

This fungal disease is caused by *Puccinia arachidis*. Rust can be readily recognized as orange coloured pustules (uredinia) that appear on the lower leaflet surface and rupture to expose masses of reddish brown urediniospores (Kessel *et al.,* 2005). Pustules appear first on the lower surface and in highly susceptible cultivars; the original pustules may be

surrounded by colonies of secondary pustules. Pustules may also appear on the upper surface of the leaflet. The pustules are usually circular and range from 0.5 to 1.4 mm in diameter. They may be formed on all aerial plant parts apart from flower and pegs (Krapovickas and Gregory, 1994). Severely infected leaves turn necrotic and desiccate but are attached to the plant. Wet weather coupled with a temp of 22-25^{o}C favours the disease (Kessel *et al.,* 2005).

Disease Control

Cultural Control**:** Crop rotation and field sanitation and strict plant quarantine regulations should be enforced to reduce the spread of rust disease to disease free areas. Early sowing in the first fortnight of June, avoid disease incidence. Intercropping with millet or sorghum with groundnut in a ratio of (1:3) is useful in reducing the intensity of the disease as well as use of resistant/tolerant varieties (Jones and Prusky, 2002).

Mechanical Control**:** Destroy volunteer (self sown) groundnut plants and crop debris to reduce / limit primary source of inocula (Jones and Prusky, 2002).

Biological Control**:** Foliar application of aqueous neem leaf extract at 2-5% is useful and economical for the control of rust disease (Kessel *et al.,* 2005).

Chemical Control**:** Spray chlorothaalonil (0.2%) or mancozeb (0.25%) or Hexaconazole/propaconazole to reduce disease incidence (Kessel *et al.,* 2005).

2.8.2.4 Aspergillus crown rot

This disease is caused by *Aspergillus spp*. Seeds may be killed due to pre-emergence rotting and post-emergence infection causes death and rapid decay of seedlings. Young plants collapse and die soon after emergence due to rotting of elongating hypocotyl (Jones and

Prusky, 2002). Collar region becomes dark brown and shredded. In mature plants large lesions develop on stem just below the soil surface and then spread upward along the branches causing wilting and death. The fungus sporulates on the surface of mature pods resulting in black sooty spores. Low soil moisture and high temperature between 30-35^{o}C favour the disease development (Kessel *et al.,* 2005).

Disease Control

Cultural Control: Crop rotation and destruction of plant debris have been recommended (Kessel *et al.,* 2005).

Mechanical Control: Remove and destroy previous season's infested crop debris in the field (Jones and Prusky, 2002).

Biological Control: Seed treatment with *Trichoderma viride/T.harizanum* at 4 g/kg seed and soil application of *Trichoderma viride/T.harizanum* at 25-62.5kg/ha, preferably in conjunction with organic amendments such as castor cake or neem cake or mustard cake at 500 kg/ ha have been found to be useful (Kessel *et al.,* 2005).

Chemical Control: Seed treatment with 3 g thiram/ kg seed is recommended (Kessel *et al.,* 2005).

2.8.2.5 Stem rot

It is caused by a fungus called *Sclerotium rolfsii.* with development of white fungal threads over affected plant tissue particularly on stem as its symptom. Base of the plant turns yellow and then wilts. Sheaths of white mycelium develop around the affected areas of the stem near the soil as a result the stem becomes shredded (Kessel *et al.,* 2005). White sclerotia of mustard seed size are produced in the infected tissues which later turn brown in colour.

Seeds in the infected pods show a characteristic bluish-grey discolouration. The disease is severe with alternate wet and dry periods (Jones and Prusky, 2002).

Disease Control

Cultural Control: Deep ploughing to bury surface litter and cultivation of groundnut in flat or slightly raised beds has been recommended (Kessel *et al.,* 2005).

Biological Control: Seed treatment with *Trichoderma viride/T.harizanum* at 4 g/kg seed and soil application of *Trichoderma viride/T.harizanum* at 25-62.5kg/ha, preferably in conjunction with organic amendments such as castor cake or neem cake or mustard cake at 500 kg/ ha (Kessel *et al.,* 2005).

Chemical Control: Seed treatment with 3g thiram + Carbendazi6m is recommended (Kessel *et al.,* 2005).

2.8.2.6 Bud necrosis

The disease is caused by Peanut Bud Necrosis Virus (PBNV) and it shows by chlorotic spots appearing on young leaflets with necrotic rings and streaks. Terminal bud necrosis occurs when temperature is relatively high (about 37^{o}C). As the plant matures it becomes stunted with short internodes and proliferation of auxiliary shoots. The virus is mainly transmitted by thrips (Kessel *et al.,* 2005). The virus survives in the hosts of thrips which act as vectors carrying the inocula to the host plants. The thrips are carried by wind and their population rapidly from January-March and August-September and the crop suffers heavy losses within these periodboth the seasons (Kessel *et al.,* 2005).

Disease Control

Cultural Control: Early sowing reduces infection. Growing of resistant varieties and destruction of alternate weed hosts like *Bidens pilosa, Erigon bonariensis, Tagetes minuta,* and *Trifolium subterraneum*. increase plant density. Early sowing and intercropping with millet restrict vector movement. Groundnut should be intercropped with fast growing cereal crops such as pearl millet in 7:1 ratio (Jones and Prusky, 2002).

Chemical Control: Spray monocrotophos 1.6 ml/l or dimethoate 2 ml/l (Kessel *et al.,* 2005).

2.8.2.7 Kalahasti malady

It is caused by organism called *Tylenchorhynchus brevilineatus*. Infected plants appear in patches in the field and are stunted with abnormal green leaves. Small, brownish lesions appear on the pegs and on young developing pods. Peg length is reduced and in advanced stages of the disease the entire pod surface becomes blackened. Discolouration is also seen on roots (Jones and Prusky, 2002).

Disease Control

Cultural Control: Grow resistant varieties like Tirupathi-2 and 3 (TPT-3). The disease incidence is less in groundnut fields sown after rice in croprotation (Jones and Prusky, 2002). **Chemical Control:** Apply carbofuran 4 kg a.i (133 kg/ha) 25-30 days after sowing along with irrigation water (Jones and Prusky, 2002).

2.8.2.8 Alternaria leaf disease

It is caused by a bacterium called *Alternaria arachidis* and *A. Tenuissima.* Lesions produced by *A. arachidis* are brown in colour and irregular in shape surrounded by yellowish halos (Jones and Prusky, 2002).. Symptoms produced by *A. tenuissima* are characterized by blight at the apical portions of leaflets which turn light to dark brown colour. In the later stages of

infection, blighted leaves curl inward and become brittle. Lesions produced by *A. alternata* are small, chlorotic and water soaked spread spread over the surface of the leaf. The lesions become necrotic and brown and are round to irregular in shape (Jones and Prusky, 2002). Veins and veinlets adjacent to the lesions become necrotic. Lesions increase in area and their central portions become pale, dry rapidly and disintegrate. Affected leaves show chlorosis and in severe attacks become prematurely senescent. Lesions can coalesce giving the leaf a ragged and blighted appearance (Jones and Prusky, 2002).

Disease Control

Chemical Control: Foliar application of Mancozeb (0.3%) or copper oxychloride (0.3%) or Carbendazim (0.1%) (Krapovickas and Gregory, 1994).

2.8.2.9 Anthracnose

The disease is caused by *Colletotrichum dematium* and *C. capsici.* Small water-soaked yellowish spots appear on the lower leaves which later turn into circular brown lesions with yellow margin (1 to 3 mm in diameter). In some cases lesions enlarge rapidly, become irregular and cover the entire leaflet, and extend to the stipules and stems. The pathogen is seed, soil and air-borne (Kessel *et al.,* 2005).

Disease Control

Cultural Control: Deep ploughing and use of healthy/certified seeds (Jones and Prusky, 2002).

Mechanical Control: Field sanitation (Jones and Prusky, 2002).

Chemical Control: Seed treatment with copper oxychloride or Mancozeb (0.3%) or Carbendazim (0.7%) are effective in controlling the anthracnose disease of groundnut (Jones and Prusky, 2002).

2.8.2.10 Tikka

This disease is caused by the two species of the fungus, *Cercospora*; i.e., *C. Personate* and *C. arachidicola.* It spreads rapidly at a temperature above 22°C and when the relative humidity is high. Small dark brown circular spots appear on the leaves. When the attack is severe, defoliation occurs and only the stem remains. The yield of susceptible varieties is substantially reduced (Kerry, 2000).

Disease Control

Cultural: Treat the seed with Thiram at the rate of 5 g per kg of seed. Collect the affected plant debris and burn them. Grow some of the tolerant varieties like T-64, C-501, MH-4, TMV-6 and TMV-10 (Jones and Prusky, 2002).

Chemical: Give 4 sprays of Outer or Zineb at the rate of 2 kg in 1000 litres of water per hectare at an interval of seven to ten days. The first spray should be given as soon as initial symptoms are detected. Two sprays of Bavistin (0.05 percent solution) have been found very effective against this disease. of Bavistin (Jones and Prusky, 2002).

2.8.2.11 Rosette

This disease is caused by the virus transmitted through aphids. The plants affected by this disease look stunted with bushy appearance. There is a marked reduction in the size of the leaflets and mottling becomes visible (Kerry, 2000).

Disease Control

Cultural Control: Rogue out the infected plants as soon as they appear in the field (Kerry, 2000).

Chemical Control: To check the spread of the disease, aphids should be killed by given a spray of Oxydemeton methyl (Metasystox) 25 EC at the rate of 1 litre dissolved in 1000 litres of water per hectare (McSpadden and Fravel, 2002).

2.8.2.12 Charcoal Rot

This disease is caused by the soil-borne fungus, Macrophomina phaseoli. A red-brown watersoaked lesion appears on stem just above the soil level. The lesion spreads upwards on the stem and down into the roots and causes death of infected plants. The dead tissue is covered with abundant sclerotia (McSpadden and Fravel, 2002).

Disease Control

Mechanical Control: Deep ploughing should be done to bury the crop residues (Jones and Prusky, 2002).

Chemical Control: Seed should be treated with Thiram at the rate of 5 g per kg of seed (Kerry, 2000). Soil application of Brassicol at the rate of 10-15 kg per hectare before sowing have been recommended.

2.8.2.13 Rust

This disease is caused by the fungus, *Puccinta arachidis*. The symptoms of the disease are characterised by the development of red pustules on leaves. Usually more pustules are found

on the lower than on the upper surface. The pustules later become dark brown. Under severe conditions, defoliation and death of plants occur (McSpadden and Fravel, 2002)

Disease Control

Cultural Control: Burning of the diseased plant debris after harvesting is recommended. **Chemical Control:** Spray Zineb at the rate of 2 kg in 1000 litres of water per hectare. The first spray should be given as soon as the initial symptoms are observed. Three more sprays should be taken up at 10 days interval after the first spray (Jones and Prusky, 2002).

2.9 Harvesting

It is important to harvest groundnut when the crop is mature. Flowering is indeterminate in the groundnut, therefore there are a variable proportion of mature and immature pods at the end of the crop cycle (Kessel *et al.,* 2005). Groundnuts are mature when the kernels are plump with 70-80% of the internal pods shells showing dark marks colour each. If harvested prematurely, the kernels shrink upon drying, resulting in decreased shelling percentage, poor seed quality and lower oil content. If harvested late, non-dormant varieties will sprout in the field, resulting in yield losses (Jones and Prusky, 2002).

2.9.1 Post harvest handling

Seed quality mainly depends on appropriate handling and storage techniques for the harvested crop. Handling involves the selection of the best seeds while good storage conditions ensure the preservation of the seed quality (Jones and Prusky, 2002). Groundnut seeds are protected by a shell, which acts as an excellent natural barrier against pests and diseases (Jones and Prusky, 2002).

Drying: The primary objective of curing or drying is to achieve a rapid but steady drying of pods in order to avoid aflatoxin contamination. Harvested plants should be staked in the field for a few days to allow them dry under sun, before stripping the pods. Then drying should be continued until the moisture content is reduced to 6-8% (Jones and Prusky, 2002). This can normally be achieved by drying the pods in the sun for 6-7 days, taking care to cover them if it rains. Under mechanized farming system, combine harvesters collect windrows, strip and clean pods in one single operation. (Kessel *et al.,* 2005).

Packaging: Pods can easily be stored in bulk. Storage in clean jute or woven polyethylene fibre bags ensures the best protection of groundnuts and facilitates manipulation of stocks (manual or palletized). Groundnut seeds should only be stored in bags or drums. (Jones and Prusky, 2002).

Seed storage and conservation: groundnut can either be shelled or stored in unshelled form. Groundnut is best stored unshelled in cool, dry conditions, protected from rain and rodents (particularly rats and mice). Bagged groundnuts (whether shelled or unshelled) should not be placed directly on a concrete floor to avoid the risk of dampness that may cause moulds to develop (Kessel *et al.,* 2005).Before bagging, pods should be dusted with Actellic Super to protect them from storage pests (Kessel *et al.,* 2005).

2.10 Importance of Groundnut

Boiled peanuts are popular snacks in the United States, India and China. Peanuts are also used in the Mali meat stew (maafe) and as sauces for South American meat dishes, (Handy, 1895). Peanuts are used to fight malnutrition. Plumpy nut and medika mamba are high protein, high energy and high nutrient peanut-based pastes developed as therapeutic food to aid in famine relief and save children from malnourishment in developing countries. Peanuts

can be used like other legumes and grains to make a lactose-free milk-like beverages and peanut milk. Vegetative parts of the plant are used as hay where as low grade or culled peanuts that are not suitable for market are used in the production of peanut oil. The cake (oilcake meal), the residue from oil processing is used as an animal feed and fertilizer to enrich the soil. Low grade peanuts are also used to feed birds.

Industrially paint, varnish, lubricating oil, leather dressings, furniture polish, insecticides, and nitroglycerin are made from peanut oil. Soap is made from saponified peanut oil, and many cosmetics contain peanut oil and its derivatives (Jones and Prusky, 2002). The protein portion of the oil is used in the manufacture of some textile fibers. Peanut shells are used in the manufacture of plastic, wallboard, abrasives, fuel, cellulose (used in rayon and paper) and mucilage (glue). Rudolf Diesel engines have been reported to use on peanut oil as fuel and it is still seen as a potentially useful fuel (Jones and Prusky, 2002).

2.11 Ex-Dakar (55-437) Groundnut

Ex-Dakar originated from South America and introduced by colonial masters to Nigeria at colonial times in 1950s (Jones and Prusky, 2002). The crop characterized by slight pod constriction, no beak, prominent reticulation, thin shell, pink seed, rounded, slight flattening, erect growth habit, medium leaflets, and compact fruiting. It is a good source of groundnut oil (contain 49%) which contains 46-49 % Oleic acid and 28 % linoleic acid. It is resistant to drought Tolerant to aflatoxin contamination and highly susceptible to leaf spot disease (Jones and Prusky, 2002).

It is a common variety in West Africa and well adapted to low rainfall area with an average pod yield of 1000-1500 kg/ha (Nigam *et al.,* 2004).

2.12 *Jatropha curcas*:

J.*curcas* is a plant which belongs to the family Euphorbiaceae and is said to have originated from Mexico and South Africa (Tint and Mya, 2009). The plant was introduced to Africa by

the Portuguese in Nigeria it is used as hedge plant (Lozan, 2007, (Reinhard, 2007).

There are several varieties of Jatropha and best known among them are, *Jatropha curcas (nontoxic)*; *J. curcas x J. integrerrima; J. gossypifolia; J. glandulifera; J. tanjorensis; J. multifida; J. podagrica ; J. integerrima* (Reinhard, 2007).

2.14 Botany:

J. *curcas* is a small shrub which grows to a height of between 3 and 5 metres. The bark exudes white coloured latex. The leaves of the plant are arranged alternatively and of large size with green to pale-green colour (Tint and Mya, 2009). The male and female flowers are produced on the same inflorescence, averaging 20 male flowers to each female flower, or 10 male flowers to each female flower and are found terminally. The seeds are mature when the capsule changes from green to yellow (Lozan, 2007).

2.15 Distribution:

J. curcas grows in tropical and subtropical regions under different soil types including poor and stony soils (Azam *et al*., 2005). It can be propagated by cuttings, which yields faster results than multiplication by seeds (Lozan, 2007). Propagation through seed (sexual propagation) leads to a lot of genetic variability in terms of growth, biomass, seed yield and oil content (Belewu, 2008). Vegetative propagation has been achieved by stem cuttings, grafting and budding. Cuttings should be taken preferably from juvenile plants and treated with 200 micro grams per litre of IBA (rooting hormone) to ensure the highest level of

rooting in stem cuttings. These vegetative methods have potential for commercial propagation of these plants (Gadekar, 2006).

J. *curcas* thrives on 250 mm (10 in) of rain a year. The use of pesticides is not necessary, due to the pesticidal and fungicidal properties of the plant (Gadekar, 2006). J. *curcas* starts yielding from 9–12 months and the best yields are obtained only after 2 – 3 years.

Gadekar, 2006 reported that productivity of *Jatropha* when used as a hedge is from 0.8 kg to 1.0 kg. of seed per meter of live fence. The seed production is around 3.5 tons / hectare (Seed production ranges from about 0.4 tons per hectare in first year to over 5 tons per hectare after 3 years).

2.16 Harvesting:

The mature dried seeds should be harvested using a long stick with a cotton bag at its side. But sometimes, the seeds could be picked from the ground and later split for its seeds. Observed average annual seed yield per plant is between 0.5-2.0 kg (Belewu, 2008).

2.17 Moringa Plant:

2.17.1Origin and Distribution:

Mornga oleifera, commonly referred to as the “miracle tree” is the most widely cultivated species of the genus *Moringa*, which belongs to the family Moringaceae. It is a fast growing and resistant shrub, native to India but now widely distributed in the tropics and subtropical areas (Gadekar, 2006). In Nigeria, M. *oleifera* is found in all ecological zones where it grows all the year round. The plant is propagated by both seeds and cuttings. The *Moringa*

plant is grows mainly in semi-arid, tropical, and subtropical areas, and grows best in dry sandy soil. It tolerates poor soils, including coastal areas (Duke, 1985). Today it is widely cultivated in

Africa, Central and South America, Sri Lanka, India, Mexico, Malaysia, Indonesia and the Philippines. It is considered one of the world's most useful plants, as every part of the it is used either for food or other beneficial proposes (Fahey, 2005).

Other common names of *Moringa* include: "drumstick" tree, due to the appearance of the long, slender, triangular pods; "horseradish" as a serult of the taste of the roots, "ben oil tree" from the oil derived from the seeds (Fahey, 2005).

2.17.2 Moringa species

There are 13 species of Moringa and they include; *Moringa drouhardi* (Madagascar); *M. concanesis* (Mostly India); *M. arborea* (Kenya); *M. oleifera* (India); *M. borziana* (Kenya and Somalia); *M. peregrine* (Red Sea Arabia, horn of Africa); *M. longituber* (Kenya, Ethiopia, Somalia); *M. stenopetala* (Kenya and Ethiopia); *M.* pygaea (North Somalia); *M. rivae* (Kenya and Ethiopia); *M. rusfoliana* (Kenya, Ethiopia, Somalia); *M. ovalifolia* (Namibia and extreme

South West Angola); *M hildebrandhi* (Madagascar) (Fahey, 2005).

2.18 Uses of Moringa

Nutritional uses

Moringa has been used to combat malnutrition, especially among infants and nursing mothers. The leaves of *Moringa* can be eaten fresh or dried into powder and stored for many months without refrigeration, without losing its nutritional value. *Moringa oleifera* leaves contain seven times the vitamin C in orange, four times the calcium in milk, four times the vitamin A in carrot, two times the protein in milk and three times the potassium in bananas, 0.75 times the iron found in spinach (Fahey, 2005).

Fresh leaves of *Moringa* have been reported to increase the volume of breast milk produced by pregnant and nursing mothers (Fahey, 2005).

Medicinal properties

Moringa preparations have been found to possess antibiotic, anti-trypanosomal, hypotensive, antispasmodic, antinuclear, anti-inflametory, hypocholesteromic, hypoglycemic properties in addition to having considerable efficacy in water purification by flocculation, sedimentation, antibiosis and even reduction of *Schistosome cercariae* titer (Fahey, 2005). Its seed contains a potent antibiotic and fungicide, *terygospermin,* which is effective against skin- infecting bacteria *Staphylococcus aureus* and *Pseudomonas aeruginosa* (Elirt *et al.,* 1980). The root powder is used as an aphrodisiac and when it is mixed with milk, is considered useful against asthma, rheumatism and enlarged spleen or liver (Elirt *et al.,* 1980).

Bio-Pesticidal Properties.

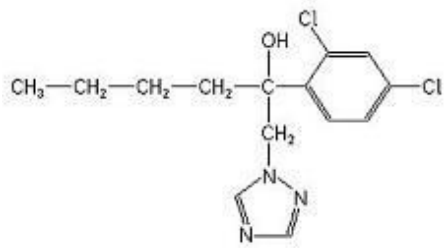
Soil incorporation of *Moringa* leaves has been known to prevent seedling damping off. While evaluating the effect of four planting materials and fernazzan D on the mycelial

growth of *Aspergillus flavus* isolated from stored maize grains, Balogun and Ojiako (2004), found that

Moringa oleifera compared favourably with Fernazan D inhibiting completely the radial growth of the fungus within the first 48 hours after inoculation. Ojiako and Adesiyun, (2008) reported that *Moringa oleifera* seed powder compared favorably with Actellic dust (2%) in the control of *Callosobruchus maculatus* on stored cowpea and had no adverse effect on viability, physical properties, nutritional and organoleptic characteristic of the stored seeds.

Puri, (1999) reported that extracts of *M. oleifera* contained; oil (41.58%), protein (40.31%), carbohydrate (9.11%), crude fibre (3.28%), phytate (10.18%), hydrogen cyanide (mg/100g 0.58), tannins (2.13%), saponins (2.25%), while Olayemi and Alabi, (1994) observed that the seed contained; 34.1 % protein, 15% carbohydrate and 15.5% lipids. Studies have shown that a steroicidal glycoside-strophantidin is the bioactive agent in the seed (Kessel *et al*; 2005).

Also extract of *M.* species contain; simple sugar, rhamnose, glucosinolates and isothiocyanates (Kessel *et al*; 2005). *Moringa* preparations have been reported to contains hypo-tensive, anticancer, and antibacterial activity including 4-(4'-*O*-acetyl-α-L rhamnopyranosyloxy)benzyl isothiocy-anate**,** 4-(α-L-rhamnopyranosyloxy)benzyl isothiocyanate**,** niazimicin, pterygospermin**,** benzyl isothiocyanate and 4-(α-L-rhamnopyranosyloxy) benzyl glucosinolate **.** While these compounds are relatively unique to the *Moringa* family, it is also rich in a number of vitamins and minerals as well as other phytochemicals such as the carotenoids (including β-carotene or pro-vitamin A) (Fahey, 2005).



2.19 Hexaconazole

Hexaconazole is a systemic and broad spectrum fungicide with protective and curative properties. Hexaconazole controls many fungal diseasesn including powdery mildew, scab and rust blackrot and other folia diseases (Sierotzki, 2000).

It is formulated as SC, SG, OL, EC or as per customer's specific requirement (Anon 2002).

It is compatible with many common pesticides (Anon 2002).

Mammalian Toxicity : Acute oral LD_{50} for male rats 2189 mg/kg and for female rats 6071 mg/kg (Anon 2002).

Environmental Toxicity : Acute oral LD_{50} for mallard ducks >4000 mg/kg (Anon 2002).

It has Shelf Life of Two years under normal storage conditions (Anon 2002).

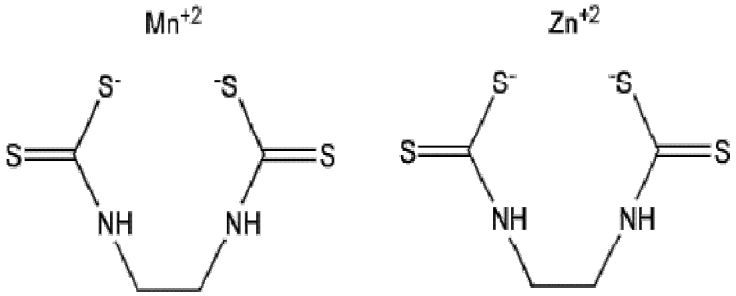
Chemical symbol of Hexaconazole

CONTROLL TOTAL™

It is a synthetic material containing 6% emulcifiable concentrate (E.C).

2.20 MANCOZEB

Mancozeb is a broad spectrum non systemic fungicide used on vegetables, fruits and turf for the control of leaf spot, downy mildew, blights, anthracnose, fruit rots, botrytis, dollar spot, melting out and brown patch. It is a multi-site inhibitor affecting various enzymes and other metabolic processes in fungi. It inhibits spore germination and is toxic to fungal cell membranes (Sierotzki, 2000).



Chemical symbol of Mancozeb

RakshaTM

It is a synthetic fungicidal powder containing 80% mancozeb as wetable powder.

2.21 Neem oil

Neem oil is extracted from the seeds of neem (*Azadirachta indica*). The oil is the most important of the commercially available products of neem used for organic farming and medicine (Sudaravalli *et al.,* 1952). Neem oil is generally red as blood, and has a rather strong odor that is said to combine the odours of peanut and garlic. It is comprised mainly of triglycerides and contains many triterpenoid compounds, which are responsible for the bitter taste. It is hydrophobic in nature and in order to emulsify it in water for application purposes, it must be formulated with appropriate surfactants (Puri 1999). Azadirachtin is the most well known and studied triterpenoid in neem oil. The azadirachtin content of neem oil varies from 300ppm to over 2500ppm depending on the extraction technology and quality of

the neem seeds crushed. Neem oil also contains steroids (campesterol, beta-sitosterol, stigmasterol) (Puri 1999).

Uses of neem oil

Neem oil has been used for preparing cosmetics (soap, hair products, body hygiene creams, hand creams) and in the treatment of a wide range of afflictions such as acne, fever, leprosy, malaria, ophthalmia and tuberculosis. It has also been used as an anthelmintic, antifeedant, antiseptic, diuretic, emmenagogue, contraceptive, febrifuge, parasiticide, pediculocide and insecticide (Sudaravalli *et al.,* 1952). Traditional routes of administration of neem extracts included oral, vaginal and topical use (Sudaravalli *et al.,* 1952). Formulations made of neem oil also find wide usage as a biopesticide for organic farming, as it repels a wide variety of pests including the mealy bug, beet armyworm, aphids, the cabbage worm, thrips, whiteflies, mites, fungus gnats, beetles, moth larvae, mushroom flies, leafminers, caterpillars, locust, nematodes and beetle. It can be used as a household pesticide for ant, bedbug, cockroach, housefly, sand fly, snail, termite and mosquitoes both as repellent and larvicide (Puri 1999). Neem oil also controls black spot, powdery mildew, anthracnose and rust caused byfungi (Puri 1999).

Neem Afri™ is a trade name of bio-pesticide made of neem oil. Commacially produced Neem Afri™ contain;

- Azadirachtin - 3000 PPM
  - Nimbin - 0.40%
- Salanin - 0.56%

2.22 RIMULGAN ™

RIMULGAN ™ is an emulsifier made from castor oil for preparation of emulsions from natural oils and water. For instance when 5 ml of neem oil is mixed with 1 ml Rimulgan and made up to 1 liter with water, the emultion produced is a 0.5% Niemlösung. Also ten (10)

ml of neem oil and 2 ml of water mixed with 1 liter Rimulgan result in a 1% Niemlösung (Puri, 1999).

Composition of RIMULGAN ™

RIMULGAN is composed of 68% castor oil, 25% oleic acid-ionic, anionic 5% calcium salts and alcohol. Its composition enables the production of finely dispersed and highly resistant emulsions (Puri, 1999).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Groundnut Variety used

Ex-Dakar (55-437) groundnut variety used was obtained from Department of Agronomy's store, Bayero University Kano.

3.2 Location or Site

The field experiment was conducted from May to September 2011 at the Teaching and Research Farm of Department of Crop Science and Technology, Federal University of Technology, Owerri. The site is geographically located between latitude 05^0 27^{l} N and longitude 07^0 0^{l}E with mean annual rainfall of between 2334.40mm and 2397.01, mean temperature of 31.00^0C and relative humidity of 89.00%.

3.3 Plants screened for antimicrobial activities;

Plants screened are *Jatropha curcas* and *Moringa oleifera*. The parts of the plants used were the roots and seeds.

The Root; *Jatropha* and *Moringa* roots were obtained from "MAJE-HARUNA FARM" Hadejia LGA, Jigawa state. Root from healthy and matured *Jatropha* and *Moringa* plants was remove using cutlass, The roots sample were further being chopped and dried. Drying was done under shade, in order to prevent alteration of root materials due to sun radiation. These dried roots were grinded into powder with grinding machine.

Plate 1: Fresh *J. curcas* roots

Plate 2: Fresh *M. oleifera* root

The Seed; *Jatropha* and *Moringa* seeds were obtained from "MAJE-HARUNA FARM" Hadejia LGA, Jigawa state. Ripe and dried *Jatropha* fruit (plate 7) and *Moringa* pods (plate 8) were harvested and deshelled to obtain the seeds which were allowed to dry under shade (plate 5 & 6). The seeds were ground into powder, using grinding machine.

Plate 3: Dried *J. curcas* fruits

Plate4: Dried *M. oleifera* pods

Plate 5: Dried *J. curcas* seeds

Plate 6: Dried *M. oleifera* seeds

3.4 Extraction of plant materials

An electronic weighing balance (malve) was used to measure seperately 30g of each of ground *Moringa* and *Jatropha* root and seed materials. Each of the weighed samples of root and seed of *Moringa* and *Jatropha* was put in four separate containers and 300ml of distilled water was added to each of the four containers to obtain 10% concentrations of each of the four different plant materials. Each container was firmly capped and shaken vigorously with hand and then allowed to stay overnight in the laboratory to enable the active ingredients of the plant materials to dissolve in the water (plate 11). Cheese cloths low folds were used to filter each of the solution in four different containers to obtain the filtrate that was used as spray (plate 12).

Plate 7: Root and Seed solutions of *J. curcas* and *M. oleifera* plants (before filtration).

Plate 8: Extracts of Root and Seed of *J. curcas* and *M. oleifera* plants (after filtration).

3.5 Agronomic practices and Treatment of groundnut in the field

Land Preparation; - The site was cleared using cutlass and the roots of tree plant were stumped. The field was tilled and 126 plots with a dimension of 2mx1m were replicates three times (42plots each). Gap of 0.5m was maintained between the plots. 130g of P_2O_5 and 1.2kg K_2O were applied three days before planting. Two groundnut seeds were sown at a space of 45cm within rows and 10cm apart, at a depth of 5cm. Extracts of the test materials were sprayed biweekly, at 2, 3 and 4 weeks after planting. 150ml each of the separate plant extracts were put separately in a 500ml capacity hand sprayer, and sprayed on the targeted plot. The sprayer was thoroughly washed after spraying each of the plant extract. For the plots receiving plant extract + RUMULGAN treatment, 3ml of the RUMULGAN was separately added to each of the 150ml of each of the plant extract. Neem oil at 0.6ml, hexaconazole at 0.3ml and mancozeb at 0.4g/plot were applied separately at ten days interval. Treatments were applied in a randomized complete block design (RCBD). The field layout is outlined below (Fig. 1).

SPRAY AT TWO WEEKS AFTER PLANTING

PLANT EXTRACTS ALONE			RUMULGAN+PLANT EXTRACTS			NEEM OIL AND SYNTHETICS		
1	2	3	1	2	3	1	2	3
CON	CON	JSE	R+JSE	CON	R+JRE	CON	MC	HX
MSE	JSE	MRE	R+MSE	R+ JRE	R+MRE	MC	HX	CON
JSE	MSE	CON	CON	R+JSE	CON	NO	CON	RI
MRE	JRE	MSE	R+MRE	R+MRE	R+MSE	HX	NO	MC
JRE	MRE	JRE	R+JRE	R+MSE	R+JSE	RI	RI	NO

SPRAY AT THREE WEEKS AFTER PLANTING

PLANT EXTRACTS ALONE			RUMULGAN+PLANT EXTRACTS			NEEM OIL AND SYNTHETICS		
1	2	3	1	2	3	1	2	3
MSE	JRE	JSE	CON	R+JSE	R+MRE	CON	MC	CON
MRE	CONT	JRE	R+JRE	R+MSE	R+JRE	NO	RI	HX
JSE	JSE	CON	R+JSE	R+JRE	R+MSE	MC	NO	NO
CON	MSE	MSE	R+MRE	R+MRE	R+JSE	HX	CON	MC
JRE	MRE	MRE	R+MSE	CON	CON	RI	HX	RI

SPRAY AT FOUR WEEKS AFTER PLANTING

PLANT EXTRACTS ALONE			RUMULGAN+PLANT EXTRACTS			NEEM OIL AND SYNTHETICS		
1	2	3	1	2	3	1	2	3
JSE	MRE	JRE	R+MSE	R+JRE	R+JRE	HX	RI	CT
JRE	JRE	JSE	CON	R+MSE	R+MRE	NO	MC	RI
MRE	MSE	MRE	R+MRE	R+JSE	R+JSE	RI	HX	CON
MSE	JSE	CON	R+JRE	CON	R+MSE	MC	NO	NA
CON	CON	MSE	R+JSE	R+MRE	CON	CON	CON	RK

Fig. 1 Field layout of treatments

Key: JES= seed extracts of *J. Curcas,* MSE= seed extracts of *M.oleifera,* JRE= root extracts of

J. Curcas MRE= root extracts of *M.oleifera* CON=control, RI= Rimulgan NO= Neem oil, HX=Hexaconazole 6% EC, MC=Mancozeb 80% WP, R+ = Rimulgan plus

3.6 Data collection

Data were collected based on the plant characteristics i.e.; **Establishment count**: Plants were counted to obtain the establishment count at two bi-weekly after planting and the following parameters were considered. They include:

Plant height: Data were collected on plant height bi-weekly. This was measured using meter rule and measurement was from the base of the stem to the terminal bud.

Number of leaves produced: The number of leaves produced in each plot was collected biweekly. The leaves produced by the sample plants were counted one after the other and the total number of leaves recorded.

Leaf area: The leaf area was determined by multiplying leaf length and width with the leaf area constant (0.66) (Jones and Prusky, 2002). The area for all the treatment levels were summed up and the average was obtained for all the treatments.

Flower initiation and days to 50% flowering: Each plot was observed for flower initiation and this was recorded including the flowers formed on weekly basis till when 50% flowering was recorded in the least flower forming plot.

Number of branches produced: Each plot was observed for production of branches. The number of branches produced per plot were counted and recorded per plot.

Incidence of leaf spot disease: Each plot was closely monitored for incidence of *Cercospora* leaf spot disease (plate 13) and the rate of spread of the disease was also recorded weekly per treatment using the following formula according to David *et al* (2003):

$$\% \text{ Disease incedance} = \frac{\text{Number of stands with disease}}{\text{Total number of stands}} \times \frac{100}{1}$$

Incidence of non *Cercospora* folia disease: The same method of determining the incidence of *Cercospora* leaf spot disease was used to determined incidence of late leaf spot, rust, *Alternaria* leaf disease and anthracnose diseases.

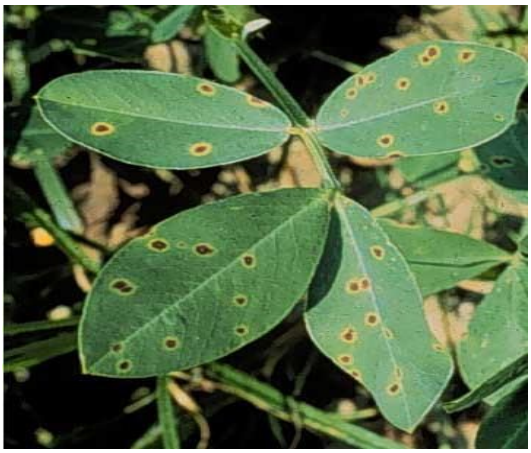


Plate 9: *Cercospora* leaf spot on sampled plant.

Leaf spot disease severity: Data were collected on the leaf spot disease severity. The severity of the disease was estimated using the visual observation and scoring according to David *et al.,* (2003) which is summarized in table 1

Table 1. Severity index of groundnut leaf spot disease

Severity Index

Severity Estimation (Spots per leaf)	Scale	Interpretation
1 20	1	Slight infection
21 40	2	Moderate infection
41 60	3	Severe infection
61 80	4	Very severe infection
81 100	5	Completely infected

Non *Cercospora* folia diseases severity: The same method of determining the severity of *Cercospora* leaf spot disease was used to determined severity of late leaf spot, rust, *Alternaria* leaf disease and anthracnose diseases of ground nut.

3.7 Yield and yield components

The following yield attributes were considered.

Number of pods per plant: This was obtained by counting the number of pods from each plant at harvest for each per treatment.

Number of seed per pod: The number of seeds of pod in each pods sampled from each treatment were counted and recorded.

100-seed weight (g): This was obtained by counting one hundred (100) seeds from the pods sampled per treatment weighed using a weighing balance.

Seed yield: The seed yield from each treated plot was obtained and then used to calculate the proportional yield obtainable from one hectare.

Plate 10: Sampled Harvested groundnut plant from treated plot

3.8 Data analyses

Collected data were analyzed with the analysis of variance (ANOVA) using GenStat statistical tool and the differences between the means were compared and separated using the Least Significant Difference (LSD) method at 5% level of significance (p= 0.05).

CHAPTER FOUR

4.0 RESULT

4.1 Effect of Treatment on Plant Height after 2 and 4 Weeks of Spray in plots after 2,3 and4 Weeks of Sowing (WAS):

The effect of treatment (2 weeks spray) on the height of groundnut after 2, 3 and 4 WAS is shown in Table 1.

Plot sprayed with RIMULGAN + *M. oleifera* seed extract recorded the highest plant height (13.67cm) at 2 WAS, followed by RIMULGAN + *J. curcas* seed extract and Neem oil which recorded 13.33 cm and this was significance when compared with plot treated with RIMULGAN alone and untreated plot that recorded the lowest plant height of 9.33 cm. Plot sprayed after 4 weeks with RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *J. curcas* seed extract and Neem oil recorded the highest plant height (41.00 cm) followed by *J. curcas* seed extract (40.33 cm) and this was significantly different with plant height

recorded in untreated plots (control) that recorded the lowest plant height of 25.33 cm (Table 2).

Plot sprayed with RIMULGAN + *M oleifera* seed extract recorded highest plant height at three weeks after planting spray regime (13.67cm), followed by RIMULGAN + *J. curcas* seed extract and Neem oil (13.33). While plot treated with RIMULGAN and untreated plot recorded the lowest (9.33). Test plants showed significant a difference on plant height of groundnut at 4 WAS when compared with untreated plot.

Heights of groundnut which treated with R+JRE and untreated plots were statistically the same at 4WAS (Table 2). Plot sprayed with Mancozeb 80% WP recorded highest plant height after weeks in four weeks after planting spray regime (13.67), followed by Hexaconazole 6% E.C and Neem oil (13.00), while untreated plot recorded the lowest (9.00). At 6WAP, plot sprayed with Neem oil recorded the highest number of leaves (40.67) followed by Mancozeb 80% WP (38.00). Whereas untreated plots (control) recorded the lowest plant height (26.33).

TABLE 1: Mean values of Treatment effects on plant height after 2 Weeks of Spray in2, 3 and 4 Weeks after sowing

Treatment	**Mean Treatment Values (cm) and Weeks After Sowing (week)**		
	2	**3**	**4**
MSE	12.00	12.00	11.00
MRE	12.33	12.33	11.00
JSE	11.67	11.67	11.33
JRE	13.00	13.00	11.67
RMSE	13.67	13.67	11.67
RMRE	12.33	12.33	11.67

RJSE	13.33	13.33	11.67
RJRE	12.00	12.00	10.33
RI	9.33	9.33	9.67
HX	10.67	10.67	13.00
NO	13.33	13.33	13.00
MC	11.33	11.33	13.67
CON	9.33	9.33	9.00
$LSD_{0.05}$	**1.936**	**1.085**	**1.346**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 2: Mean values of Treatment effects of plant height after 4 Weeks of Spray in 2, 3 and 4 Weeks after sowing

Treatment	**Mean Treatment Values (cm) and Weeks After Sowing (week)**		
	2	**3**	**4**

MSE	38.33	35.33	35.33
MRE	35.33	35.67	37.00
JSE	40.33	38.33	36.67
JRE	39.33	36.33	32.67
RMSE	41.00	36.00	37.00
RMRE	40.00	34.00	34.67
RJSE	41.00	37.67	37.67
RJRE	39.33	32.67	33.33
R	25.33	32.33	27.33
HX	36.33	38.00	37.00
NO	41.00	38.67	40.67
MC	35.33	35.33	38.00
CON	25.67	31.33	26.33
$LSD_{0.05}$	**5.594**	**NS**	**6.717**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.2 Effect of Treatment on Number of Leaves of groundnut after 2 and 4 Weeks spray plots

after 2,3 and 4 weeks of sowing:

There were significant differences in term of number of leaves among the treated and untreated plots, after 2 weeks in two weeks after sowing plots (table 3). Plot treated 2WAS with Neem oil recorded highest (11.33 cm), followed by RIMULGAN + *M. oleifera* seed extract and RIMULGAN + *J. curcas* seed extract (10.67 cm), where as plot treated with JRE recorded the lowest (6.67 cm) which was not statistically different from control plot in number of leaves at 2 WAS. Plots sprayed after 4weeks in plots 2WAS with RIMULGAN + *M. oleifera* seed extract and RIMULGAN + *J. curcas* seed extract recorded the highest number of leaves (27.33 cm), followed by Neem oil (25.00 cm), while the untreated plot recorded the lowest (17.00 cm) (Table 4).

There were significant differences in number of leaves among the plots treated with MSE, RMSE, RJSE and NO and untreated plots, after 2 weeks spray in three weeks after sowing plots (Table 3). Treatment materials also showed no significant differences on number of leaves of groundnut treated with MRE, JSE, HX and MCat 4 weeks spray when compared with untreated plot (Table 4). Numbers of leaves of groundnut of the treated and untreated plots were statistically the same at 4 WAS.

There was no significant difference in term of number of leaves among the treated and untreated plots, after 2 weeks spray in three weeks after sowing plots (table 4). Treatments applied except MSE, RMRE, RJRE and R showed statistical significant differences from control plot in number of leaves in 4WAS plots (Table 4). Plots sprayed with Neem oil and Mancozeb 80% WP recorded highest (35.00), followed by Hexaconazole 6% E.C (34.33), while untreated plot recorded the lowest (23.00).

TABLE 3: Mean values of Treatment on no. of leaves after 2 Weeks Spray in 2, 3 and 4

Weeks after sowing

Treatment	Mean Treatment Values (cm) and Weeks After Sowing (week)		
	2	**3**	**4**
MSE	7.00	9.667	7.67
MRE	7.33	9.000	9.33
JSE	8.33	9.000	9.00
JRE	6.67	9.000	9.67
RMSE	10.67	10.000	10.33
RMRE	8.33	9.333	9.00
RJSE	10.67	10.000	10.00
RJRE	7.67	9.333	9.33
R	8.33	9.000	8.00
HX	8.67	9.000	9.67
NO	11.33	10.000	11.00
MC	9.33	9.000	10.00
CON	7.67	9.000	7.00
$LSD_{0.05}$	**1.153**	**0.4802**	**NS**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 4: Mean values of Treatment on no. of leaves after 4 weeks spray in 2, 3 and 4

Weeks after sowing

Treatment	Mean Treatment Values (cm) and Weeks After Sowing (week)		
	2	**3**	**4**
MSE	23.00	23.67	28.67
MRE	20.67	23.67	31.67
JSE	20.67	20.67	31.00
JRE	21.00	21.00	32.33
RMSE	27.33	21.67	32.33
RMRE	24.33	27.33	29.33
RJSE	27.33	22.00	31.33
RJRE	23.00	22.33	30.00
R	17.33	22.00	23.67
HX	20.67	22.00	34.33
NO	25.00	24.67	35.00
MC	22.33	22.33	35.00
CON	17.00	21.00	23.00
$LSD_{0.05}$	**5.402**	**NS**	**7.347**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*
RMRE: *RIMULGAN + Moringa oleifera Root Extract*
RJSE: *RIMULGAN + Jatropha curcas Seed Extract*
RJRE: *RIMULGAN + Jatropha curcas Root Extract*
RI: *RIMULGAN*
CT: *Hexaconazole 6% EC*
NA: *Neem Oil*
RK: *Mancozeb 80% WP*
CON: *Control*

4.3 Effect of Treatment on Leaf area of groundnut after 2 and 4 Weeks of spray:

The test materials showed significant differences on the leaf area of groundnut when compared with the control (untreated) plots, after 2 weeks spray in two weeks after sowing plots (Table 5). Plots sprayed with RIMULGAN + *J. curcas* seed extract recorded the highest leaf area (5.60 cm), followed by RIMULGAN + *M. oleifera* seed extract (5.55 cm), while untreated plot recorded lowest (1.48). At 4 WAS, treated plots are significantly higher than the untreated (table 6), plot sprayed with RIMULGAN + seed extracts *J. curcas* and of *M. oleifera* the recorded highest (2.00 cm) followed by plot sprayed with neem oil (1.667 cm) while untreated plot recorded lowest (0.333 cm). The test materials showed no significant differences on leaf area of groundnut after 2 weeks spray in three and four weeks after sowing, when compared with untreated plot (Table 5).

Groundnut's leaf areas of the treated and untreated plots were not statistically the same after 2 weeks of spray. The leaf area in plots sprayed after 4 weeks were significantly higher than the untreated plots (control). The plot sprayed with Neem oil recorded the highest leaf area (9.02), followed by RIMULGAN + *J. curcas* seed extract (8.86), while the untreated plot recorded the least (5.92) in 3 WAS plots (Table 6).

The plots treated with RMSE and RJSE recorded significantly higher leaf area than the untreated plots in 2WAS. Plots sprayed with Mancozeb 80% WP recorded highest (6.483) followed by Neem oil (6.417) while plot sprayed with RIMULGAN alone recorded lowest (4.270) in 4WAS (Table 6).

TABLE 5: Mean values of Treatment on leaf area after 2 Weeks Spray in 2, 3 and 4 Weeks after sowing plots

Treatment	Leaf Area (cm^2) and Weeks After Sowing (week)		
	2	**3**	**4**
MSE	2.82	7.81	2.607
MRE	2.63	5.62	2.413
JSE	2.41	3.64	2.360
JRE	2.56	3.86	2.480
RMSE	5.55	4.30	3.100
RMRE	4.68	5.27	2.323
RJSE	5.60	4.52	2.763
RJRE	4.98	5.19	2.173
R	1.74	0.10	2.213
HX	3.67	4.52	2.357
NO	5.47	6.27	2.693
MC	3.46	3.86	2.347
CON	1.48	3.93	2.170
$LSD_{0.05}$	**1.716**	**NS**	**NS**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 6: Mean values of Treatment on leaf area after 4 Weeks Spray in 2, 3 and 4 Weeks after sowing plots

Treatment	Leaf Area (cm^2) and Weeks After Sowing (week)		
	2	**3**	**4**
MSE	0.667	8.13	5.517
MRE	1.000	8.09	5.703
JSE	1.000	7.70	5.167
JRE	0.333	7.54	5.103
RMSE	2.000	8.51	5.873
RMRE	1.000	8.12	6.040
RJSE	2.000	8.86	6.130
RJRE	1.000	8.12	5.913
R	1.333	6.45	4.270
HX	1.333	7.54	5.657
NO	1.667	9.02	6.417
MC	1.333	8.00	6.483
CON	1.000	5.92	4.303
$LSD_{0.05}$	**0.9509**	**1.455**	**1.0414**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*
RMRE: *RIMULGAN + Moringa oleifera Root Extract*
RJSE: *RIMULGAN + Jatropha curcas Seed Extract*
RJRE: *RIMULGAN + Jatropha curcas Root Extract*
RI: *RIMULGAN*
CT: *Hexaconazole 6% EC*
NA: *Neem Oil*
RK: *Mancozeb 80% WP*
CON: *Control*

4.4 Effect of Treatment on Number of Branches of groundnut:

The result of groundnut with test materials showed significant differences on number of branches after 2weeks spray in two and four weeks after sowing plots (Table 7). Plots sprayed with RIMULGAN + *M. oleifera* seed extract and RIMULGAN + *J. curcas* seed extract recorded the highest number of branches (2.00), followed by Neem oil (1.667) and plots treated with *J. curcas* root extract recorded lowest (0.333) after 2 weeks spray. The test materials showed significant effect on number of branches after 4 weeks spray when compared with control (untreated) plot in 2 and 3 WAS (Table 8). Plot sprayed with Mancozeb 80% WP recorded highest (3.00), followed by RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *J. curcas* seed extract and Nee oil (2.333) in 2 WAS plots and plots treated with RIMULGAN and untreated plots recorded the least (1.00). Test materials showed no significant differences on number of branches of groundnut after 2 weeks spray in three weeks after sowing plots when compared with untreated plot indicating that numbers of branches of groundnut of the treated and untreated plots were statistically the same after 2 weeks spray. Plants in 3 WAS plots sprayed with RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *M. oleifera* root extract, RIMULGAN + *J. curcas* seed extract,

RJRE and Neem oil recorded highest number of branches (2.00), followed by *M. oleifera* seed extract, *J. curcas* seed extract and *J. curcas* root extract (1.667), while the untreated plots recorded the lowest (1.00). Plots under 4WAS sprayed with Neem oil recorded the highest number of branches (2.00), followed by Hexaconazole 6% E.C and Mancozeb 80% WP (1.667), while plots treated separately with *Jatropha* are *Moringa* extracts recorded the lowest (0.667). Treatment materials had no significant effect on number of branches at 4 WAS when compared with untreated plot. Numbers of branches in treated and untreated plot were statistically the same (Table 8).

TABLE 7: Mean values of Treatment effects on number of branches after 2 Weeks Spray in 2, 3 and 4 Weeks after sowing plots

Treatment	Number of branches and Weeks After Sowing (week)		
	2	**3**	**4**
MSE	0.667	1.000	0.667
MRE	1.000	1.000	0.667
JSE	1.000	0.667	0.667
JRE	0.333	1.000	0.667
RMSE	2.000	1.000	1.000
RMRE	1.000	1.000	1.000
RJSE	2.000	1.000	1.333
RJRE	1.000	1.000	0.667
R	1.333	0.667	1.000
HX	1.333	1.000	1.667
NO	1.667	1.000	2.000
MC	1.333	1.000	1.667
CON	1.000	0.333	1.000
$LSD_{0.05}$	**0.9509**	**NS**	**0.7097**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 8: Mean values of Treatment effects on number of branches after 4 Weeks Spray in 2, 3 and 4 Weeks after sowing plots

Treatment	Number of branches and Weeks After Sowing (week)		
	2	**3**	**4**
MSE	2.000	1.667	1.667
MRE	1.667	1.667	1.667
JSE	1.667	1.667	1.667
JRE	1.333	1.333	1.667
RMSE	2.333	2.000	1.667
RMRE	1.667	2.000	2.000
RJSE	2.333	2.000	2.000
RJRE	2.000	2.000	1.667
R	1.000	1.333	1.667

HX	2.000	1.333	1.667
NO	2.333	2.000	2.000
MC	3.000	1.333	1.667
CON	1.000	1.000	1.667
$LSD_{0.05}$	**0.9348**	**0.6471**	**NS**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.5 Effect of Treatment Materials on Flower Initiation of groundnut after 2 Weeks: There was significant differences in flower initiation of groundnut after 2 weeks spray in 2,3 and 4 weeks after sowing plots, when compared with untreated plots (Table 9). Plots sprayed with RIMULGAN + *M. oleifera* seed extract and Neem oil recorded the highest (13.00) followed by RJSE and RJRE (12.33) while untreated plot recorded the lowest (5.00) in 2 WAS plots.

Plants in plots 3 WAS, sprayed with RIMULGAN + *M. oleifera* seed extract and Neem oil gave the highest flower (13.00) followed by RIMULGAN + *J. curcas* seed extract and RIMULGAN + *J. curcas* root extract (12.33) while untreated plot recorded the least (5.00).Test materials had significant effects on flower initiation after 2 weeks spray in four weeks after sowing plots, when compared with untreated plots.

Plots sprayed with Hexaconazole 6% E.C recorded the highest number of flower (5.00) followed by Neem oil and Mancozeb 80% WP (4.33) where as plots treated with RIMULGAN alone and untreated plot recorded the lowest number of flowers (2.00).

TABLE 9: Mean values of Treatment effects on flower initiation after 2 Weeks Spray in 2, 3 and 4 Weeks after sowing

Treatment	Number of flowers and Weeks After Sowing (week)		
	2	**3**	**4**
MSE	8.00	8.00	2.33
MRE	6.67	6.67	2.33

JSE	6.33	6.33	2.67
JRE	7.00	7.00	2.33
RMSE	13.00	13.00	3.67
RMRE	8.67	8.67	3.00
RJSE	12.33	12.33	3.67
RJRE	12.33	12.33	3.00
R	7.00	7.00	2.00
HX	10.67	10.67	5.00
NO	13.00	13.00	4.33
MC	11.67	11.67	4.33
CON	5.00	5.00	2.00
$LSD_{0.05}$	**3.934**	**2.155**	**1.232**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.6 Effect of Treatment on the Number of Pods per Plant:

The test materials had significant effects on the number of pods per plant in the two, three and four weeks after sowing plots (Table 10). Plots treated with Neem oil recorded the highest number of pods (24.33), followed by RIMULGAN + *M. oleifera* seed extract and

RIMULGAN + *J. curcas* seed extract (22.67), while untreated plot recorded the lowest (15.00) in 2WAS plots.

In three weeks after sowing plots, those treated with Neem oil recorded the highest pods (24.33), followed by RIMULGAN + *M. oleifera* seed extract and RIMULGAN + *J. curcas* seed extract (22.67), while untreated plot recorded lowest (15.00) and the difference was significant at P = 0.005.

Treatment materials also had significant effect on the number of pods/plant in four weeks after sowing plots. Plots treated with Hexaconazole 6% E.C, Neem oil and Mancozeb 80% WP recorded highest number of pods (37.67), followed by RIMULGAN + *J. curcas* seed extract (32.67), while the untreated plots recorded the lowest (23.00).

TABLE 10: Mean values of Treatment effects of No. of pods per plant at 2, 3 and 4 Spray Weeks.

Number of pods and	
Weeks After Sowing (weeks)	

Treatment	2	3	4
MSE	17.33	17.33	28.00
MRE	19.00	19.00	29.67
JSE	18.67	18.67	27.67
JRE	18.67	18.67	31.00
RMSE	22.67	22.67	30.67
RMRE	22.00	22.00	30.33
RJSE	22.67	22.67	32.67
RJRE	21.33	21.33	30.00
R	17.67	17.67	24.33
HX	21.33	21.33	37.67
NO	24.33	24.33	37.67
MC	20.67	20.67	37.00
CON	15.00	15.00	23.00
$LSD_{0.05}$	**4.567**	**7.281**	**4.993**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.7 Effect of Treatment on Seed of Groundnut:

The test materials had significant effects on seeds of groundnut when compared with seeds from untreated plot after two weeks spray in 2,3 and 4 weeks after sowing (Table 11). Plot

sprayed with RIMULGAN + *M. oleifera* seed extract weighed highest (191.7g), followed by Neem oil (190.0g), while untreated plot weighed the least (128.0g). Crops in 3 WAS plots sprayed with RIMULGAN + *M. oleifera* seed extract recorded the highest weight (191.7g), followed by Neem oil (190.0g), while untreated plot recorded lowest (128.3g).

After 2 weeks spray, a crop in 4 WAS showed significant differences in weight when compared with untreated plot. Plots sprayed with Mancozeb 80% WP recorded the highest weight (199.3g), followed by Hexaconazole 6% E.C (193.7g), while plot sprayed with *M. oleifera* seed extract and untreated plot recorded the lowest weight (161.0g).

TABLE 11: Mean weight of seeds of groundnut after 2, 3 and 4 Weeks after sowing.

	Weight of seeds (g) and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	156.7	156.7	161.0
MRE	171.7	171.7	174.0
JSE	146.3	146.3	170.3
JRE	174.7	174.7	171.7
RMSE	191.7	191.7	181.7
RMRE	167.3	167.3	171.7

RJSE	184.3	184.3	176.0
RJRE	154.0	154.0	166.7
R	129.7	129.7	161.7
HX	148.3	148.3	193.7
NO	190.0	190.0	192.3
MC	149.7	149.7	199.3
CON	128.3	128.3	161.0
$LSD_{0.05}$	**27.72**	**30.31**	**16.11**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.8 Effect of Treatments on groundnut Yield:

The effect of treatments on groundnut yield in 2, 3 and 4 WAS is shown in Table 12. There were significant differences in seed yield after spraying in 2, 3 and 4 weeks after sowing. Plot treated with RIMULGAN + *M. oleifera* seed extract recorded the highest yield (1.480kg), followed by Neem oil (1.410kg), and while untreated plot recorded the lowest yield (0.903kg) in 2 WAS plots. There was also significant differences on overall seed yield

after treatment spray three weeks after sowing plots. Plots treated with RIMULGAN + *J. curcas* seed extract recorded the highest seed yield (2.147kg), followed by RIMULGAN + *M. oleifera* seed extract (2.083kg), while untreated plot recorded the least (0.780kg).

Seed yield after treatment in four weeks after sowing plots was significantly different when compared with the untreated plots. Plots treated with Hexaconazole 6% E.C recorded highest (1.797kg), followed by Mancozeb 80% WP (1.753 kg), which were not significantly different from yield in plots treated with JRE and RMSE. The plot sprayed with RIMULGAN which recorded the lowest yield (1.157 kg) which was however not significantly different with the yield recorded in control plot (1.270).

TABLE 12: Mean values of yield after spraying in 2, 3 and 4 WAS.

	Groundnut yield (kg) and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	1.267	1.277	1.413
MRE	1.350	1.443	1.397

JSE	1.260	1.670	1.540
JRE	1.200	1.297	1.613
RMSE	1.480	2.083	1.613
RMRE	1.200	1.763	1.497
RJSE	1.347	2.147	1.577
RJRE	1.203	1.330	1.307
R	1.110	1.067	1.157
HX	1.267	1.447	1.797
NO	1.410	2.037	1.720
MC	1.223	1.243	1.753
CON	0.903	0.780	1.270
$LSD_{0.05}$	**0.1994**	**0.7948**	**0.2199**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.9 Effect of Treatment on incidence of *Cercospora* Disease of Groundnut at 2, 4 and 6 Weeks After Spray (WAS):

The incidence of *Cercospora* disease in plots sprayed after 2 weeks sprayed at two, three and four weeks after sowing, reduced significantly when compared with untreated plots (Table 13). Plots treated with RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *M. oleifera* root extract, RIMULGAN + *J. curcas* seed extract, RIMULGAN + *J. curcas* root extract and Neem oil checked the disease (no disease incidence), followed by M. *oleifera* root extract and *J. curcas* seed extract (1.67%). Whereas crop in the untreated plots (control) recorded highest disease incidence (13.33%). The test materials consistently recorded disease incidence even after 4 weeks of spray (Table 14).

Plots treated with RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *M. oleifera* root extract, RIMULGAN + *J. curcas* seed extract, RIMULGAN + *J. curcas* root extract and Neem oil showed no disease incidence (0%), followed by *M. oleifera* seed extract and M. *oleifera* root extract (5.00%). The untreated plots (control) recorded the highest disease incidence (23.33%). The treatment materials also gave significant low disease incidence in 6 WAS, when compared with control plot. Plots sprayed with RIMULGAN + *M. oleifera* seed extract and RIMULGAN + *J. curcas* root extract recorded the lowest disease incidence after 2 WAS (0.00), followed by RIMULGAN + *M. oleifera* root extract, and Neem oil (3.33%), where as plots treated with RIMULGAN recorded the highest disease incidence (18.33%) against the control plots of 16.67%.

After 6 weeks of spray, plots treated with RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *M. oleifera* root extract, RIMULGAN + *J. curcas* seed extract, RIMULGAN + *J. curcas* root extract, and Neem oil recorded no incidence of the disease (0.00) in 3WAS

plots, followed by *M. oleifera* seed extract and M. *oleifera* root extract (5.00%), while and untreated plot recorded highest (23.33%) (Table 15).

Test materials showed significant reduction in *Cercospora* disease incidence after 2 weeks spray in four weeks after sowing plots, when compared with untreated plot (Table 13). Untreated plot (control) recorded highest incidence of the disease (8.33%), followed by plots treated with *M. oleifera* seed extract and RIMULGAN (6.67%) where as plots treated with Hexaconazole 6% E.C, Neem oil and Mancozeb 80% WP recorded no disease. The test materials were consistent in recording very low incidence of the disease at 4 WAS, with plots treated with Hexaconazole 6% E.C, Neem oil and Mancozeb 80% WP recording no disease (0.00) followed by *J. curcas* root and seed extracts, and RIMULGAN + *M. oleifera* seed extract with 5% disease incidence, while untreated plot recorded the highest disease incidence (13.33%).

The treatment materials also gave significant low disease incidence after 6 weeks spray, when compared with untreated plot. Plots sprayed with Hexaconazole 6% E.C, Neem oil and Mancozeb 80% WP had no disease incidence (0.00), followed by M. *oleifera* root extract,

JRE, RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *M. oleifera* root extract and RIMULGAN + *J. curcas* seed extract, (5.00%), while untreated plot recorded the highest disease incidence 18.33% in plots of 4 WAS (Table 15).

TABLE 1 : Percentage incidence of Leaf Spot Disease of groundnut after Weeks

3 2

Spray in 2, 3 and 4 Weeks after sowing (WAS) plots	**Percentage disease incidence (%) and Weeks After Sowing (weeks)**		
Treatment	**2**	**3**	**4**
MSE	3.33	3.33	6.67
MRE	1.67	1.67	5.00
JSE	1.67	1.67	5.00
JRE	3.33	3.33	5.00
RMSE	0.00	0.00	5.00
RMRE	0.00	0.00	5.00
RJSE	0.00	0.00	5.00
RJRE	0.00	0.00	5.00
R	10.00	10.00	6.67
HX	3.33	3.33	0.00
NO	0.00	0.00	0.00
MC	3.33	3.33	0.00
CON	13.33	13.33	8.33
$LSD_{0.05}$	**4.284**	**1.827**	**2.401**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

TABLE 1 : Percentage incidence of Leaf Spot Disease of groundnut after Weeks
RK: *Mancozeb 80% WP*

CON: *Control*

4 3

Spray in 2, 3 and 4 Weeks after sowing (WAS) plots			
	Percentage disease incidence (%) and		
Weeks After Sowing (weeks)			
Treatment	**2**	**3**	**4**
MSE	5.00	10.00	8.33
MRE	5.00	6.33	6.67
JSE	13.33	6.33	5.00
JRE	10.00	8.00	5.00
RMSE	0.00	0.00	5.00
RMRE	0.00	3.33	8.33
RJSE	0.00	1.67	8.33
RJRE	0.00	0.00	6.67
R	13.33	18.33	8.33
HX	11.67	11.67	0.00
NO	0.00	3.33	0.00
MC	11.67	11.67	0.00
CON	23.33	16.67	13.33
$LSD_{0.05}$	**7.582**	**6.735**	**4.066**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

TABLE 1 : Percentage incidence of Leaf Spot Disease of groundnut after Weeks

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

5 4

Spray in 2, 3 and 4 Weeks after sowing (WAS) plots

Percentage disease incidence (%) and

Weeks After Sowing (weeks)

Treatment	**2**	**3**	**4**
MSE	10.00	5.00	6.67
MRE	6.33	5.00	5.00
JSE	6.33	13.33	6.67
JRE	8.00	10.00	5.00
RMSE	0.00	0.00	5.00
RMRE	3.33	0.00	5.00
RJSE	1.67	0.00	5.00
RJRE	0.00	0.00	13.33
R	18.33	13.33	16.67
HX	11.67	11.67	0.00
NO	3.33	0.00	0.00
MC	11.67	23.30	0.00
CON	16.67	23.33	18.33
$LSD_{0.05}$	**7.129**	**4.320**	**4.441**

TABLE 1 : Percentage incidence of Leaf Spot Disease of groundnut after Weeks

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.10 Effect of Treatment on Severity of *Cercospora* Leaf Spot Disease of groundnut: Treatment materials showed significant differences on severity of *Cercospora* disease of groundnut, after 2, 4 and 6 weeks spray after 2, 3 and 4 weeks after sowing (Table 16, 17 and 18). The spread of the disease severity was checked in all the plots, except Hexaconazole 6% E.C (0.333) and Neem oil (0.667), while plots treated with RIMULGAN alone recorded the highest severity index (1.00). After 4 weeks of spray, plot treated with RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *M. oleifera* root extract, RIMULGAN + *J. curcas* seed extract, RIMULGAN + *J. curcas* root extract and Neem oil showed no severity of the disease (0.00) in 2WAS plots and this is followed by Mancozeb 80% WP (0.333), while untreated plot recorded the highest severity index (1.667).

Plots sprayed after 6 weeks with RIMULGAN + *J. curcas* root extract had no disease severity (0.00), followed by RIMULGAN + *J. curcas* seed extract and Neem oil (0.333), while plots treated with RIMULGAN and untreated plot recorded highest (2.00) in 2 weeks plots (Table 18). Test materials showed no significant differences on severity of *Cercospora* disease of groundnut after 4 and 6 weeks of spray in 3 WAS plots when compared with untreated plot, indicating that severity of *Cercospora* disease of groundnut in the treated and untreated plots were statistically the same (Tables 17 and 18).

The severity of *Cercospora* disease of groundnut was significantly different after 2, 4 and 6 weeks spray in four weeks after sowing plots. After 2 weeks spray, the untreated plots recorded the highest severity of the disease (1.333), while all other treated plots had the same severity index (1.00). After 4 weeks spray, untreated plots (control) recorded the highest severity of the disease (2.333) followed by RIMULGAN (2.00), while plots treated with

Neem oil and Mancozeb 80% WP recorded lowest (0.333) (Table 17).
Plots treated with RIMULGAN after 6 weeks spray and control recorded highest severity of the disease (2.333), followed by *M. oleifera* root extract (2.00), while plots sprayed with Neem oil and Mancozeb 80% WP recorded lowest (0.333) in plots 4 WAS (Table 18).

TABLE 1 : effects of treatment on Severity of Leaf Spot Disease of groundnut after in 2, 3 and 4 Weeks after sowing (WAS) plots

Weeks Spray			6 2
	Severity index and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	0.000	0.000	1.000
MRE	0.000	0.000	1.000
JSE	0.000	0.000	1.000
JRE	0.000	0.000	1.000
RMSE	0.000	0.000	1.000
RMRE	0.000	0.000	1.000
RJSE	0.000	0.000	1.000
RJRE	0.000	0.000	1.000
R	1.000	1.000	1.000
HX	0.333	0.333	1.000
NO	0.667	0.000	1.000
MC	0.333	0.333	1.000
CON	0.000	0.667	1.333
$LSD_{0.05}$	**0.4407**	**0.2698**	**0.2691**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 1 : effects of treatment on Severity of Leaf Spot Disease of groundnut after

7 4

Weeks Spray in 2, 3 and 4 Weeks after sowing (WAS) plots

	Severity index and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	0.667	1.000	1.000
MRE	1.000	1.000	1.000
JSE	0.667	1.333	1.000
JRE	1.000	1.333	1.000
RMSE	0.000	1.000	1.333
RMRE	0.000	1.000	1.333
RJSE	0.000	1.000	1.000
RJRE	0.000	1.333	1.000
R	1.333	1.667	2.000
HX	0.667	1.333	0.667
NO	0.000	1.000	0.333
MC	0.333	1.333	0.333
CON	1.667	2.000	2.333
$LSD_{0.05}$	**0.6280**	**NS**	**0.7224**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

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Weeks Spray

	Severity index and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	1.000	1.000	2.000
MRE	1.000	1.333	1.000
JSE	1.000	1.667	1.000
JRE	1.000	1.667	1.333
RMSE	1.000	1.000	1.000
RMRE	0.667	1.000	1.667
RJSE	0.333	1.000	1.000
RJRE	0.000	1.333	1.333
R	2.000	1.667	2.333
HX	1.333	1.333	0.667
NO	0.333	1.000	0.333
MC	1.000	1.333	0.333
CON	2.000	2.000	2.333
$LSD_{0.05}$	**0.6746**	**NS**	**1.0127**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

TABLE 1 : effects of treatment on Severity of Leaf Spot Disease of groundnut after in 2, 3 and 4 Weeks after sowing (WAS) plots

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.11 Effect of Treatment on development of Non *Cercospora* Folia (NCF) Disease of groundnut:

Treatment materials showed significant differences on incidence of non *Cercospora* folia disease after 2 weeks spray in 2, 3 and 4 weeks after sowing (Table 19). Plot treated with *M. oleifera* seed extract, *M. oleifera* root extract, *J. curcas* seed extract, RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *J. curcas* seed extract and Hexaconazole 6% E.C recorded no incidence of the disease (0.00), followed by *J. curcas* root extract, RMRE, Neem oil and Mancozeb 80% WP that recorded (1.67%), while plot treated with RIMULGAN alone recorded the highest disease incidence (10.00%) in 2 WAS plots. There was significant difference on incidence of non *Cercospora* folia diseases of groundnut after 4 and 6 weeks spray with test materials when compared with untreated plots in 2 WAS plots (Tables 21 and 22), indicating that incidence of non *Cercospora* folia diseases of groundnut of the treated and untreated plot were statistically the same after 4 and 6 weeks spraying. Treatment materials showed significant differences in non *Cercospora* foliar disease incidence after 2 weeks spray in three Weeks After Sowing when compared with untreated plot (Table 19). Plots treated with *M. oleifera* seed extract, M. *oleifera* root extract, *J. curcas* seed extract,

RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *J. curcas* seed extract and Hexaconazole 6% E.C recorded lowest (0.00), followed by RIMULGAN + *M. oleifera* root extract, Neem oil and Mancozeb 80% WP (1.67%), while plots treated with RIMULGAN alone recorded highest incidence of the disease (10.00%) and this was similar to the result obtained after 4 weeks spray in 3 WAS (Table 20). The treatment materials consistently gave very low incidence of the disease after 6 weeks spray, when compared with untreated plot. Plot sprayed with Neem oil recorded no disease (0.00), followed by RIMULGAN + *M. oleifera* seed extract, RIMULGAN + *J. curcas* seed extract, and Mancozeb 80% WP which recorded (1.67%), while untreateds plot recorded the highest incidence of the disease (5.00%) in 2 WAS plots (Table 20).

: Percentage incidence of Non *Cercospora* Foliar Disease of groundnut after in 2, 3 and 4 Weeks after sowing (WAS) plots

TABLE 19 2 Weeks Spray

	Percentage disease incidence (%) and Weeks After Sowing (weeks)			
MSE	0.00	0.00	6.67	**Treatment**
MRE	0.00	0.00	8.33	**2**
JSE	0.00	0.00	5.00	**3**
JRE	1.67	1.67	5.00	**4**
RMSE	0.00	0.00	5.00	
RMRE	1.67	1.67	6.67	
RJSE	0.00	0.00	6.67	
RJRE	3.33	3.33	6.67	
R	10.00	10.00	5.00	
HX	0.00	0.00	0.00	
NO	1.67	1.67	0.00	
MC	1.67	1.67	0.00	
CON	8.33	8.33	8.33	
$LSD_{0.05}$	**5.254**	**2.726**	**3.350**	

Key:

: Percentage incidence of Non *Cercospora* Foliar Disease of groundnut after in 2, 3 and 4 Weeks after sowing (WAS) plots

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 20 4 Weeks Spray

	Percentage disease incidence (%) and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	0.00	0.00	8.33
MRE	0.00	0.00	6.67
JSE	1.67	0.00	5.00
JRE	0.00	1.67	5.00
RMSE	0.00	0.00	5.00
RMRE	0.00	1.67	8.33
RJSE	0.00	0.00	8.33
RJRE	0.00	3.33	6.67
R	3.33	10.00	6.67
HX	0.00	0.00	0.00

: Percentage incidence of Non *Cercospora* Foliar Disease of groundnut after in 2, 3 and 4 Weeks after sowing (WAS) plots

NO	1.67	1.67	0.00
MC	1.67	1.67	0.00
CON	3.33	8.33	11.67
$LSD_{0.05}$	**NS**	**3.364**	**4.575**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 21 6
Weeks Spray

	Percentage disease incidence (%) and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	3.33	3.33	3.33
MRE	3.33	3.33	3.33
JSE	3.33	3.33	3.33

: Percentage incidence of Non *Cercospora* Foliar Disease of groundnut after in 2, 3 and 4 Weeks after sowing (WAS) plots

JRE	5.00	3.33	5.00
RMSE	1.67	1.67	5.00
RMRE	3.33	3.33	5.00
RJSE	1.67	1.67	3.33
RJRE	3.33	3.33	5.00
R	3.33	3.33	5.00
HX	3.33	3.33	1.67
NO	0.00	0.00	1.67
MC	1.67	1.67	1.67
CON	3.33	5.00	5.00
$LSD_{0.05}$	**NS**	**3.067**	**NS**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

: Percentage incidence of Non *Cercospora* Foliar Disease of groundnut after in 2, 3 and 4 Weeks after sowing (WAS) plots

CON: *Control*

4.12 Effect of Treatment on Severity of Non *Cercospora* Foliar (NCF) Diseases of groundnut:

Treated materials showed significant differences in severity of non *Cercospora* foliar disease of groundnut after 2 weeks spray in 2, 3 and 4 weeks after sowing plots (Table 22). All the plots treated with the test materials in 2 and 3 WAS showed no spread of the disease (0.00), except *J. curcas* root extract (0.333%) and RIMULGAN, Hexaconazole 6% E.C, Mancozeb

80% WP (0.667%), while untreated plots recorded the highest severity of the disease (1.00%). There were no significant differences in severity of non *Cercospora* foliar diseases of groundnut after 4 and 6 weeks spray in 2 and 3 WAS and after 6 weeks spray in 2 WAS plots when compared with the untreated plots (Tables 23 and 24), indicating that the severity of non *Cercospora* foliar diseases of groundnut of the treated and untreated plots were statistically the same after 4 and 6 weeks spray. Treatment materials showed significant differences on severity of non *Cercospora* foliar disease of groundnut after 6 weeks spray in 3 and 4 WAS spray when compared with untreated plots, where as severity of non *Cercospora* foliar diseases of groundnut of the treated and untreated plots were statistically the same after 2 weeks spray (Table 24). Plot sprayed after 4 weeks with Neem oil had the least severity index (0.00), followed by RIMULGAN + *M. oleifera* seed extract and

RIMULGAN + *J. curcas* seed extract (0.333), while plot sprayed RJSE, RJRE, MC, RIMULGAN and Hexaconazole 6% E.C recorded 0.667 where as untreated plot recorded the highest severity of the disease (1.00) in 3 and 4 WAS plots (Table 23). Treated

materials showed significant differences on severity of non *Cercospora* foliar disease of groundnut after 2, 4 and 6 weeks spray in 4 WAS plots (Tables 22, 23 and 24).

TABLE 22: Severity of non *Cercospora* foliar Disease of groundnut after 2 Weeks Spray in 2, 3 and 4 Weeks after sowing (WAS) plots

	Severity index and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	0.000	0.000	1.333
MRE	0.000	0.000	1.000
JSE	0.000	0.000	1.000
JRE	0.333	0.000	1.000
RMSE	0.000	0.000	1.000
RMRE	0.000	0.000	1.000
RJSE	0.000	0.333	1.000
RJRE	0.000	0.000	1.333
R	0.667	0.667	1.667
HX	0.667	0.667	0.000
NO	0.000	0.000	0.000
MC	0.667	0.667	0.000
CON	1.000	1.000	1.333
$LSD_{0.05}$	**0.5563**	**0.4674**	**0.5225**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 23: Severity of non *Cercospora* foliar Disease of groundnut after 4 Weeks Spray in 2, 3 and 4 Weeks after sowing (WAS) plots

	Severity index and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	0.333	0.333	1.333
MRE	0.333	0.333	1.000
JSE	0.333	0.333	1.333
JRE	0.333	0.333	1.000
RMSE	0.333	0.333	1.333
RMRE	0.333	0.333	1.333
RJSE	0.667	0.667	1.000
RJRE	0.667	0.667	1.333
R	0.667	0.667	1.667
HX	0.667	0.667	0.000
NO	0.000	0.000	0.000
MC	0.667	0.667	0.000
CON	1.000	1.000	1.333
$LSD_{0.05}$	**NS**	**NS**	**0.6183**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

TABLE 24: Severity of non *Cercospora* foliar Disease of groundnut after 6 Weeks Spray in 2, 3 and 4 Weeks after sowing (WAS) plots

	Severity index and Weeks After Sowing (weeks)		
Treatment	**2**	**3**	**4**
MSE	1.000	1.000	1.333
MRE	0.667	0.667	1.000
JSE	0.667	0.667	1.333
JRE	0.333	0.667	1.000
RMSE	0.667	0.333	1.333
RMRE	0.667	0.667	1.333
RJSE	0.333	0.333	1.333
RJRE	0.667	0.667	1.333
R	1.000	1.000	1.333
HX	1.000	1.000	0.000
NO	0.667	0.000	0.000
MC	0.000	0.667	0.000
CON	1.000	1.000	1.667
$LSD_{0.05}$	**NS**	**0.4665**	**0.5617**

Key:

MSE: *Moringa oleifera* Seed Extract

MRE: *Moringa oleifera Root Extract*

JSE: *Jatropha curcas Seed Extract*

JRE: *Jatropha curcas Root Extract*

RMSE: *RIMULGAN + Moringa oleifera Seed Extract*

RMRE: *RIMULGAN + Moringa oleifera Root Extract*

RJSE: *RIMULGAN + Jatropha curcas Seed Extract*

RJRE: *RIMULGAN + Jatropha curcas Root Extract*

RI: *RIMULGAN*

CT: *Hexaconazole 6% EC*

NA: *Neem Oil*

RK: *Mancozeb 80% WP*

CON: *Control*

4.2 Discussion

The result of the study has shown that the fast plants significantly reduced the incidence and severity of *Cercospora* leaf spot of groundnut when sprayed after 2, 4 and 6 weeks in 2, 3 and 4 weeks after sowing plots. Neem material and RIMULGAN + seeds and roots extracts of *Moringa* and *Jatropha* were found to be most effective in reducing and checking the incidence and severity of the foliar diseases of groundnut in two and four weeks after spray plots. The fungicidal effects of neem material have bben recorded by Ghewande (1989) who noted that the leaf extracts of *Azadirachta indica, Lawsonia, Tridax* sp. and *Pongamia* were found useful in managing foliar diseases of groundnut. Hassanein, N.M *et al.,*2008 also reported that efficacy of leaf extracts of neem (*Azadirachta indica*) and Chinaberry(*Melia azedrach*) against early blight and wilt disease of tomato. Also, Khan and Kumar (1990) reported that leaf extracts of *Azadirachta indica* has antifungal effect and was used in checking the seed mycoflora of wheat. Sobti *et al*. (1995) observed that extracts of *Azadirachta indica, Polyalthia longifolia, Oscimum gratissimum* were useful in the control of groundnut pathogens such as *Macrophomina phaseolina, Aspergillus flavus* and *A. niger*. Tomar and Chandel (2006) worked on certain plant extracts against *Fusarium* wilt, caused by *Fusarium oxysporum* f. sp. *gladioli* (L. Massey) and reported that *Azadirachta indica, Allium sativum* and *Oscimum sanctum* inhibited mycelial growth of the pathogen by 60 %. Okwu *et al*., (2007) also reported that growth of *Fusarium oxysporum* which causes

damping-off disease of okra (*Hebiscus esculentus*) was inhibited *in vitro* by the extracts of *Citrus species* which in turn recorded increase in yield components and overall fruit yield.

The fungicidal effect of seed extracts of *M. oleifera* in this work could be attributed to the presence of bio-active agent steroidal glycoside-strophantidrin (Olayemi and Alabi, 1994). This bio-active agent have been found to inhibit the radial mycelial growth of *Aspergillus flavus* in treated maize seeds for the first 48hrs after inoculation (Balogun and Ojiako2004) and this is in line with the findings of Dubey (1998) who reported that the extracts of *Moringa spp.* inhibited the growth of *Thanetophorus cucumeris, Ficus benghalensis* and *Eclipta alba*. Moreover, Wissenberg, *et al*., (1998), reported that Strophantridin (a C_{23} steroidal glycone) inhibited the growth of red flower beetle (*Tribolium castaneum*) and tobacco horn worm (*Manduca sexta*). Adandonon *et al.,* (2006) also reported Biocontrol agents in combination with *Moringa* oleifera extract for integrated control of Sclerotiumcaused cowpea damping-off and stem rot.

The antimicrobial potential of seed extracts of J. *curcas* could be as a result of several sterols and diterpenes (phorbol esters) which are the most toxic molecules in the plant (Haas *et al*., 2002). This result is in agreement with the findings of Makkar *et al*.,(1998) who reported that *J. curcas* seed extracts contained phorbol esters which exerted potential insecticidal effects against *Busseola fusca* and *Sesamia calamistis.* Adebowale and Adedire (2006) also reported that *J. curcas* oil offered 12-wk protection for treated cowpea seeds against *C. maculatus*. In another study, where J. *curcas* oil was used as an emulsifiable concentrate (JEC) it produced toxicity toward *Callosobruchus chinensis* (mung bean), inhibiting their oviposition when sprayed on them. Furthermore, the seed extracts have been found to inhibit and control maize weevil in stored maize grains (Ohazuruike *et al*., 2003).

The efficacy of Mancozeb (80% WP) is in agreement with the findings of Salako, (2008) who reported the evaluation a formulation of tridemorph + maneb (0.39 and 1.26 kg a.i./ha respectively), carbendazim (0.125 kg a.i./ha), benomyl (0.30 kg a.i./ha), tridemorph (0.45 kg a.i./ha) and a non systemic fungicide, mancozeb (2.00 kg a.i./ha) against groundnut leafspots caused by *Mycosphaerella arachidis* Deighton *(Cercospora arachidicola* Hori) and *M. berkeleyii* Jenkins (*Cercosporidium personatum* (Berk. & Curt.) Deighton) and rust, caused by *Puccinia arachidis* Speg., using ultra low volume application. Application of mancozeb also recorded fungicidal effect against seed borne fungal pathogen of farmer saved sorghum (*Sorghum bicolor*) and groundnut *(Arachis hypogaea)* seeds (Syed *et al.,* 2012).

Mancozeb application resulted in higher pod and haulm (shoot) yields than when the systemic fungicides were applied alone. Cheema and Jeyarajan, (1972) and Walker, (1972) also reported that Captan, carbendazim, copper oxychloride, mancozeb and sulfur were used to control leaf spot (*Mycosphaerella arachidis*) in groundnuts. All fungicides significantly reduced disease intensity compared with the control. Mancozeb was the most effective fungicide followed by carbendazim and copper oxychloride. Maximun pod yield was recorded in plots sprayed with mancozeb followed by carbendazim (Cheema and Jeyarajan, 1972) and (Walker, 1972). Shiferaw *et al*., (2011) reported that the use of mancozeb (80% WP) at various (eight) spray regimes controled late blight (*Phytophthora infestans*) disease of potato with significance increase in tuber yield. The treatments were found to be more effective when sprayed in 2 WAS plots. This is line with the findings of Culbreath *at al.,*(2000), which reported that application of pyraclostrobin at 14- day interval performed higher than 28-day interval, although, similar to the application of the material at 21-day interval.

The test materials recorded significant increase on yield and yield attributes of groundnut in two, three and four weeks after sowing plots. The spray in two weeks after sowing plots, significantly enhanced flower initiation of the crop, when compared with untreated plots. The treatment materials also significantly reduced incidence and severity of non cercospora folia disease of groundnut at varied stages of groundnut. RIMULGAN + seed extracts of *Moringa* and *Jatropha* were among the treatments that recorded the lowest incidence and severity of the diseases in two weeks after spray plots.

The treatment materials showed no significant differences in the reduction of incidence and severity of non *Cercospora* foliar diseases of groundnut after four and six weeks spray, at 5% probability level. The treated plots recorded significant increase in growth parameters of the crop after treatment in 2 WAS, for instance, the plant height was significantly increased after two weeks spray. Significant increase on plant height was also recorded after four weeks spray, with neem oil and RIMULGAN + seed extracts of *Moringa* and *Jatropha*, while RIMULGAN + root extract of *Moringa* and *Jatropha* recorded second highest. Treatment with, neem oil and RIMULGAN + seed extracts of *Moringa* and *Jatropha* enhanced the number of leaves after two and four weeks spray respectively. The spray after two and four weeks with RIMULGAN + seed extracts of *Jatropha* recorded highest leaf area, where as RIMULGAN + seed extracts of *Moringa* and *Jatropha* recorded the highest number of branches after two weeks spray. The treatments with the plant extracts significantly enhanced the yield components of groundnut when compared with control plots at 5% probability level, with the neem oil and RIMULGAN + seed extract of *Moringa* recorded highest. RIMULGAN + seed and root extracts of *Jatropha* also recorded second highest. Neem oil recorded highest number of pods per plant and RIMULGAN + seed extract of *Moringa* the recorded highest seed weight of groundnut.

Treatment materials showed significant reduction on the incidence and severity of non *Cercospora* foliar diseases of groundnut after two and four weeks spray, with RIMULGAN + seeds extracts of *Moringa* and *Jatropha* recording the lowest incidence the disease. After six weeks spray, RIMULGAN + seeds extracts of *Moringa* recorded lowest disease incidence.

After two and four weeks spray, RIMULGAN + seed extracts of *Jatropha* and recorded highest leaf area, where as RIMULGAN + seed extracts of *Moringa* and *Jatropha* recorded the highest number of branches of groundnut suggesting that treatment of the crop with those test materials could enhance photosynthesis and yield of the crop. Spraying the crops four weeks after sowing, had significant effects on the yield components of the crop when compared with the control plots at 5% probability level.

Generally, this study ranked RIMULGAN + *J. curcas* seed extracts, RIMULGAN + *M. oleifera* seed extracts, (in that order) superior to RIMULGAN + *J. curcas* root extracts and RIMULGAN + *M. oleifera root* extracts both in control of folia diseases (cercospora leaf spot) and grain yields, suggesting that, seed extracts of *J. curcas* and *M. oleifera* have possess greater antimicrobial properties than the root extracts. Spraying the crops two weeks after sowing was found to be the best spray period in controlling the foliar diseases of groundnut in the field.

CHAPTER FIVE

Summary, Conclusions and Recommendations

The study showed that the extracts of *Moringa oleifera* and *Jatropha curcas* alone or in combination controled both the *Cercospora* and other foliar diseases of groundnut. However, the RIMULGAN + seed extracts *Moringa oleifera* and *Jatropha curcas* were more effective and comparable with Neem oil and synthetic fungicides (Hexaconazole 6% EC and Mancozeb 80% WP) than the root extracts. Spraying the crops two weeks after sowing was found to be the best spray period in controlling the foliar disease of groundnut in the field.

This result on plant extracts could form the basis for a successful formulations and commercialization of bio-fungicides in developing countries, where low input of agriculture is in vogue. Farmers are therefore advised to use these bio-fungicides in the field to reduce menace of foliar diseases in the field. In Nigeria, these plants are readily available and cost effective when compared with synthetic chemicals which are not only scarce and expensive to resource poor farmers but harzardous to both human and environment. They have also been found to be cheap, easily bio-degradable, technologically and environmentally friendly. They could provide valuable alternatives to the use of synthetic fungicide in the management of groundnut diseases.

It is recommended that the potentials of this plant products as protectants of folia diseases, be further explored. Further research on agronomic practices aimed at domestication and/ or

cultivation of *Moringa oleifera* and *Jatropha curcas* plants is recommended to enhance their production and possible exploitation for production of biopesticides which could be used in the control of plant diseases both in the field and storage.

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APPENDIX

ANOVA TABLES FOR TWO WEEKS AFTER PLANTING SPRAYING REGIME

1. RCBD ANOVA TABLE SHOWING 100 SEEDS WEIGHT

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	856.8	428.4	1.58		
TREATMENTS	12	15861.6	1321.8	4.88**	<.001	
RESIDUAL	24	6494.5	270.6			
TOTAL	38	23213.0				

2. RCBD ANOVA TABLE SHOWING FLOWER INITITIATION AT 4 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	173.282	86.641	15.83		
TREATMENTS	12	300.308	25.026	4.57**	<.001	
RESIDUAL	24	131.385	5.474			
TOTAL	38	604.974				

3. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 8 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)

BLOCKS	2	2.51	1.26	0.07	
TREATMENTS	12	1279.74	106.65	5.96**	<.001
RESIDUAL	24	429.49	17.90		
TOTAL	38	1711.74			

4. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 6WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	247.44	123.72	6.11		
TREATMENTS	12	1956.41	163.03	8.05**	<.001	
RESIDUAL	24	485.90	20.25			
TOTAL	38	2689.74				

5. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 4WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	11.538	5.769	0.89		
TREATMENTS	12	614.103	51.175	7.92**	<.001	
RESIDUAL	24	155.128	6.464			
TOTAL	38	780.769				

6. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 4WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.35897	0.17949	2.63		
TREATMENTS	12	3.74359	0.31197	4.56**	<.001	
RESIDUAL	24	1.64103	0.06838			
TOTAL	38	5.74359				

7. RCBD ANOVA TABLE SHOWING NUMBER OF PODS PER PLANT

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	24.359	12.179	1.66		
TREATMENTS	12	248.923	20.744	2.82**	0.015	
RESIDUAL	24	176.308	7.346			
TOTAL	38	449.590				

8. RCBD ANOVA TABLE SHOWING SEED YIELD PER PLOT

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.00763	0.00382	0.27		
TREATMENTS	12	0.73829	0.06152	4.39**	0.001	
RESIDUAL	24	0.33617	0.01401			
TOTAL	38	1.08209				

9. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 6WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.6667	0.3333	2.40		
TREATMENTS	12	11.5897	0.9658	6.95**	<.001	
RESIDUAL	24	3.3333	0.1389			
TOTAL	38	15.5897				

10. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 8WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.8205	0.4103	2.56		
TREATMENTS	12	14.9231	1.2436	7.76**	<.001	
RESIDUAL	24	3.8462	0.1603			
TOTAL	38	19.5897				

11. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 8WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.9744	0.4872	2.68		
TREATMENTS	2	3.3333	0.2778	1.53^{ns}	0.181	
RESIDUAL	24	4.3590	0.1816			
TOTAL	38	8.6667				

12. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 4WAP

Source of variation	d.f.	S.S	M.S.	V.r	F.PR	Tab.(0.05)
BLOCKS	2	0.0513	0.0256	0.24		
TREATMENTS	12	4.7692	0.3974	3.65**	0.003	
RESIDUAL	24	2.6154	0.1090			
TOTAL	38	7.4359				

13. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 6WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	2.6667	1.3333	6.86		
TREATMENTS	12	2.4103	0.2009	1.03^{ns}	0.452	
RESIDUAL	24	4.6667	0.1944			
TOTAL	38	9.7436				

14. RCBD ANOVA TABLE SHOWING INCIDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 8 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	116.667	58.333	21.00		
TREATMENTS	12	56.410	4.701	1.69^{ns}	0.132	
RESIDUAL	24	66.667	2.778			
TOTAL	38	239.744				

15. RCBD ANOVA TABLE SHOWING INCIDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 4 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS stratum	2	16.667	8.333	0.86		
TREATMENTS	12	389.744	32.479	3.34**	0.006	
RESIDUAL	24	233.333	9.722			
TOTAL	38	639.744				

16. RCBD ANOVA TABLE SHOWING INCIDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 6 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	1.282	0.641	0.19		
TREATMENTS	12	60.256	5.021	1.47^{ns}		0.204
RESIDUAL	24	82.051	3.419			
TOTAL	38	143.590				

ANOVA TABLES FOR THREE WEEKS AFTER PLANTING SPRAYING REGIME

17. RCBD ANOVA TABLE SHOWING 100 SEEDS WEIGHT

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	7874.5	3937.3	12.17		
TREATMENTS	12	10810.6	900.9	2.79*		0.016
RESIDUAL	24	7762.8	323.5			
TOTAL	38	26447.9				

18. RCBD ANOVA TABLE SHOWING FLOWER INITITIATION AT 4 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	80.769	40.385	24.71		
TREATMENTS	12	102.308	8.526	5.22**		<.001
RESIDUAL	24	39.231	1.635			
TOTAL	38	222.308				

19. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 8WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	50.00	25.00	1.57		
TREATMENTS	12	816.67	68.06	4.26**		0.001

RESIDUAL	24	383.33	15.97	
TOTAL	38	1250.00		

20. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 6WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	8.974	4.487	0.68		
TREATMENTS	12	507.692	42.308	6.44**	<.001	
RESIDUAL	24	157.692	6.571			
TOTAL	38	674.359				

21. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 4WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	5.128	2.564	2.18		
TREATMENTS	12	152.564	12.714	10.82**	<.001	
RESIDUAL	24	28.205	1.175			
TOTAL	38	185.897				

22. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 4WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.05128	0.02564	1.00		
TREATMENTS	12	1.23077	0.10256	4.00**	0.002	
RESIDUAL	24	0.61538	0.02564			
TOTAL	38	1.89744				

23. RCBD ANOVA TABLE SHOWING NUMBER OF LEAVES AT 4WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.05128	0.02564	0.32		
TREATMENTS	12	6.66667	0.55556	6.84**	<.001	
RESIDUAL	24	1.94872	0.08120			
TOTAL	38	8.66667				

24. RCBD ANOVA TABLE SHOWING NUMBER OF PODS PER PLANT

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS STRATUM	2	280.67	140.33	7.52		
TREATMENTS	12	687.69	57.31	3.07**	0.009	
RESIDUAL	24	448.00	18.67			
TOTAL	38	1416.36				

25. RCBD ANOVA TABLE SHOWING SEED YIELD

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	2.5038	1.2519	5.63		
TREATMENTS	12	6.1272	0.5106	2.30*	0.040	
RESIDUAL	24	5.3389	0.2225			
TOTAL	38	13.9699				

26. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 6WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	1.0582	0.5291	1.77		
TREATMENTS	11	9.0966	0.8270	2.77*	0.022	
RESIDUAL	21(1)	6.2765	0.2989			
TOTAL	34(1)	14.5714				

27. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 8WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.0513	0.0256	0.13		
TREATMENTS	12	4.0000	0.3333	1.73^{ns}	0.122	
RESIDUAL	24	4.6154	0.1923			
TOTAL	38	8.6667				

28. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 8WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.66667	0.33333	4.00		
TREATMENTS	12	6.30769	0.52564	6.31**	<.001	
RESIDUAL	24	2.00000	0.08333			
TOTAL	38	8.97436				

29. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 6WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)

BLOCKS	2	1.5897	0.7949	4.33	
TREATMENTS	12	3.5897	0.2991	1.63^{ns}	0.150
RESIDUAL	24	4.4103	0.1838		
TOTAL	38	9.5897			

30. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 4WAP

Source of variation	**d.f.**	**S.S**	**M.S.**	**V.r.**	**F.PR**	**Tab.(0.05)**
BLOCKS	2	0.15385	0.07692	1.00		
TREATMENTS	12	4.92308	0.41026	5.33**	<.001	
RESIDUAL	24	1.84615	0.07692			
TOTAL	38	6.92308				

31. RCBD ANOVA TABLE SHOWING INCIDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 6 WAP

Source of variation	**d.f.**	**S.S**	**M.S.**	**V.r.**	**F.PR**	**Tab.(0.05)**
BLOCKS	2	6.359	3.179	0.80		
TREATMENTS	12	123.590	10.299	2.58*	0.023	
RESIDUAL	24	95.641	3.985			
TOTAL	38	225.590				

32. RCBD ANOVA TABLE SHOWING INCIDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 8 WAP

Source of variation	**d.f.**	**S.S**	**M.S.**	**V.r.**	**F.PR**	**Tab.(0.05)**
BLOCKS	2	3.846	1.923	0.58		
TREATMENTS	12	89.744	7.479	2.26^{ns}	0.043	

RESIDUAL	24	79.487	3.312	
TOTAL	38	173.077		

33. RCBD ANOVA TABLE SHOWING INCIDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 4 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	3.846	1.923	0.73		
TREATMENTS	12	141.026	11.752	4.49^{ns}	<.001	
RESIDUAL	24	62.821	2.618			
TOTAL	38	207.692				

ANOVA TABLES FOR FOUR WEEKS AFTER PLANTING SPRAYING REGIME

34. RCBD ANOVA TABLE SHOWING 100 SEEDS WEIGHT

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	7601.69	3800.85	41.57		
TREATMENTS	12	5903.69	491.97	5.38**	<.001	
RESIDUAL	24	2194.31	91.43			
TOTAL	38	15699.69				

35. RCBD ANOVA TABLE SHOWING FLOWER INITITIATION AT 4 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	6.5128	3.2564	6.10		
TREATMENTS	12	35.0256	2.9188	5.46**	<.001	
RESIDUAL	24	12.8205	0.5342			

TOTAL	38	54.3590				

36. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 8 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	16.667	8.333	1.20		
TREATMENTS	12	1283.333	106.944	15.40**	<.001	
RESIDUAL	24	166.667	6.944			
TOTAL	38	1466.667				

37. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 6 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	26.923	13.462	2.31		
TREATMENTS	12	560.256	46.688	8.02**	<.001	
RESIDUAL	24	139.744	5.823			
TOTAL	38	726.923				

38. RCBD ANOVA TABLE SHOWING INCIDENCE OF LEAF SPOT DISEASE OF G/NUT AT 4 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	1.282	0.641	0.32		
TREATMENTS	12	258.974	21.581	10.63**	<.001	
RESIDUAL	24	48.718	2.030			
TOTAL	38	308.974				

39. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 4WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.05128	0.02564	1.00		
TREATMENTS	12	7.69231	0.64103	25.00**	<.001	

RESIDUAL	24	0.61538	0.02564		
TOTAL	38	8.35897			

40. RCBD ANOVA TABLE SHOWING NUMBER PODS PER PLANT

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	352.667	176.333	20.09		
TREATMENTS	12	776.103	64.675	7.37**	<.001	
RESIDUAL	24	210.667	8.778			
TOTAL	38	1339.436				

41. RCBD ANOVA TABLE SHOWING SEED YIELD PER PLOT

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	1.29257	0.64629	37.97		
TREATMENTS	12	1.37491	0.11458	6.73**	<.001	
RESIDUAL	24	0.40849	0.01702			
TOTAL	38	3.07597				

42. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 6WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	1.5897	0.7949	4.33		
TREATMENTS	12	11.5897	0.9658	5.26**	<.001	
RESIDUAL	24	4.4103	0.1838			
TOTAL	38	17.5897				

43. RCBD ANOVA TABLE SHOWING SEVERITY OF LEAF SPOT DISEASE OF G/NUT AT 8WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)

BLOCKS	2	0.6667	0.3333	0.92	
TREATMENTS	12	16.1026	1.3419	3.72**	0.003
RESIDUAL	24	8.6667	0.3611		
TOTAL	38	25.4359			

44. RCBD ANOVA TABLE SHOWING INCIDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 4 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	5.128	2.564	0.65		
TREATMENTS	12	324.359	27.030	6.84**	<.001	
RESIDUAL	24	94.872	3.953			
TOTAL	38	424.359				

45. RCBD ANOVA TABLE SHOWING INCIDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 6 WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	39.744	19.872	2.70		
TREATMENTS	12	473.077	39.423	5.35**	<.001	
RESIDUAL	24	176.923	7.372			
TOTAL	38	689.744				

46. RCBD ANOVA TABLE SHOWING INCEDENCE OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 8WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	1.282	0.641	0.13		

TREATMENTS	12	69.231	5.769	1.20^{ns}	0.338
RESIDUAL	24	115.385	4.808		
TOTAL	38	185.897			

47. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 4WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	0.35897	0.17949	1.87		
TREATMENTS	12	10.92308	0.91026	9.47**	<.001	
RESIDUAL	24	2.30769	0.09615			
TOTAL	38	13.58974				

48. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 6WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	1.4359	0.7179	5.33		
TREATMENTS	12	12.3077	1.0256	7.62**	<.001	
RESIDUAL	24	3.2308	0.1346			
TOTAL	38	16.9744				

49. RCBD ANOVA TABLE SHOWING SEVERITY OF NON CERCOSPORA FOLIA DISEASE OF G/NUT AT 8WAP

Source of variation	d.f.	S.S	M.S.	V.r.	F.PR	Tab.(0.05)
BLOCKS	2	2.6667	1.3333	12.00		
TREATMENTS	12	13.6410	1.1368	10.23**	<.001	
RESIDUAL	24	2.6667	0.1111			
TOTAL	38	18.9744				