Scholars Academic Journal of Biosciences (SAJB) **ISSN 2321-6883**
Sch. Acad. J. Biosci., 2013; 1(5):217-226

(An International Publisher for Academic and Scientific Resources)
www.saspublisher.com

Review Article

Management of Cowpea Insect Pests

***[1]R.O. Oyewale, [2]L.J. Bamaiyi**
[1]Department of Crop Production, Federal University of Technology Minna, Niger state. Nigeria
[2]Institute of Agricultural Research/ Ahmadu Bello University Zaria, Kaduna state, Nigeria.

Corresponding author
R.O. Oyewale
Email: rashove@yahoo.com

Abstract: Cowpea is mainly grown in tropical and sub-tropical regions in the world for vegetable and grains and to lesser extent as a fodder crop. It is a most versatile pulse crop because of its smothering nature, drought tolerant characters, soil restoring properties and multi-purpose uses. Cowpea is a hardy crop but it hosts many insect pests that attack vegetables. These include; leaf miners, whiteflies (*Bemisia tabaci*), leafhoppers (*Empoasca sp*.), mites (*Tetranychus* spp.), thrips (*Megalurothrips sjostedti*), *Ootheca sp., Clavigralla sp., Maruca sp*. and aphids (*Aphis craccivora*) which generally cause low yield and sometimes total yield losses and crop failure occur due to the activities of a spectrum of insect pests which ravage the crop in the field at different growth stages. Several management strategies are available such as use of synthetic organic insecticides, botanical insecticides are naturally occurring chemical extracted from plants which break down readily in the soil and are not stored in plant or animal tissue, insect resistance cowpea variety (such as *Bt* gene which comes from a soil bacterium called *Bacillus thuringiensis). Bt* proteins selectively kill certain types of insects without affecting other living organisms. As such, *Bt* bacteria and *Bt* proteins have been used for years as biological controls for certain insect pests in farming, especially in the organic food industry.
Keywords: Cowpea, insect pest, management, insecticides

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is an important grain legume in the tropics and subtropics. It is a native to central Africa and belongs to the family Fabaceae [1], and is eaten in the form of grain, green pods, and leaves [2]. The roots are eaten in Sudan and Ethiopia, and the peduncles and stems are used as fibres in Nigeria [1]. Cowpea is known as vegetable meat due to high amount of protein in the grain with better biological value on dry weight basis. The grain contains 26.61 % protein, 3.99 % lipid, 56.24 % carbohydrates, 8.60 % moisture, 3.84 % ash, 1.38% crude fibre, 1.51 % gross energy, and 54.85% nitrogen free extract [3]. It is mostly grown as an intercrop with sorghum, maize and millet [4]. Cowpea is usually preferred by farmers because of its role in increasing soil fertility through nitrogen- fixation [5, 4] and production of nutritious fodder for livestock. Under sole cropping, the potential grain yield is high (1.5 - 3.0 t ha^{-1}), especially, when insecticide was applied. However, the actual yields obtained by farmers in South Africa are much lower averaging less than 500 kg ha^{-1} [4, 6]. Insect pests are considered to be largely responsible for this, as their attack can result in 90 - 100% yield reduction [7].

Cowpea is mainly grown in tropical and sub-tropical regions in the world for vegetable and grain and to lesser extent as a fodder crop. It is a most versatile pulse crop because of its smothering nature, drought tolerant characters, soil restoring properties and multi-purpose uses. More than 11 million hectares are harvested worldwide, 97% of which is in Africa. Nigeria cultivates 4.5million hectares annually representing over 60% of total production. The crop can be harvested in three stages; while the pods are young and green, mature and green and dry. The grain yield of cowpea in Nigeria is 700kg/ ha [8]. The highest production of cowpea comes from the northern states of Nigeria (about 1.7 million tonnes from 4 million hectares).

The sale of cowpea seeds and fodder earns income to farmers. In Nigeria, farmers who cut and store cowpea fodder for sale at the peak of the dry season have been found to obtain as much as 25% of their annual income by this means. Cowpea also plays an important role in providing soil nitrogen to cereal crops (such as maize, millet and sorghum) grown after cowpea cropping [8].

Origin and distribution of cowpea

Cowpea (*Vigna unguiculata* (L) Walp) is a tropical, annual herbaceous legume, which belongs to the family Papilionaceae (Fabaceae), order Leguminosae and genus *Vigna* [1,9, 10]. The genus *Vigna* consists of over one hundred different species widely found in the tropical and sub-tropical regions, and has great morphological and ecological diversity [11, 12] The common names of this crop include black-eye bean, southern pea, bean, cowpea, china pea and cow grain. In Nigeria, it is commonly referred to as beans, "ewa" (Yoruba), "wake" (Hausa) and "ikedi" (Igbo) [13]. The crop can be grown on many soil types, but does best on well-drained, fertile, sandy-loam soils.

Cowpea production is considered suitable in areas with annual rainfall of 750-1500 mm [14]. Cowpea varieties could be prostate, semi-erect, erect or climbing. Pods could be coiled, round, crescent or linear [15]. Most cowpea cultivars are indeterminate in nature, producing flowers and seed over a long period. However, some are determinate and produce flowers and seed within a season[16] of cowpea has been very difficult to determine, due to the fact that various researchers have reported different areas as centres of origin. [17] postulated that, based on the presence of wild progenitors of cowpea in West and Central Africa, the region was the centre of domestication of cowpea. This view was corroborated by [18] who also reported that cowpea originated from sub-humid and semi-arid regions of West Africa. This view was also shared and supported by [19]. However, some studies on the genetic exploration of cowpea in Africa suggested that Swaziland may be the primary centre of origin of wild progenitors, because this country has higher species diversity throughout the world [11, 19]. Regardless of its centre of origin, cowpea is extensively cultivated in Africa, Asia, Australia, Brazil, the Caribbean's, India and the United States of America (U.S.A). The major areas of production in Central and West Africa, which account for about 89 % of the total area of world production, are Nigeria, Niger, Mali, Burkina Faso, Senegal, Cameroon and Democratic Republic of Congo, [20]. Modest amounts also emanate from Mozambique, Tanzania, Uganda, Sudan, Kenya and Somalia. Other producers are Myanmar, Haiti, Serbia, Sri Lanka and Egypt [20]. The main producing areas in Nigeria are within the Guinea and Sudan savannas [19]. However, some appreciable quantities are grown in the rain forest belts, particularly in the South West, which has two (2) growing seasons, namely; early (March – July) and late (August – November) [21]. The major producing states in Nigeria include; Kaduna, Katsina, Zamfara, Bauchi, Sokoto, Kebbi, Plateau, Borno, Yobe, Jigawa, Niger, Benue, Nasarawa and Kano where most cowpeas are traditionally grown as intercrops with cereals such as millet, maize and sorghum[18,22,23]. In this system, the yields are low; inter-specific competition is high, population density is undetermined and harvesting is complicated by differing maturities of the intercrops [10] estimated a world total area of about 12.5 million hectares grown to cowpea annually. The food and Agricultural Organization of United Nations (FAO) estimated a production of more than 5.2 million metric tonnes of dry cowpea grains worldwide in the year 2010 [8]. The report also showed that cowpea production in Nigeria accounted for 58 % of the total world's output; making Nigeria the largest producer with an output of 2.9 million metric tonnes. Production in Nigeria is highest in the North East (703.13 metric tonnes from 641.03 ha), followed by the North West (519.51 metric tonnes from 1068.02 ha) and North Central (166.58 metric tonnes from 307.70 ha) [24].

Importance and uses of cowpea

Cowpea (*Vigna unguiculata* (L) Walp) is an important grain legume in the diet of many people in the third world countries as it provides not only high quality protein (25.4%) but also constitute the cheapest source of dietary protein for low income sectors of the population [15, 25]. It is also a good source of carbohydrate (56.8%) calcium, iron, vitamin B and carotene. Although cultivated primarily for its edible seeds, direct consumption of cowpea leaves is also widespread in Africa [26]. In fresh form, the young leaves, immature pods and peas are used as vegetables, while snacks and main meal dishes are prepared from the dried grain [27]. Beside its usefulness in human diet, it serves as an important fodder crop in different parts of Africa [29]. The haulm containing about 20% protein is highly valued feed and is sold for almost the same price as cowpea grain on dry weight basis [30]. Thus, cowpea promotes crop livestock integration, thereby leading to a better nutrient cycling and enhanced income generation [31]. Although cowpea has high grain yield potentials ranging from 1.5 to 3.0 t/ha [31], actual yields in the traditional cropping systems in Africa are consistently low as the range is between 50 to 350kg/ha [7, 26, 32, 33] .

Cowpea cropping systems

The predominance of mixed cropping systems in developing countries of the tropics and sub-tropics and northern Nigeria in particular was reported by [34]. The advantages attached to these practices include profit maximization [35], more efficient use of labour and land, reduction of soil erosion, yield stability and risk minimization [36, 37]. Small scale farmers constitute the majority in Northern Nigeria, and where large scale farmers are found, they mostly practice mono-cropping. With increase in population, the demand for land has also increased, resulting in intense cultivation with little or no fallow periods, hence the need for intercropping [38]. About 83 % of the cultivated area in northern Nigeria has been devoted to mixed- cropping [39]. The popularity of maize and cowpea mixtures has been reported in the Savannah region of Nigeria [40]. Mixed cropping is used to include terms similar in meaning as inter-planting (the partial mixing of crops where by a crop or crops are sown sand harvested after another crop in the mixture [40] and relay cropping, where the second crop is sown into a standing crop at a time when the standing crop is at its reproductive stage but before harvesting (the growing period only overlaps briefly) [39]. In Nigeria, [40] reported that mixed cropping of cereals with legumes results in better returns which were obtained by alternating two rows of cowpea with one row of maize. There is a potential to integrate more legumes in the existing cropping systems as intercrops because the growing of sole crops has been rejected by small scale farmers due to labour and land constraints [41]. If legumes are intercropped in a timely manner, competition with maize crop for light, water and nutrients can be minimized while yield is increased. A

relay intercropped legume is not likely to benefit companion maize crop but has the potential to increase yields of subsequent maize crop [42].

Cowpea is important in multiple cropping systems which involve monocropping, relay cropping and mixed intercropping. In Asia, cowpea is grown as an intercrop with cereals, cotton or sugarcane, and relay-cropped in standing rice. In Africa, cowpea is grown as an intercrop with millet, sorghum or maize [43]. The practice of cereal-cowpea intercropping and crop rotation, coupled with effective soil fertility management can increase yields of cereals succeeding cowpea by fixing 150kg\ha of N, which can supply 80 - 90 % of plants total requirement [44]. According to [45], cereal-legume mixtures are the predominant cropping pattern in Northern Nigeria. The mixtures are mostly Sorghum\Millet\Cowpea, Sorghum\Millet\Groundnut,Cassava\Maize\Cowpea,Cassava\Yam\Maize,Yam\Maize\Cowpea,Cassava\Melon\Vegetable, Millet\Cowpea\Okra etc.

Constraints to cowpea production

In Nigeria, cowpea yield is very low, grain yield ranges between 100 and 300 kg/ha. This is due to several constraints such as weather, parasitic weeds, insects, and diseases. However, production can be improved through the use of improved pest-resistant and high-yielding varieties. Good land preparation, pest control, fertilizer application, harvesting and storage also help to improve production. In addition, adequate and good distribution of rainfall especially from planting till mid- podding is very vital for high yield of cowpea. [46] reported that the reasons for low yields are numerous but most of the time it involves a combination of limiting factor such as low plant density, shading by cereal crops, abiotic (e.g. drought, poor soil fertility) and biotic (e.g. arthropod pests, birds and rodents) factors. However, in most parts of West Africa, insect pests are the most important constraint to cowpea production [7,26, 47-51] listed at least 20 major insect pest species in various cowpea producing regions of the world in which the number vary from region to region. The most damaging of all the insect pests are the flowering and post flowering insect pests . The major flowering and post flowering insect pest of cowpea in tropical Africa are the flower bud thrips, (*Megalurothrips sjostedti* Tryb.), cowpea pod borer (*Maruca vitrata* F.) and a complex of pod sucking bugs out of which *Clavigralla tomentosicollis* Stal is the dominant species [7]. Complete crop failure may occur especially in situation where management strategies are not applied.

Pests of cowpea

Plant insect pests, diseases and weeds impose a serious threat to crop production in Nigeria. Population of weeds, insect pests and diseases have increased over the years especially by the introduction of monoculture farming in the country [52]. Traditionally, Nigerian farmers have been relying heavily on pesticides for the control of various weeds, insect pests and diseases, leading to the high importation of these products and their price have become so high that it is becoming impossible for local farmers to afford [53-56]. These have created the need for alternatives to synthetic pesticides. But inadequate infrastructure for research and extension remains a constraint to the advancement and continuity of such important activity in the country [57].

Diseases of cowpea

Cowpea is susceptible to diseases that affect legumes. The fungal diseases include: Damping-off (*Pythium* spp.) may occur on seedlings under moist conditions and in dense plantings. Root rot (*Verticillium* spp.) and stem rot (*Fusarium* spp.) may also be a problem. Cowpea is susceptible to powdery mildew (*Erysiphe polyqoni*) during wet winter months and under humid conditions. Other diseases that affect cowpea include anthracnose (*Colletotrichum lindemuthianum)*, charcoal rot (*Sclerotium bataticola*), and fusarium wilt (*Fusarium oxysporum vr. tracheiphilum)*.Viral diseases include: Cowpea aphid-borne mosaic virus (CABMV) Genus potyvirus, blackeye cowpea virus (BLCMV) Genus potyvirus, cowpea mosaic virus (CPMV) Genus comovirus, cowpea mottle virus (CPMOV) Genus carmovirus. Nematodal diseases include: Root knot nematode (*Meloidogyne* spp.), root lesion nematode (Pratylenchus spp.), dagger nematode (*Xiphinema* spp.).While bacterial diseases include: Cowpea blight (*Xanthomonas campestris pv. Vignicola*), cowpea bacterial pustule *(Xanthomonas campestris pv. Vigna unguiculata*). In the establishment phase, rodents and birds can be important pests by feeding on the seeds [58] .

The major pests of cowpea in the field in northern Nigeria, Niger, and Burkina Faso include: the legume pod borer, *Maruca vitrata* Fabricius; the coreid pod-bugs, *Clavigralla tomentosicollis* Stal and *Anoplocnemis curvipes* (F.); the groundnut aphid, *Aphis craccivora* Koch; and, thrips, *Megalurothrips sjostedti* Trybom and *Sericothrips occipitalis* Hood. A limited amount of work has been done to understand these insect pests in these areas. Also, there are few alternatives to pesticide sprays for many of these pest species. Two notable exceptions to this situation exist. The first is *M. vitrata*, where a potential biotechnology-based pest management solution exists. Transgenic cowpea expressing the Bt-protein Cry1Ab, effective against *M. vitrata* already exists. However, these plants are unlikely to be available for use by African farmers during the current CRSP funding cycle. However, before transgenic Bt-cowpea can be released there will be a need for an insect resistance management (IRM) plan.

Although transgenic plants, and traditional plant breeding for insect resistant varieties are potentially effective methods for managing at least two pests of cowpeas, a better understanding of pest populations is needed in order to integrate these, and other, pest control options into an overall integrative pest management (IPM) plan to maximize cowpea production in the field. IPM refers to a pest management strategy where a variety of complementary approaches are used to minimize the negative effects of pests on a given crop or cropping system.

Yields are however, generally low [59], sometimes total yield losses and crop failure occur [49] due to the activities of a spectrum of insect pests which ravage the crop in the field at different growth stages [50]. The major insect pests which severely damage cowpea during all growth stages are the cowpea aphid (*Aphis craccivora* Koch), foliage beetles (*Ootheca sp, Medythia spp*), the flower bud thrips (*Megalurothrips sjostedti* Trybom) the legume pod borer (*Maruca vitrata* Fabricius) and the sucking bug complex, of which *Clavigralla spp, Anoplocnemis spp, Riptortus spp, Mirperus spp, Nezara viridula* Fab and *Aspavia armigera* L are most important and are prevalent. Without their management, reasonable grain yield cannot be obtained [7, 61]. Several management strategies are available [69] but chemicals are most effective, giving several fold increase in grain yield [63]. Sometimes, however, farmers spray their farms as many as eight to ten times during the growing season [64]. Danger encounter in the use of chemicals such as environmental pollution, toxicity to mammals, hazards to users and consumers [65] has led to suggestions on alternative control measures are being sought. Total abandonment of chemicals could however, spell doom to man as this will worsen the present food situation [66]. Chemicals could be judiciously used in consonance with other control measures so as to minimise the large number of sprays in farms. Various synthetic chemicals are available in the market and new products with different trade names abound yearly. Their efficacy against the wide spectrum of cowpea pests should be tested.

Insect pest of cowpea

Cowpea is a hardy crop but it hosts many insect pests that attack vegetables. These include; leaf miners, whiteflies (*Bemisia tabaci*), leafhoppers (*Empoasca sp*.), mites (*Tetranychus* spp.), thrips (*Megalurothrips sjostedti*), *Ootheca sp., Clavigralla sp., Maruca sp*. and aphids (*Aphis craccivora*). Cowpea's attraction for insects may be an advantage if the crop also attracts a sizable population of beneficial insects, but it is not, rather result to pest out breaks and then move on to attack cash crops. If allowed to form pods, cowpea may also attract stinkbugs. Careful weekly monitoring is important to ensure that the cowpea planting is not becoming a source of pests on the farm [59].

There are numerous important insect pests of cowpeas worldwide and most locations have 2 – 4 species being key pests [67].The most damaging pests are flower bud thrips, *Megalurothrips sjostedti* Tryb. (Thysanoptera : Thripidae), the legume pod borer, *Maruca vitrata* Fab. (Lepidoptera : Pyralidae) and the pod sucking bug (PSB) complex of which *Clavigralla spp*. Stal. (Hemiptera : Coreidae), *Anoplocnemis curvipes* Fab. (Hemiptera : Coreidae), *Riptortus dentipes* Fab. (Hemiptera : Alydidae) and *Aspavia armigera* are the most damaging [68,69,71]**.** In Nigeria, major field insect pests of cowpea include aphids (*Aphis craccivora* Koch.), thrips (*Megalarothrips sjostedi* Trybom), legume pod borer (*Maruca vitrata*), spiny brown bug (*Clavigralla tomentosicollis* Stal.), flower beetle (*Mylabris* Species), leaf-footed plant bug (*Leptoglossus australis* F.) and foliage beetle (*Oothaca mutabilis* Salhib) [70]. Attack by these insects is often so severe that farmers obtain no yields, especially when improved cowpea varieties are grown without insecticide protection [68, 71]. However according to [72], yield losses in cowpea due to insect pests in Nigeria farms was estimated to be above 80%.

Management of Cowpea Pests

Due to the devastating effect of insect pests of Cowpea at almost every stage of its development, several approaches have been adopted in its control. Research into the control of these insect pests has centred primarily on the use of synthetic insecticides [73]. Amongst the insecticides are Azodrin, Thiodan DDT, Dursban and Dimecron, which have been found to be effective against the leafhoppers. Over the years, chemical pesticides had made a great contribution to the fight against pests and diseases. However, their widespread and long-term use resulted in insecticide resistance and biomagnifications of insecticides, which in turn resulted in restrictions on their export. Problems, like soil and /water contamination and dramatic increase of the harmful residues in many primary and derived agricultural products arose, which endangered both the general environment and human health. It is estimated that the financial cost of the damage to the environment and social economy is about $ 8.1 billion a year. The use of synthetic organic insecticides in crop pest control programs around the world had caused tremendous damage to the environment, pest resurgence, pest resistance to insecticides, and lethal effects on non-target organisms [74]. Insect pests of cowpea have mainly been controlled with synthetic insecticides [74]. Most insecticidal compounds fall within four main classes - organophosphates, organochlorines. carbamates and pyrethroids. Protecting the crop with insecticide application increased yields several fold and for the improved varieties, virtually no yields were obtained under no insecticide protection. Earlier studies by [68, 71] concluded that in Northern Ghana, complete crop failure often results when improved cowpea varieties are grown without

insecticide sprays. The results confirm the economic impact of chemical control in cowpea production and further show that with proper timing; two insecticide applications (at flowering and again at podding) could produce as good a cowpea crop as 4 sprays. This would be advantageous from the perspectives of lower costs and environmental pollution [75].

Botanical Insecticide

As a result of the problems of pesticide resistance and negative effects on non-target organisms including man and the environment, organochlorine has been reportedly banned in developed countries. These resurcitated the idea of botanical insecticides as a promising alternative to pest control. Botanical insecticides are naturally occurring chemical extracted from plants which break down readily in the soil and are not stored in plant or animal tissue. Often their effect are not long lasting as those of synthetic pesticides [76]. Botanical insecticides are generally pest – specific and are relatively harmless to non-target organisms. They are biodegradable and harmless to the environment. Also, the possibility of insect developing resistance to botanical insecticide is less likely [77]. Over 2000 species of plants are known to possessed insecticidal activities. Despite this only a few have been scientifically evaluated [76, 78], *Petiveria alliacea* which is commonly known as Anamu belongs to the family phtolaccacea [79] reported several biological compounds in the root of *P. alliacea* which include: benzalhyde ,dibenzyltrisulfide , cis and trans-stibene *e.t.c* of which dibenzyltrisulfide is insecticidal compound. Laboratory and field tests have shown the effectiveness of this plant extract against armyworm, leaf-cutting caterpillars, ants, whiteflies and the three stages of mosquitoes [74]. Fish bean (*Tephnosia vogelii*) which has been listed among plants that posses insecticidal properties [52], contains rotenoids [80] of which the leaves contain the highest concentrations [81]. Rotenone is both stomach and contact poison, useful against sucking and biting insects. *T. vogelii* extracts have been reported to be effective in the control of ticks, lice and flies on animals [80]. Also, formulation of *T.vogelii* + locust lotion was observed to be effective as Lambdacyalothrin in the management of insect pests of Okra in the field [74]. *Caryedon serratus* on groundnut was effectively controlled by *T. vogelii* [82]. In addition, *T.vogelii* was observed to have had negative effect on the fecundity of *Tribolium casteaneum* . Research in recent years has been turning more towards selective biorational pesticides, generally perceived to be safer than the synthetic [83], while, extensive works on the use of plant extracts in pest management were also documented [84] the use of inexperience and safe protectants of plant origins was extensively reviewed [85]. The use of Cashew Nut Shell Liquid (CNSL) has been gaining more attention due to its possession of the active Phenolic compounds, Anacardic acid and Cardol, which also have corrosive and abrasive properties [86]. It was demonstrated that low concentration of CNSL could be effective in the management of *Callosobruchus maculatus* [73]. Similar work was also reported in preventing oviposition in *C. maculatus* [87].

Insect Resistant Cowpea Varieties

The use of leafhopper resistant cowpea varieties was also adopted at the International Institute of Tropical Agriculture [88]. The varieties include Tvu59, Tvu123, VITA -1, VITA- 3 that do not need insecticide protection against leafhoppers. *Bt* is an abbreviation for *Bacillus thuringiensis*, a soil bacterium that is common around the world. These bacteria produces specialised proteins, called *Bt,*. *Bt* crops have significantly improved the cost effectiveness and sustainability of crop production in North and South America, Europe, Africa, the Middle East, Asia and Australia. *Bt* proteins selectively kill certain types of insects without affecting other living organisms [89]. As such, *Bt* bacteria and *Bt* proteins have been used for years as biological controls for certain insect pests in farming, especially in the organic food industry. Modern biotechnology has produced *Bt* crops which are modified to produce specific *Bt* proteins in the plant cells to protect against specific pests. These crops do not need conventional pesticide sprays to destroy the pests that are controlled by the specific *Bt* protein. The *Bt* gene comes from a soil bacterium called *Bacillus thuringiensis*. The *Bt* gene used in *Maruca*-resistant cowpeas (*cry1Ab*) is the same gene used in several *Bt* maize events that have been approved for use in many countries, including Argentina, Australia, Canada, China, Brazil, the EU, Japan, Korea, Mexico, Netherlands, Philippines, South Africa, Switzerland, Taiwan, the UK, the US and Uruguay. The gene was identified and developed by Monsanto and is used successfully in several commercial crops [89]. However, despite concerted efforts by many institutions over the last two decades to develop varieties with resistance to the cowpea insect pest complex, resistant varieties are still not reach farmers. Chemical control using synthetic insecticides therefore remains the most popular control tactic especially when these pests have exceeded the economic injury level [90]. Without their control, reasonable grain yield cannot be obtained [7, 61]. Several management strategies are available [62] but chemicals are most effective, giving several fold increase in grain yield [63]. Sometimes, however, farmers spray their farms as many as eight to ten times during the growing season [64]. Because of the danger of the use of chemicals such as environmental pollution, toxicity to mammals, hazards to users and consumers [65], alternative control measures are being sought. But total abandonment of chemicals could however, spell doom to man as this will worsen the present food situation [66]. Chemicals could be judiciously used in consonance with other control measures so as to minimise the large number of sprays in farms. Various synthetic chemicals are available in the market and new products with different trade names abound yearly.

Their efficacies against the wide spectrum of cowpea pests are being tested.

Synthetic Insecticides

The introduction of synthetic pyrethroids to the Agricultural market is a welcome addition to a wide range of pesticides already in use on different crops in Nigeria [91]. The advantages have been enumerated by [92] and thought the synthetic pyrethroids are generally safe a reduction in the number of applications would not only increase the profit margin accruing to the farmer but would also be in consonance with pest management practices [93]. Chemical methods are the only ones employed at present on a large scale for the control of insect pests of cowpea in Nigeria, particularly those infesting the flowers and pods. The pod borer complex of cowpea, of which *Maruca vitrata* Geyer is the most important, also include *Cydia ptychora* Meyrick, *Virachola antalus* Hopkins and *Helicovepa armigera* Hubner . In order to minimise hazards due to the use of excessive amounts of insecticide, breeders and entomologist are actively engaged in research to produce varieties which combine insect resistance with the qualities of grain preferred by consumers. However, until the advent of such varieties it is expedient to combine other pest management practices, as was suggested by [94] for *C. ptychoda*, with minimum but effective insecticide spray schedules that can be based on a reduction in the frequency or rate of application or both [95].

Because of the persistent nature of organochlorine insecticeds, the organophosphate group was looked to as an alternative, and monocrotophos proved quite effective [95] despite its high mammalian toxicity. The appearance of the synthetic pyrethroids therefore opened a new vista in cowpea pest management work. Trial conducted in Nigeria have already indicated that the synthetic pyrethroids are promising in cowpea pest control [91, 96].The advantages of the pyrethroids enumerated by [92] include high potency to insect pests, low mammalian toxicity and short persistence. They are therefore, likely to cause minimum disturbance to the environment and make possible the production of crops devoid of residues.

In addition, experiments were carried out in four soybean fields. The overall environmental impact of each pesticide was estimated using the Environmental Impact Quotient (EIQ), ingredients in the pesticide on a number of organisms, including birds, fish, bees, in addition to other factors such as the toxicity to beneficial organisms, such as the ladybird and flower bug. The conventional insecticide dimethoate and the two organic insecticides, mineral oil and *Beauveria bassiana* had the highest environmental impact. The impact of the mineral oil insecticide, for example, was more than ten times greater than that of dimethoate because it has to be used in high doses. The organic insecticides did not offer significant protection of crop yields compared with the untreated control, and were least selective in that they killed both aphids and the natural control insects. The synthetic insecticides were the most selective – even the least selective synthetic insecticide, dimethoate, was still more selective than the organic insecticides. The researchers suggest that certain organic management practices are not necessarily more environmentally sustainable than conventional systems. An integrated pest management approach might be more suitable, as such a system is flexible enough to include whichever practices have the smallest environmental impact. [97].

Further researches should be geared towards identifying the active ingredients responsible for the killing of insects and understanding the mode of action of the various ingredients contain in the botanicals as well as knowing the quantity of each ingredient to apply per area of farm land that will be effective for the purpose in which they are applied.

REFERENCES

1. Cobley SL; Introduction to the Botany of Tropical Crops. Longman Group Limited. Essex, England, 1956: 79 – 98.
2. Adejumo TO; Identification, incidence, severity and methods of control of the causal organism of false smut disease of cowpea *Vigna unguiculata* L. Walp.. African Agricultural Technology Foundation (AATF), 2012.
3. Owolabi A.O, Ndidi U.S, James B.D, Amune, F.A; Proximate, Antinutrient and Mineral composition of five varieties(improved and local) of cowpea, *Vigna unguiculata* , commonly consumed in Samaru community, Zaria-Nigeria. Asian Journal of Food Science and Technology, 2012; 4(2):70-72.
4. Asiwe J.A.N; Baseline survey on the production, constraints and utilization of cowpea in South Africa: Implications to cowpea improvement. Proceedings International Conference on indigenous vegetables and legumes: Prospects for fighting poverty, hunger and malnutrition. Organized by IPGRI, ICRISAT and ISHS, 12-15 December 2006 in Hyderabad, India. 2006:621-622.
5. Blade S.F, Shetty S.V.R., Terao T., Singh B.B; Recent developments in cowpea cropping systems research. In: Singh BB, Mohan Raj DR, Dashiell KE, Jackai LEN (eds.) Advances Cowpea Research Copub. of IITA and JIRCAS., IITA, Ibadan,1997; Nigeria.
6. Asiwe J.A.N, Belane D, Dakora, F.D; Evaluation of cowpea breeding lines for nitrogen fixation at ARC-Grain Crops Institute, Potchefstroom, South Africa. *Abstract*, the 16th International Congress on

Biological Nitrogen Fixation, Montana, USA, 2009; 14 -19.
7. Jackai L.E.N and Daoust R.A; Insect pests of cowpea. Annual Review of Entomology, 1986; 31**:** 9 – 119
8. FAO. STAT; Bulletin of Tropical Legumes, 2011; http//.www.Icrisat.org/tropical legumes 11
9. Martin J.H. and Leonard W.H; Principles of field crops production. London, U.K. collier MacMillan, 1956: 186.
10. Singh B.B, Mohan Raj D.R, Dashiell K.E and Jackai L.E.N; Advances in cowpea research, 1997; IITA, Ibadan, Nigeria and JIRCA, Japan.
11. Ng N.O and L.M. Monti; Cowpea Genetic Resources. International Institute of Tropical Agriculture IITA. Amarin Printing Group Co. Ltd., 1990; 200.
12. Paino D'urzo M., M. Pedalino, S Grillo, R. Rao and M. Tucci; Variability in major seed protein in different Vigna species. International Institute for Tropical Agriculture, 1990: 2000.
13. Singh B.B and Ajeigbe H; Evaluation of Improved Cowpea Varieties in the Sudan Savana. IITA Annual Report, 1998; 24-25.
14. Anthonio Q.B.O; General Agriculture for West Africa, London, George Allen and Unwin,1979;215
.
15. Rachie K.O and Singh S.R; Cowpea research production and utilization. John Wiley and Sons. New York. Brisbanepp, 1985; 22-25
16. Fatokun C.A, S.A. Tarawali B.B. Singh P.M. Kormawa and M. Tamo; Challenge and opportunities for enhancing sustainable cowpea production. Proceeding of the world cowpea conference 111 held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 2002; 299.
17. Rawal K.M; Natural hybridization among wild weedy and cultivated *Vigna unguiculata(L)walpEuphytica*, 1975; 24:699-707.
18. Steele W.M; The cowpea, (*Vigna unguiculata (L) walp*) the bambara nut (*Voandzia subterranean L (DC)* Lima bean, (*Phaseolus lunatus L*) in Northern Nigeria Paper read at FAO Technical meeting on Improvement of Vegetable and Grain Legume Production in Africa, Dakar18-24thJanuary,1965.
19. Mongo C.M; Biology and epidemiology of *Sphaceloma sp*. The pathogen of cowpea scab. Department of Crop Protection, Ahmadu Bello University Zaria Ph.D Thesis, 1996; 86p
20. FAO; Agricultural production status world wide web sites pages, 2008; http:www.fao.org/faostat
21. Ebong U.U; Cowpea production in Nigeria Memorandum No.8, pp.9 Federal Department of Agricultural Research, Ibadan,1965;
22. Emechebe A.M and D. McDonald; Seed-born pathogenic fungi and bacteria of cowpea in Northern Nigeria, 1979; PANS 25 (4):401-404.
23. Chemeda F; Effect of planting pattern, relative planting date and intra-row spacing on a haricot bean maize intercrop. African Crop Science Journal, 1997; 5 (1):15 – 22.
24. NAERLS and NFRA; Annual Agricultural Performance Survey Report of Nigeria National Research Council. 2000. The Future Role of Pesticides in US Agriculture Washington, DC: Natl. Acad. Press, 2009; 301.
25. Stanton R.W; Grain Legume Pest in Africa. *PANS*, 1966; **12**: 100 – 1003.
26. Rachie K.O; Introduction. Pages xxi –xxiii. In: Research, Production and utilization,S.R. Singh and O.K. Rachie (eds). John Wiley and Sons, Chichester, UK. Raheja A.K. and Hays, A.M. (1975). Sole crop cowpea production by farmers using improved practices. Tropical Grain Legumes Bulletin, 1985; 1(1):6.
27. Nelson S.S, T.A. Ohlev, and C.A. Mitchel; Cowpea Leaves for Consumption, Production and Utilization and Nutrient Composition. In: B.B.Sigh, D.R. Mashan Ray, K.E. Dashiell And Len Jackai (Eds), 1997; 326- 332. Advances in Cowpea Research Devon Science Publishing.
28. IITA; Improving and intensifying cereal legume systems in the moist and dry savannas of West and Central Africa. Project F. Ibadan Nigeria, 2002; 313 pp.
29. Quin F.M; Introduction in:Advance in Cowpea Research Devon Science Publishing, 1997; 4-15
30. IITA; Cowpea Cereal systems improvement in the dry savannas. IITA Annual report. Project11, Ibadan, Nigeria, 1997; 63.
31. Alghali A.M; Intercropping as a component of insect pest management for grain cowpea *Vigna unguiculata* (L.) Walp production in Nigeria. Insect Science and its Application, 1993; I4 (1):49–53.
32. Mortimore M J; Singh B.B., Harris F., and Blade, S.F; Cowpea in international cropping system. 2006;99 – 113.
33. Emechebe A.M and Singh B.B; Technology options and research challenges to increase cowpea production under striga and draught stress in Semi-arid Africa. Pages 207 – 217. In: Technology Options for sustainable Agriculture in sub-sahara Africa, T. Benzuneh, A.M. Emechebe, J. Sedgo and M. Ouedrago (eds.). Published by SAFRAGRAD, Ouagadougou, Burkina Faso, 1997.

34. Norman D.W; An Economic Survey of Three Villages in Zaria Province 2. Input- output Study Vol. 1 Samaru Miscellaneous Paper No. 37. IAR, A.B.U Zaria, 1972.
35. Abalu G.O.I; A Note on Crop Mixture under Indigenous conditions. *Journal of Developmental Studies*, 1976; 12: 212-220
36. Okigbo B.N and Greenland D..J; Intercropping System in Tropical Africa. Madison, Wisconsin, American Society of Agronomy, 1976.
37. Boller E., Hani F., Poehling Editors; Ecological Infrastructures: Ideabook on functional biodiversity at the farm level l.IOBC, OILB, Mattenbach AG, Winterther, Switzerland, 2004; 2: 291 –295.
38. Weber G, Elemo K and Lagoke S.T.O; Weed communities in intensified cereal –based cropping systems of Northern Guinea Savanna. IITA Research, 1996; No.13.
39. Willey R.W and Osiru D.S.O; Studies on Mixture of Maize and Beans (Phaseolus vulgaris) with particular reference to plant population. Journal of Agricultural Science (Cambridge) England, 1972; 79: 519-529.
40. Baker E.F.I; Mixed Cropping in Northern Nigeria 1. Cereal and Legumes, Experimental Agriculture, 1978; 14: 293-298.
41. Kumwenda J.D.T, S.R. Waddigton, S.S. Snapp, R.B. Jones and M.J. Blackie; Soil Fertility Management Research for Maize Cropping Systems of small-holders in Southern Africa.A review NRG, 1996; 96 – 102, CIMMYT, Mexico, DF.s
42. Jeranyama P., O.B. Hesterman and C.C Sheaffer; Medic Planting Date Effect on Dry Matter and Nitrogen Accumulation when clear – seeded or intercropped with corn. Agronomy Journal, 1989; 90: 601 – 606.
43. CABI; Crop Protection Compendium. Global module, 2nd edition CABI publishing, Wallingford, UK, 2000.
44. Fatokun C.A; Breeding cowpea for resistance to insect pests: attempted crosses between cowpea and *Vigna vexillata*. In: Fatokun CA, Tarawali SA, Singh BB, Kormawa PM, Tamo M, Eds. Challenges and opportunities for enhancing sustainable cowpea production.Ibadan-Nigeria: IITA 2000; 52-61
45. NAERLS and PCU; Field Situation Assessment of Wet Season Agricultural Production in Nigeria. *Crop* Protection, 2004; 22:57 – 64.
46. Tamo M, Arodokoun D, Zenz, C. and Adeoti R; The importance of alternative host plants for Biological Control of two Cowpea Insect Pests, the Pod borer, *Maruca vitrata* Fabricius) and the Flower thrips, *Megalurothrips sjostedti* Trybom. Proceedings of the 3rd world Cowpea Research Conference, Ibadan Nigeria, 2003.
47. Booker R.H; Pests of Cowpea & their Control in northern Nigeria. Bulletin of Entomological Research, 1965; 55: 663-672
48. Singh B.B, Chambliss O.L and Sharma B; Recent Advances in Cowpea breeding, pages 30 – 49. In: Advances in Cowpea research, edited by B.B. Singh,D.R. Mohar Raj, K.E. Dashiell and LEN Jackai. CO. Publication of intentional institute of Tropical Agriculture IITA and Japan International Research Centre for Agricultural Science (JIRSCA), Ibadan, Nigeria. Stanton, R.W.(1966).Grain Legume Pest in Africa. *PANS*., 1978; 12: 100-1003.
49. Singh S.R. and Jackai L.E.N; Insect pests of cowpeas in Africa, their life cycle, Economic importance and potentials for control. Pages 217 – 231. In: cowpea Research production and utilization, edited by S.R. Singh, and K.O. Rachie John Wiley, and Sons, N.Y, 1985.
50. Olatunde J.A, Odebiyi, Chiang H.S. and Jackai L.E.N; Identification of sources of resistance in cowpea, *Vigna unguiculata* L. Walp. to *Clavigralla tomentosicollis*. Stal. (Hemipera: Coreidae) Insect Science Application, 1991; 12 (4): 455-461
51. Karungi J, Adipala E., Kyamanywa S., Ogenga – latigo M.W., Oyobo N. and Jackai L.E.N; Pest management in cowpea. Part 2. Integrating Planting time, plant density and insecticide application for management of cowpea field insect pests in Eastern Uganda. Crop Protection, 2000; 19:237 -245.
52. Jackai L.E.N and C.B. Adalla; Pest Management Practices in Cowpea: A review. Pages 240-258 *in* Advances in Cowpea Research, edited by B. B. Singh, D. R. Mohan, Raj, K. E. Dashiell, and L. E. N. Jackai. Co-publication of International Institute of Tropical Agriculture (IITA) and Japan International Research Centre for Agricultural Sciences (JIRCAS). IITA, Ibadan, Nigeria, 1997.
53. Emosairue S. O. and Ubana U. B.; Field evaluation of neem for the control of some cowpea insect pests in Southern Nigeria. Global Journal of Pure and Applied Science, 1998; 4: 237-241
54. Nwanze K.F; Components for the management of two insect pests of pearl millet in Sahelian West Africa. Insect Science Application, 1991; 12: 673-678.
55. Schwab A.I., Jager I., Stoll G., Gorgen R., Prexterschwab S. and Attenburger R;Pesticide in tropical agriculture: hazards and alternatives. The Pesticide Registration Regulations (2005). Retrieved July 10, 2010 from PANACTA
56. Van den B.J. and Nur A.F ; Chemical control. In: Andrew P (ed.) African CerealStem borers:

Economic Importance, Taxonomy, Natural Enemies and Control. CAB International in association with the ACP-EU Technical Centre for Agricultural and Rural Co-operation (CTA), 1998; 319-332.

57. Okrikata E. and Anaso C.E; Influence of some inert diluents of neem kernel powder on protection of sorghum against pink stalk borer (*Sesamia* calamistis Homps) in Nigerian Sudan savannah. Journal of Plant Protection Research, 2008; 48(2): 161- 168.
58. Bugaje S.M., Kuta D.D., Magashi A.I., Ubale A.S; Food Security in Nigeria. Paper presented at the conference of young agricultural specialists, organized by SELHOZ (A Nigerian Non Governmental Organization Based in Russia, 2007; Held on 22nd July – 5th August at The People's Friendsip University, Russia, Moscow.
59. Hector V. and Jody S; Sustainable Agriculture, Green manure crops: Cowpea ,2002; 3.
60. Singh S.R. and Van emdem H.F; Insect pests of grain legumes. Annual Reviews of Entomology, 1979; 24: 255-278.
61. Tamo M, Baumgartner I, Delucchi V. and Herren H. R; Assessment of key factors responsible for the pest status of the bean flower thrips, *Megalurothrips sjostedti* in West Africa. Bulletin of Entomological Research, 1993; 83: 251 – 258.
62. Jackai L.E.N; Cowpea Entomology Research at IITA and its impact on food production in the tropics. *Nigerian* Journal of Entomology, 1985; 6: 87-97.
63. Jackai L.E.N; The use of neem in controlling cowpea pests. IITA Research, 1993; 7:5-11.
64. Omongo C. A., Adipala E., Ogenga Latigo M. W., Kyamanywa S; Insecticide application to reduce pest infestation and damage on cowpea in Uganda. African journal of Plant Protection, 1998; 4 (2), 91-100
65. Alabi O.Y., Odebiyi J.A. and Jackai L.E.N; Field evaluation of cowpea cultivars (*Vigna unguiculata* (L) Walp.) for resistance to flower bud thrips (*Megalurothrips sjostedti* Trybom) Thysanoptera: Thripidae) International Journal of Pest Management, 2003; 49 (4): 287-291.
66. Stern, V. M; Economic threshholds. Annual Revision of Entomology, 1973; 18: 259- 280.
67. Agyen-Sampong M; Pests of cowpea and their control in Ghana. In S R Singh, H F van Emden and T A Taylor (eds). Pests of grain legumes, 1978.
68. Tanzubil P.B; Field evaluation of Neem extracts for control of insect pests of cowpea in Northern Ghana. Journal of Tropical Forest Products (Malaysia), 2000; 6: 165 – 172.
69. Jackai L.E.N; Integrated pest management of borers of cowpea and beans. Insect Science and its Application, 1995; 16: 237 – 250
70. Malgwi A.M and Onu J.I; Insect Pests of Cowpea and Groundnut in Girei Local Government Area of Adamawa State. Nigerian Journal of Entomology, 2004; 21:137-151.
71. Tanzubil P.B; The control of insect pests of caowpea with neem (Azadirachta indica) in Northern Ghana. Tropical Pest Management, 1991; 37 (3): 216 -217.
72. Oparaeke A.M, Dike M.C, Amotobi C.I; Insecticidal Potentials of Extracts of Garlic, *Allium sativum* (Linneaus) Bulb and African Nut-Meg, *Monodora myristica* (Gaertn) Dunal Seed for Insect PestControl on Cowpea. In. Entomology in Nation Building:The Nigerian Experience. Occasional Publication, 2000; 32:169-174.
73. Echendu T.N.C; Ginger, cashew and neem as surface protectants of cowpea against infestation and damage by *Callosobruchus maculatus* (Fab.) Journal of Tropical Science, 1991; 31:209-211.
74. Shen Y.C, Zhang Y.B; Biopesticides. Chemical Industry Press, Beijing, 2000.
75. Alao F. O. and Adebayo T. A; Comparative Toxicity of Botanical and Synthetic Insecticides Against major Field Insect Pests of Cowpea (Vigna unguiculata (L) Walp). Journal of Natural production and Plant Resources, 2011; 1(3): 86-95
76. Ebenezer, O.O; Managemet of major field pests and yield of cowpea (*Vigna unguiculata* (L) Walp) under calendar and monitored application of synthetic chemicals in Asaba, Southern Nigeria. African journal of General Agriculture,2010;6 (3):177-186.
77. Isman M.B; Botanical insecticides, deterrents, and repellents in modern agriculture and an increasingly regulated world. Annual Revision of Entomology, 51: 45- 66.
78. Schmutterer H; Properties and potentials of natural pesticides from the neem tree, *Azadirachta indica*. Annual Review of Entomology, 1990;35: 271–298.
79. Ojo I.O; On the effectiveness of insecticides of biological origin. Proceeding of 25th Annual Conference. Entomological Society of Nigeria, 1996; 30:25-31
80. Lungu J. M and Gichia L*;* Research Bulleting. University of Wisconsin , 269.
81. McDavid A. and R.S.J. Lesseps; Proceedings from the first National Symposium Lutsaka, Zambia, 1995;135 – 147.
82. Merck N.J; The Merck Index, 12th ed., Merck Research Laboratories Whitehouse station, 1996; 10330
83. Delobel A, Malonga P; Journal of Stored Product Research, 1987; 23: 173 – 176.

84. Arnason J.T., B.J.R. Philogen and P., Morand; An overview of the use of plant Insecticides of Plant Origin. ACS, Symposium Series No. 387 American Chemical Society Washington, D.C. USA; 1995;213.
85. Mordue, A.J. and A. Blackwell. (1993). Azadirachtin: An update. Journal of Insect Physiology, 39: 903-924.
86. Lale N.E.S; An overview of the use of plant Insecticides of Plant Origin. ACS, Symposium Series No. 387 American Chemical Society Washington, D.C. USA, 1995;213.
87. Olotuah O.F and Ofuya T.I; Comparative Protection of Cowpea, *Vigna unguiculata* (L.) Walpers Against Field Insect Pests Using Cashew Nut Shell Liquid and Cypermethrin (Cymbush). Pakistan Journal of Nutrition, 2010; 9(2):158-161
88. Ofuya T.I. and O.E. Fayape; Evaluation of cashew nut shell liquid and powder for the control of *Callosobruchus maculatus* (Fabricus) (Coleoptera: Bruchidae) Infesting Stored Seeds of Cowpea,*Vigna unguiculata* (L.) Walpers. Applied Tropical Agriculture, 1999; 4:72-77.
89. IITA; Research Highlights, Ibadan, Nigeria, 1974; IITA
90. Jackai L.E.N., Goudou C., Asiwe J.A.N., Tayo B.O; Integrated control of the cowpea aphid using seed dressing and varietal resistance. Samaru Journal of Agricultural Researches, 2001; 17: 13-23.
91. Dina S.O; Synthetic pyrethroids for the control of cowpea insect pests. Journal of Agricultural science, 1979; 93: 735-747.
92. Elliot M; Properties and applications of pyrethroids. *Environmental Health perspective*, 1976; 14: 3-13.
93. Dina S.O; Interactions between rate, spray interval and number of applications of the synthetic pyrethroid Decis in cowpea (*Vigna unguiculata*) pest control. Journal of Agricultural science , 1982; 99:471-478.
94. Taylor T.A; A review of 50 years applied entomology in Nigeria: Legume crops. Proceedings of the Entomology Society of Nigeria, 1967; 20-24.
95. Dina S.O. and Medaigedu J. A; Field tests with insecticides to control *Maruca vitrata* and other pod boring insects of cowpea in southern Nigeria. Journal of Economic Entomology, 1976; 69:173-177
96. Caswell G.H and Raheja A.K; Preminary trials using synthetic pyrethroids to control pests of cotton and cowpea. *Samaru* Agricultural Newsletter, 1977; 19:46-49.
97. Bahlai C.A., Xue Y., McCreary C.M; Choosing Organic Pesticides over Synthetic Pesticides May Not Effectively Mitigate Environmental Risk in Soybeans, PLoS ONE , 2010;5(6): 11250.