

Guide to Cowpea Production in Northern Nigeria

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Cover: Harvesting mature cowpea pods, Kano State, Nigeria.



Forward and Acknowledgements

This handbook is intended to guide farmers, extension personnel, students of agriculture and researchers in Nigeria to use improved varieties and complementary production practices to increase productivity. The guide draws its lessons from the work and experience of IITA and partners in Research for Development on crop-based systems in Nigeria.

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strengthen the institutions that form the market system and the networks that serve smallholder farmers who have been disenfranchised by conflict; and facilitate the engagement of youth and women in economic and entrepreneurial activities.

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Introduction

The importance of cowpea

Cowpea (*Vigna unguiculata* L. Walp.) is an important grain legume, a major staple food crop for household nutrition in sub-Saharan Africa, especially in the dry savanna regions of Nigeria. It plays an important role in human nutrition, food security, and income generation for both farmers and food vendors in the region. The grain is rich in protein (25%), carbohydrates, vitamins, and minerals and complements the mainly cereal diet in countries that grow cowpea as a major food crop. In addition to the grain, the young green leaves and pods are consumed as a vegetable by the people; the haulms (biomass) from the plants provide important nutritious fodder for ruminants, especially during the dry season. In Nigeria, farmers who cut and store fodder for sale at the peak of the dry season have been found to increase their annual income by 25% (Dugje et al. 2009). Cowpea also plays an important role in providing soil nitrogen to cereal crops (such as maize, millet, and sorghum) when grown in rotation, especially in areas where poor soil fertility is a problem. It does not require a high rate of nitrogen fertilization; its roots have nodules in which soil bacteria called Rhizobia help to fix nitrogen from the air, some of which are left behind for subsequent crops in the soil after harvesting. The crop also grows and covers the ground quickly, preventing erosion.

There is a big market for the sale of cowpea grain and fodder in Nigeria. The important cowpea-producing States in Northern Nigeria are, Adamawa, Bauchi, Benue, Borno, Gombe, Kaduna, Yobe, Niger, Katsina, Kebbi, Sokoto, Taraba, and Zamfara. The bulk of production comes from the drier areas of the Guinea savanna, and the Sudan savanna,

agroecological zones of Nigeria. Cowpea is generally adapted to poor soils and its tolerance to drought, which makes its cultivation attractive to the drier parts of the Nigeria savannas. Production in Nigeria is increasing, and consumption is also at an all-time high, raising hopes over the sustainability of a key source of plant protein for millions of Nigerians (FAO 2017). For instance, the area under cultivation in Nigeria has increased by about 2.9 times from 1.2 million ha for the period 1980–1984 to about 3.5 million ha between 2014 and

2018. During the same period, production increased from 524 thousand tons from 1980-1984 to about 3 million tons from the 2014–2018 period. The average yield/ha also followed the same trend from 409 kg/ha between 1980 and 1984 to about 900 kg/ha from 2014 to 2018 (FAO, 2018). Studies conducted by Kormawa et al. (2000) revealed that in Nigeria more urban households (72%) consume cowpea than any other grain legume.. This is an indication that there is a good domestic market, providing an important opportunity to increase incomes and employment and reduce poverty in rural areas. Despite its importance, cowpea production in the Northern Nigeria savannas is faced with numerous constraints such as insect pests, diseases, the parasitic weed *Striga gesnerioides*, poor soil fertility, and intermittent drought (Singh and Tarawali 1997). The combination of these stresses can cause complete crop loss if not properly managed. Researchers in the sub-region have developed several varieties that are either resistant/or tolerant to these stresses. These varieties, along with improved management practices, have been found to substantially increase yield in Nigeria (Kamara et al. 2018)

This guide draws its lessons from the work and experience of IITA and partners in Research for Development on cowpea-based systems in Nigeria. The handbook is intended to guide farmers, extension personnel, students of agriculture in higher institutions, and researchers in Nigeria to use improved varieties and complementary production practices to increase productivity.

Important steps in growing cowpea

Site selection

Proper site selection is very important. Select a well-drained sandy loam soil for rainfed cowpea, and inland depressions or along the shores of a lake for a dry season crop using residual moisture. Cowpea does not tolerate excessively wet conditions or waterlogging and should not be grown on poorly drained soil.

Land preparation

Clear the site of shrubs and stubble. Alternatively, spray the field with Glyphosate (Round-up) at the rate of 4 L/ha [about 2 1/3 peak liquid milk tins (157 ml) of chemical in a 15-L sprayer or 3 milk tins of chemical in a 20-L knapsack sprayer] and leave the field for at least 10 days for emerged weeds to be killed. Land can also be prepared manually with the African hand-hoe. Soils should be cultivated deeply enough to ensure that no barrier (such as a hardpan) exists to penetration of the soil by the taproot. If using a tractor, plough and harrow the field to provide sufficient tilth for good root growth (Fig. 1). Well-prepared land ensures good germination and reduces weed infestation. Make ridges thereafter, if desired. Where the soils are more fragile and prone to erosion, adopt minimum or zero tillage.



Figure 1. Cowpea planted with hand on a well-prepared field.



Figure 2. (a) Good seeds for planting and (b) Bad seeds for planting.

Seed preparation for planting

Select good seeds (Fig. 2a) without damage holes or wrinkles (Fig. 2b) for planting. Well-stored seeds under optimum conditions will have good germination.

Pre-sowing seed dressing

Before sowing, treat seeds with Apron XL[®] at the rate of 10 g/4-5 kg of seeds (1 sachet). This will enhance good germination and protect the seedlings from fungal infection soon after emergence.

Planting date

When to plant

Planting date affects cowpea seed yield and quality. It also affects the use of insecticides for controlling insect pests. High yields of good quality seeds are obtained when cowpea is planted so that the crop matures in dry weather. In Northern Nigeria, reproductive development is determined primarily by the response to photoperiod. Some genotypes are photoperiod-sensitive, while others are photoperiod-insensitive. Photoperiod is determined by day length and is a critical factor in determining the appropriate planting time. For example, planting photoperiod-sensitive cowpea varieties at the onset of the rainy season (June or early July) will delay flowering and promote excessive vegetative growth that may result in a low yield owing to long daylength. For the photoperiod-sensitive cowpea to flower early, these varieties should, therefore, be planted from late- July to mid-August when the daylength is becoming shorter, depending on the amount and distribution of rainfall. On the other hand, the erect type, early and medium maturing varieties that are photoperiod-insensitive can be planted at any time in the year, provided rainfall is sufficient, or there are irrigation facilities.

Cowpea breeders in Nigeria have developed a range of varieties differing in plant type, growth habits, maturity and seed type. Plant types are often categorized as erect, semi-erect, prostrate (trailing), or climbing. There is much variability within the species. Growth habit ranges from indeterminate to fairly determinate with the non-vining types tending to be more determinate. These varieties respond differently to different photoperiods and growing environments. Some varieties, such as the local and indeterminate improved varieties, are

photoperiod- sensitive. An important strategy to maximize yield is the ability to fit the crop varieties into their different planting dates for optimal performance. Table 1 highlights the planting dates recommended in some locations in Northern Nigeria. With the effects of climate change, the prediction of planting dates in the savannas from climate alone is becoming more difficult. Thus, planting dates may be chosen, based on plant maturity by ensuring that the critical growth stage, such as flowering, is synchronized with the availability of sufficient rainfall.

Table 1. Rainfall distribution and planting dates of cowpea in Northern Nigeria.

Agroecological zone	Commencement of rains	Rainfall duration	Cowpea growth habit	When to plant after rains fully established
Sahel zone	May	June–August	Determinate (early and medium maturity)	14–28 June
			Indeterminate (medium maturity)	20–25 June
Sudan savanna	June	June–September	Determinate (early and medium maturity)	25 June–24 July
			Indeterminate (medium and late maturity)	19–22 July
Northern Guinea savanna	July	July–October	Determinate (early and medium maturity)	25 July–8 August
			Indeterminate (medium and late maturity)	28 July–3 August
Southern Guinea savanna	August	August–November	Determinate (early and medium maturity)	25–30 August
			Indeterminate (medium and late maturity)	24–28 August

Choice of varieties

Select a variety that is suited to your agro-ecological zone, based on its suitability for the prevalent climatic conditions and cropping systems. The choice of variety is based on maturity period, yield potential, drought tolerance, responsiveness to daylength, parasitic weed infestation, and pest and disease resistance. Table 2 shows some of the important issues to be considered when selecting a variety for a particular environment. The color and size of the seeds are very important to consumers and farmers. These, however, vary with regions. Some regions have a strong preference for large-seeded varieties with brown seed coats; others prefer white seed coats. Some farmers also prefer varieties that are suitable for intercropping. Selected varieties recommended for Northern Nigeria are presented in Tables 3–5

Table 2. Criteria in selecting a cowpea variety for a particular environment.

Production constraint	Variety to use	Where to buy seeds
Drought	Drought tolerant and early maturing	Buy your seeds from a recognized seed company, CBO, agro-dealer's shop, or Research institute or contact your State ADPs. Do not buy seeds from the open market for planting.
Heat	Heat resistant	
<i>Striga</i> infestation	<i>Striga</i> resistant	
Short rainfall (300-500 mm/year)	Extra-early and early maturing (look for the varieties that have a maturity period that falls within 60–70 days)	
Pests and diseases	Varieties that have some resistance/tolerance to major pests and diseases	

Cowpea varieties recommended for some Areas in Northern Nigeria

Table 3. Cowpea varieties recommended for Northern Nigeria.

Variety	Yield (t/ha)	Seed coat texture	Growth habit	Maturity	Other qualities	Agroecological zones
IT99K-573-1-1 (SAMPEA14)	2.6	Rough seed coat, white color with brown helium, medium seed size	Determinate	Medium (70–75 days)	Resistant to <i>Fusarium</i> wilt and <i>Striga</i> , tolerant to drought	Northern Guinea savanna, Sahel, Sudan savanna
IT99K-573-2-1 (SAMPEA15)	2.6	Rough seed coat, white color with black helium, medium seed size	Determinate	Medium (70–75 days)	Tolerant to drought; resistant to <i>Striga</i>	Northern Guinea savanna as well as Sahel and Sudan savanna
UAM09 1055-6 (FUAMPEA 1)	1.9	Rough seed coat, white color with brown helium, medium seed size	Determinate	Early (60–65 days)	Tolerant to drought; resistant to <i>Striga</i> , short cooking time	Sudan savanna and Sahel region
UAM09 1051-1 (FUAMPEA 2)	2.0	Rough seed coat, brown color with brown helium, medium seed size	Indeterminate	Medium (70–75 days)	Short cooking time, resistant to <i>Striga</i> . <i>Good for intercropping</i>	Sudan, and Northern Guinea savannas
IT89KD-288 (SAMPEA 11)	2.0	Rough seed coat, white color with brown helium, large seed size	Indeterminate	Late (80–85 days)	Resistant to nematodes. <i>Good for intercropping</i>	Northern/Southern Guinea savannas
IT07K-292-10 (SAMPEA16)	2.5	Rough seed coat, white color with black helium, large seed size	Determinate	Early (65–70 days)	Tolerant to drought	Sudan savanna and the Sahelian region
IT07K-313-18 (SAMPEA17)	2.5	Rough seed coat, brown color with black helium, large seed size	Determinate	Medium (70–75 days)	Tolerant to <i>Striga</i>	Sudan savanna and the Sahelian region

Table 3. Contd.

Variety	Yield (t/ha)	Seed coat texture	Growth habit	Maturity	Other qualities	Agroecological zones
IT07K-297-13 (SAMPEA 18)	2.3	Rough seed coat, white color with brown helium	Determinate	Medium (70–75 days)	Tolerant to <i>Striga</i> and <i>Alectra</i>	Sudan and Northern Guinea savannas
IT08-150-12 (SAMPEA 19)	2.4	Rough seed coat, white color with brown helium	Determinate	Medium (70–75 days)	Tolerant to <i>Striga</i> and <i>Alectra</i>	Sudan and Northern Guinea savannas

Sowing and spacing for cowpea

Erect varieties should be planted at a close spacing of 50 cm between rows and 20 cm between plants, especially for early and extra-early maturing varieties (55–70 days). Also, for erect type, double row planting can be done on a ridge to maximize high yield, but the seed rate/ha has to be doubled. Recently, a 2-fold higher seed yield has been achieved by using a higher plant population through double row planting on a ridge (Kamara et al., 2016). For semi-erect varieties, spacing should be 75 cm between rows and 25–30 cm between plants. For prostrate/creeping varieties, plant at a spacing of 75 cm between rows and 40 cm within rows. For all recommended plant spacings, sow 3 seeds/hill, and thin to 2 plants/stand at 2 weeks after planting. Cowpea should be planted either on ridges or on flatbeds, depending upon the field preparation. Planting can be done manually, or mechanical planters can be used if available.

Seed requirements

About 15–30 kg of seed, depending on the variety, seed size, and cropping system, is required to plant 1 ha of land. More seeds are required when erect varieties are used than when prostrate varieties are adopted because the erect variety is spaced more closely. Also, fewer seeds are required when the cowpea is to be grown in mixture with other crops. The larger the seeds, the more seeds/ha are required. Table 8 shows the seed rate/ha for the different cowpea types.

Table 4. Seed rate/ha based on recommended plant spacing.

Cowpea Type	Growth habit	Maturity	Cropping system	Spacing (cm)	Quantity of seed/ha
Erect	Determinate	Extra-early, early, and medium	Sole	50 cm between rows and 20 cm within rows (50 × 20 cm)	30 kg (12 <i>mudus</i>)
Semi-erect	Indeterminate	Early and medium	Sole	75 cm between rows and 30 cm within rows (75 × 30 cm)	20 kg (8 <i>mudus</i>)
Semi-erect	Indeterminate	Early and medium	Intercrop	75 cm between rows and 25 cm within cereal stands (75 × 25 cm)	25 kg (12 <i>mudus</i>)
Prostrate	Indeterminate	Medium and late	Sole/intercrop	75 cm between rows and 50 cm within rows (75 × 50 cm)	15 kg (6 <i>mudus</i>)

Sowing and spacing for cowpea + cereal mixture

Where cowpea is to be intercropped or relayed with other crops such as maize, the spacings should be 75 cm inter-row × 25 cm intra-row (Figs 3a and 3b). Only a shade-tolerant variety should be used. Also, the cowpea should be planted at about 5–7 weeks after the first crop—maize, sorghum, or millet—has been planted. For strip intercropping, adopt 2 rows of cereal to 4 rows of cowpea to improve the productivity of erect and shade-sensitive varieties. The cereal and cowpea should be planted at the recommended spacing.

Sowing depth

Sow seeds at a depth of 2.5 to 5 cm for most varieties; planting seeds more than 5 cm deep will delay emergence. The seeds may rot, and the plant stand will be uneven. Emergence is epigeal, where the cotyledons emerge from the ground during germination. This type of emergence makes cowpea more susceptible to seedling injury since the plant does not regenerate buds below the cotyledonary node.



Figure 3. (a) Maize + cowpea strip intercropping. (b) Cowpea relayed into maize.

Fertilizer rate and application

Cowpea plants do not require too much nitrogen fertilizer because they fix their own nitrogen from the air using the nodules in the roots. However, in areas where soils are poor in nitrogen, a small quantity of about 15 kg/ha of nitrogen in the form of NPK 15:15:15 (2 bags) is needed as a starter dose for a good crop. If too much nitrogen fertilizer is used, the plant will grow luxuriantly with poor grain yield. Cowpea requires more phosphorus than nitrogen in the form of single super phosphate or SUPA. About 30 kg of P/ ha (~4 bags) in the form of SUPA is recommended for production to help the crop to nodulate well and fix its own nitrogen from the air. Table 5 presents the recommended rate of fertilizer for cowpea production. However, a soil test is the best way to determine soil nutrient levels.

Table 5. Recommended fertilizer rate for cowpea.

Fertilizer nutrient/ha	Quantity equivalent in bags/ha	Time of application	Remarks
15 kg N	2 bags of NPK	Apply at planting by incorporating into the soil	This will also supply 15 kg each of nitrogen, phosphorus, and potassium.
30 kg P (P_2O_5)	4 bags of single super phosphate (SUPA)	Apply during land preparation or just before sowing to enable the proper placement and also to ensure sufficient supply of phosphorus in early stages of plant growth when its requirement is the highest.	It is, therefore, necessary to place P in the root zone or in the soil layer where the roots are most active. When super phosphate is applied in moist soil or in dry soil after rain or irrigation, the phosphate part (H_2PO_4) is dissolved in the soil water. The roots of growing plants easily take up this form of phosphorus.

Weed management in cowpea

There are three groups of weeds: grasses, sedges, and broadleaf types and these compete with desired crop plants for light, water, nutrients, and space. Generally, weed infestation is a serious problem in cowpea production and is more severe at the beginning (5–8 weeks after planting). Cowpea is not a strong competitor with weeds, especially at the early stage of growth. Weeds also can harbor pests and reduce both the yield and the quality of the seeds. Fodder yield can also be reduced, especially at the early stage of growth. Weed control measures could be applied during pre-planting or immediately after planting and should be based on the nature of the problem and the resources available to the farmer. At present, the most commonly employed methods to control weeds in cowpea are manual, mechanical, or chemical. Adequate weed control is necessary for proper growth and high yields.

Manual control: Manual weed control is the most common method used by farmers in cowpea production. However, this is not sustainable and imposes drudgery on the farmer. If you decide to carry out manual weed control, weed cowpea twice with the hoe, first at 2 weeks after planting, and secondly at 4–5 weeks later to ensure a clean field. A third weeding just before flowering may be necessary, depending on the field situation or the presence of a perennial weed such as *Imperata cylindrica*. Poor weed control or delay in weeding can cause a drastic reduction in yield.

Chemical control: Chemical weed control involves the use of herbicides, which contain chemical substance(s) used to kill weeds. This method has several advantages, such as less dependence on labor, efficiency even during the rainy season, and effectiveness in controlling weeds. If you decide to use a herbicide to control weeds, be sure to select the appropriate product for your

situation (see Table 6 for some of the recommended herbicides). Herbicides are classified by the way they act. Some herbicides kill weeds only when the weeds have emerged, and others suppress the germination of weed seeds.

Different herbicides contain different active ingredients, and so they are applied at different times. Those that are applied before planting or before land preparation are referred to as pre-planting herbicides and are mainly aimed at land preparation and the clearance of troublesome weeds that are already growing. Those that are applied after planting but before the germination of both the planted seeds and of weeds are called pre-emergence herbicides. Those that are applied after the germination of seeds are called post-emergence herbicides.

Clay soils require higher rates of herbicide application than loamy or sandy soils. When applying herbicides, you need to adjust the amount of herbicide you apply according to the type of soil. For example, when researchers or chemical manufacturers indicate a recommended dosage of 3–5 l/ha, it means that farmers should apply 5 l/ha in clay soils, 4 liters/ha in loamy soils, and 3 l/ha in sandy soils.

Chemical weed control, if used properly, is safe and effective in controlling weeds in cowpea. The choice of herbicide, however, depends on the predominant weed species and the availability of the herbicide. Generally, chemical weed control, in conjunction with manual weeding, is most promising. If a herbicide is used at planting, one hoe weeding or two may be required at 4 and 7 weeks after planting.

Proper land preparation is a prerequisite to efficient weed management in cowpea. Where the land is poorly prepared or planting is delayed and there are weed seedlings on the soil surface, apply a mixture Glufosinate ammonium (150–550 ml) and Pendimethalin, Stomp, Dual Gold or Butachlor (50–450 ml) depending on product formulation, the soil type in a tank of 15 or 20 liter capacity and applied immediately after planting or the following day. Glufosinate ammonium controls emerged grasses and broadleaf weeds; Pendimethalin, Butachlor, or Stomp prevents weed seeds from germinating. Do not apply herbicides that are not recommended for cowpea to avoid damage to the plants.

Table 6. Some recommended herbicides and application rates for weed control in cowpea.

Product trade name	Brand or common name	Rate (liters/ha)‡	Quantity/sprayer load	Conditions of use	Remarks
A) Pre-land preparation herbicides					
Glufosinate ammonium	Lifeline, Basta, Slasha	1.6-5 liters	150-400 ml in 15 L sprayer or 180-550 ml in 20 L sprayer	Contact/semi-systemic herbicides for total weed control. Apply on non-cultivated land or before planting.	Plant after the weeds are killed. Do not mix glufosinate-ammonium with glyphosate for use.
Glyphosate	Round-up Turbo, Glycel, Kill off, Cleanweed, Sarosate, Touchdown forte, Deensate, Rhonasate, Delsate etc	4-6 liters	350-500 ml in 15 L sprayer or 450-650 ml in 20 L sprayer	Systemic herbicide. Apply on emerged weeds before land preparation.	Apply where troublesome weeds are common. Wait for 10 days after the application before preparing the land.
(B) Pre-emergence herbicides					
Pendimethalin	STOMP 455 CS	2-3 liters	150-250 ml in 15 L sprayer or 250-350 ml in 20 L sprayer	Apply immediately after planting or a day later.	Apply where troublesome weeds such as <i>Rottboellia</i> are common. Do not plant or replant any crop other than those mentioned for one year after application.
S-Metolachlor	Dual Gold 960 EC	0.6-1.6 liters	50-150 ml in 15 L sprayer or 70-180 ml in 20 L sprayer	Apply immediately after planting or a day later.	

Note: ‡ for all the herbicides application rates will depend on formulation and label rate (Read the herbicide label for recommended rates). About 12 loads of 15-liter or 9 loads of 20-L sprayers are required for a hectare. Where animal power is used to conduct land preparation, allow rain to fall on the prepared land before planting. Spray herbicides immediately after planting or the next day after planting to enhance the effectiveness. Good land preparation is a pre-requisite for effective weed control in cowpea. Where land preparation is poorly done, and weeds are present at planting, apply glufosinate ammonium at the label rate to kill existing weeds before planting.

Pests and diseases

Cowpea is susceptible to a wide range of pests and diseases that attack the crop at all stages of growth. These include insects, bacteria, fungi, and viruses. High pest densities can cause complete loss of grain yield if no control measures are taken.

Major biotic constraints to cowpea production and productivity

Parasitic weeds

The two types of parasitic weeds that attack cowpea are *Striga gesnerioides* and *Alectra vogelii* but *Striga* is more prevalent and has a more devastating effect than *Alectra* in northern Nigeria. *Striga gesnerioides* is widespread in areas with low rainfall and poor soil fertility, conditions that are common throughout the northern Guinea and Sudan savanna zones as well as the Sahelian zone. The parasite uses its haustorium to penetrate the root of the plant and sap the nutrients from the host to the *Striga*

seedling. It causes stunting, wilting and yellowing between the veins of cowpea leaves, resulting in the death of infested plants. The problem becomes worse when soil moisture is limiting.



Striga gesnerioides parasitizing cowpea.

The seeds of these parasites can survive in the soil for many years (more than 20 years) until a susceptible variety is planted. *Striga* can cause complete crop loss if left uncontrolled. Cultural control measures include cowpea–cereal rotation, nitrogen fertilizer, suicidal germination in a trap crop system, and herbicide control. However, the use of a resistant

variety is an effective and affordable option for the control of *Striga* and *Alectra*. Many varieties that are completely resistant to *Striga* and *Alectra* have been developed and are available in Nigeria.



Alectra vogelii parasitizing cowpea.

Cowpea major diseases and their control

Fungal, bacterial, and viral diseases affect cowpea. Different diseases affect different parts of the crop at different stages of growth. The major and common diseases are anthracnose, *Sclerotium* stem, root, and crown rot, damping off, *Cercospora* leaf spot, *Septoria* leaf spot, *Fusarium* wilt, Bacterial blight, and scab.

Fungal diseases

Fusarium wilt:

Fusarium wilt (FW) is caused by the fungal pathogen, *Fusarium oxysporum* f.sp. *tracheiphilum* (*Fot*). It is one of the diseases that pose a major threat to cowpea production worldwide. The disease causes substantial yield losses ranging from 50 to 100%. The occurrence and epidemic spread of this soil-borne disease are influenced by factors such as soil nutrient levels, temperature, and moisture stress. The fungal pathogen *F. oxysporum* has a wide host range, encompassing plants in the Leguminosae, Malvaceae, and Solanaceae families and causes vascular wilt. The pathogen enters the plant through the root system and invades the vascular tissue. Infected plants exhibit a reduction in plant growth, leaf chlorosis, wilting, and vascular discoloration, which result in the death of infected plants with severe overall yield loss. Broad irregular patches of affected plants are visible in infested cowpea fields. The disease is a soil-borne and seed-borne fungus that is difficult to manage through fungicide applications alone. The most cost-effective and environmentally safe control is the use of resistant cultivars when they are available.



Cowpea stem infected with *Fusarium* wilt.

Cercospora leaf spot (CLS) disease is caused by two fungi; *Cercospora canescens* Ellis and Martin and *Pseudocercospora cruenta* (Sacc.) Deighton (formerly *Cercospora cruenta*). Both pathogens survive the no-crop period on infected crop residues and in infected seeds. *Pseudocercospora cruenta* (Sacc.) is the most widespread and most destructive disease of cowpea in the Northern and Guinea savanna zones of Nigeria. Most of the damage from CLS occurs late in the growing season when the crop's vegetative and reproductive parts are fully developed. The disease attacks the leaves, causing a serious yield loss because of severe defoliation. The disease not only reduces grain yield but can also impair fodder quality and consequently undermine efforts to promote crop-livestock integration. The disease is encountered during the relatively hot conditions and high humidity of the rainy season.

The disease symptom on infected plants presents necrotic spots on the upper leaf surface and profuse masses of conidiophores and conidia, appearing as downy grey to black mats, on the lower leaf surface. CLS disease is seed-borne and seed transmitted. The most effective means to control economic losses from CLS is using cowpea varieties with genetic resistance to the disease.



Cercospora leaf spot infected leaves.

Bacterial blight disease

Bacterial blight of cowpea (CoBB), caused by the bacterium *Xanthomonas axonopodis* pv. *vignicola*, is an important disease of cowpea, causing severe losses in grain yield of more than 64-100% in some areas of Nigeria. The symptoms of CoBB appear as tiny, water-soaked, translucent spots, which are more clearly visible from the abaxial surface of the leaves. The spots enlarge, coalesce, and develop into big necrotic spots, usually with a yellow halo, and lead to premature leaf drop. The pathogen also invades the stem causing cracking with brown stripes. Pod infection appears as dark green water-soaked areas, from where the pathogen enters the seeds and causes discoloration and shriveling. CoBB is seed-borne, and the pathogen can be spread by wind-driven rain and insects. Different strategies are used to control the disease, including cultural practices, intercropping, and the application of chemicals. Cultivation of resistant cowpea varieties is the most promising strategy to control the disease.



Cowpea leaves infected with Bacterial blight.

Scab disease of cowpea

Cowpea scab disease is caused by the fungi pathogen known as *Sphaceloma* sp. The disease is widespread in tropical Africa and is seed-borne and a major disease in savanna areas. The disease affects all plant parts above the soil, causing up to 100% yield loss. Symptoms of leaf infection include the appearance of spots on both leaf surfaces and cupped, small greyish lesions along the vein. Infected stems show oval to elongated silver-grey lesions, egg-shaped white spots surrounded by red or brown rings on the stem, and pit-like spots with grey powder surrounded by brown borders on pods. When the infection is high, leaves, stems, and pods alike are heavily spotted, plants remain small, and leaves, flowers, and pods drop before maturing. Chemical control may be effective by treating seeds with Mancozeb at the rate of 80 g/kg of seeds. However, the most effective means to control economic losses from scab is using cowpea varieties with genetic resistance/tolerance to the disease.



Cowpea pod infected with Scab.

Virus diseases

Cowpea is severely affected by a range of virus diseases causing significant yield and economic losses owing to reduced grain production, poor quality seeds, and costs incurred in phytosanitation and disease control. The majority of the viruses infecting cowpea are vectored by insects (mainly aphids, beetles, and whiteflies), and some are seed-transmitted. Most of the virus infections result in foliar symptoms such as mosaic and mottling, thickening/brittleness of older leaves, wrinkling, leaf distortion, a severe reduction in leaf size, and stunting of plants resulting in yield losses ranging from 10 to 100%. Mixed infections with more than one virus are common under field conditions. Seven viruses are recognized to infect cowpea in Nigeria. Three are beetle-transmitted [*Cowpea yellow mosaic virus* (CPMV), genus *Comovirus*; *Cowpea mottle virus* (CMeV), and *Southern bean mosaic virus* (SBMV)]; two are aphid-borne [*Cowpea aphid-borne mosaic virus* (CABMV), genus *Potyvirus*, and *Cucumber mosaic virus* (CMV), genus *Cucumovirus*]; two are whitefly-transmitted [*Cowpea golden mosaic virus* (CPGMV), genus *Bigeminivirus*, *Cowpea mild mottle virus* (CPMMV), genus *Carlavirus*]. The best way to control virus disease is to grow a resistant variety or control the vectors where applicable with insecticides. Rogue out plants with symptoms during active growth.



Cowpea yellow mosaic virus.



Cowpea mottle virus.

Insect Pests

Insect pest-damage poses a serious threat to sustainable cowpea production in Nigeria, particularly during the flowering and post-flowering growth stages. The direct damage generally causes low yields, and sometimes total yield losses and crop failures occur owing to the activities of a spectrum of insect pests that ravage the crop in the field at different growth stages and also destroy the grain in the store. The most serious pest species attacking cowpea include aphids (*Aphis craccivora* Fabricius), whiteflies (*Bemisia tabaci*), flower thrips (*Megalurothrips sjostedti* Trybom), pod borers (*Maruca vitrata* Fab) and a complex of pod and seed-sucking bugs such as *Riptortus dentipes* Fab, *Clavigralla tomentosicollis* Stal, *Anoplocnemis curvipes* Fab, and *Nezara viridula*. Attack by these insects is often so severe that farmers obtain no yields, especially when improved varieties are grown without insecticide protection.

Pre-flowering pests of cowpea

The most damaging pre-flowering insect pests of cowpea are aphids (*Aphis craccivora*), and whiteflies (*Bemisia tabaci*).



Cowpea plant infested by aphids.

Aphis craccivora feeds by piercing the plant tissue and sucking sap from the under-surface of young leaves and stem tissues, and on the pods of mature plants. The cowpea aphid causes economic losses both directly by sucking sap and indirectly through the transmission of viral diseases. It not only causes direct damage to the plant but also acts as a vector in transmitting *Cowpea aphid-borne mosaic virus* and *Cucumber mosaic virus*. Aphids excrete large quantities of a sugary substance called honeydew, which supports the growth of sooty mold. This mold, a fungus, is dark-colored and reduces the amount of sunlight that reaches the leaf. The honeydew produced on the plant is evidence of aphids feeding on the crop. Mild damp weather favors the development of aphid populations. Chemical control can be effective when appropriate chemical insecticides are used. See Table 6 for a list of chemical insecticides to control this pest.



Cowpea aphid-borne mosaic virus.

Whiteflies cause direct damage and weaken plants by sucking sap and removing nutrients. The leaves become mottled and yellowish. Damage may be more severe when plants are under water stress. Infested plants may wilt, turn yellow, become stunted, or die when infestations are severe or of long duration. Whiteflies not only cause direct damage to the plant but also act as a vector in transmitting *Cowpea yellow mosaic virus*. The adults are small with white wings, which are densely covered with a waxy powder. Nymphs are black and round or oval. Chemical control can be effective when appropriate insecticides are used. See Table 7 for a list of chemical insecticides to control this pest.



Cowpea yellow mosaic.

Flowering Pests

The most damaging flowering insect pests of cowpea are *thrips*, (*Megalurothrips sjostedti* Trybom.) and *Maruca*. They are frequently responsible for total crop loss. The adults are tiny black slender insects with two pairs of feathery wings. Both adults and the wingless larvae (nymphs) are attracted to white, yellow, and other light-colored flowers. The pest feeds on flower buds and flowers. Attack during the pre-flowering period may damage the terminal leaf bud and bracts, causing the latter to become deformed with a brownish-yellow appearance. Severely infested plants do not produce any flowers. When the population of *thrips* is very high, open flowers are distorted and discolored. Flower buds and flowers fall prematurely without forming any pods. Yield losses from this insect pest have been estimated at between 20 and 100%. The current management of *thrips* relies on chemical control with insecticides or the use of a tolerant variety. See Table 7 for a list of chemical insecticides to control this pest.



Thrips on cowpea flower.

Post-flowering pests

Maruca

Among the cowpea pod borers, *Maruca vitrata* is the most widespread. It is a pre- and post-flowering pest and feeds on every part of the plant. The adult is a nocturnal moth, light brown with whitish markings on its forewings, and lays eggs on the plant. The larvae that emerge damage plants in the field, particularly during the reproductive stage, through feeding on the tender parts of the stems, peduncles, flower buds, flowers, pods, and seeds. The holes bored on the buds, flowers, or pods by feeding are the damage symptom. Infested pods and flowers are webbed together. This pest can cause a significant grain yield reduction of between 20 and 80% if not controlled with insecticides. Complete crop failure may occur, especially in situations where management strategies are not applied. No good sources of resistance have been found within the cowpea genotypes. See Table 7 for a list of chemical insecticides to control this pest.



Larvae boring into a cowpea pod.

Pod-sucking bugs (*Anoplocnemis curvipes*)

This is a major pest of cowpea in tropical Africa. Yield losses caused by *A. curvipes* vary from 30 to 70%. It sucks the sap from green pods, causing them to shrivel and dry prematurely, resulting in seed loss. Plant tolerant cultivars and spray with recommended insecticides. See Table 7 for a list of chemical insecticides to control this pest.



Anoplocnemis curvipes on cowpea pod.

Storage pests

Callosobruchus maculatus (Fabricius)

The cowpea weevil, *Callosobruchus maculatus* (Fabricius) is a cosmopolitan field-to-store pest that begins its attack shortly before harvest and continues in storage where it develops. The adults lay their eggs on the seeds, and the larvae bore into grains, feeding on the cotyledons and causing substantial losses. The damage affects the quality of the seeds and taints the taste of the crops, thus affecting the market value. This beetle is responsible for most of the losses which occur in stored cowpea seeds. The damage can be controlled by packing cowpea or grain in PICS bags for either short or long-time storage.



Cowpea weevils laying eggs on cowpea seed.



Cowpea seed damaged by weevil.

General approaches to insect pest control

There are various ways of controlling the insect pests of cowpea. Most specific control methods can be classified into the following major categories: host plant resistance, cultural, physical, mechanical, biological, and chemical strategies. The two most important and widespread methods are chemical control and host plant resistance. Due to the complex pest problems, farmers cannot plant cowpea without the use of chemical insecticide to control them. Insecticide application is the most widely known means of control in cowpea (Matteson 1982) because it is effective, convenient, and fast-acting. For now, no good sources of resistance gene(s) have been found within the genotypes for most of the pests. However, the indiscriminate and excessive use of chemicals by farmers makes the development of sustainable integrated pest management (IPM) strategies imperative for pest control. IPM strategies include the integration of judicious use of insecticides, resistant varieties, adjusted planting dates, close spacing aimed to minimize the use of chemicals, and reduce the harmful effects of insecticides on man and the environment as well as minimize increases in resistance to insecticides.

The search for more sustainable methods of pest control through host-plant resistance (HPR) is becoming more attractive every day. Additionally, the opportunity for utilizing new insect resistance genes and the ability to move these across plant species, through plant biotechnology, open new doors to the field of HPR.

Use of insecticides to control cowpea insect pests on the field

Because insecticides are mostly used by farmers to control insect pests, there is a need for the applicator to understand their proper handling and use for the desired result.

Spraying regime

Generally, 2–3 sprays with appropriate chemical insecticides are required for a good crop of cowpea, depending on the variety and the severity of insect attack. Late-maturing indeterminate varieties require more sprays than early maturing varieties because of the staggered flowering period. Adopt the following spraying regime to control insects using any of the insecticides listed in Table 7.

First spraying: Conduct the first spraying between 30 and 35 days (4–5 weeks) after planting when flower bud initiation has started. This will control flower thrips and an early attack of *Maruca* and ensure good flowering (7–9 weeks). For varieties susceptible to aphids, one spraying may be needed at the seedling stage, 14–21 days after planting using “Imiforce” insecticide. Other recommended insecticides and the application rates are presented in Table 7.

Second spraying: Conduct the second spraying 10 days afterward when the crop is in full flowering and podding to control *Maruca* and other sucking or chewing insects. Insecticides that contain both contact and systemic action can be used. The recommended insecticides and the application rates are presented in Table 7.

Third spraying: Conduct the third spraying when necessary, 10 days after the second spraying for medium varieties, and when there is an attack of *Maruca* and pod sucking bugs. A fourth spraying may be necessary for late-maturing indeterminate varieties. Insecticides that contain both contact and systemic action can be used. The recommended insecticides and the application rates presented in Table 7.

Table 7. Some recommended insecticides for control of insect pests in cowpea.

Active ingredient	Brand or common name	Application rate	Estimate for one sprayer load	Mode of action	Remarks
Lamda-Cyhalothrin 2.5% EC (Insecticide)	Karate 2.5 EC,	0.4– 0.8 L/ha	35–70 ml in 15-L sprayer or 50-80 ml in 20-L sprayer	Contact and stomach insecticide	Controls flying and soil-dwelling insects such as whiteflies and <i>aphids</i>
Lamda-Cyhalothrin plus Dimethoate	Kartodim 315EC	0.8–1 L/ha	50–60 ml in 15-L knapsack sprayer or 70-80 ml in 20-L knapsack sprayer	Systemic action	Controls sucking pests such <i>Maruca</i> and pod sucking bugs
Cypermethrin plus Dimethoate insecticide	Best Action, Cyperdiforce, Superplus, Sierpaplus		80–100 mL in 15-L sprayer or 100-120 ml in 20-L sprayer	Systemic action	Controls plant sucking insects such <i>Maruca</i> and pod sucking bugs
Acetamiprid a neonicotinoid insecticide	Assail 30 SG	Follow label directions	Read and follow label direction for crop specific	Systemic action as well as contact and stomach poison	Active against <i>aphids</i> and whiteflies

Types of insecticides' mode of action

Insecticides can be classified into two major groups:

Systemic insecticide: The chemicals are absorbed by the plant when sprayed and then work from the inside of the plant when the insect feeds on it.

Contact insecticide: The chemical works effectively only where it touches the target insect on the field.

External factors to consider when spraying

The following weather conditions and external factors will have an influence on the efficiency of spraying.

Wind: Spraying in very windy conditions is not recommended because the wind causes the droplets to drift from the target. Wind can be tolerated to some extent by using nozzles that produce bigger droplets (Fig. 4), but spraying is not recommended in the wind with speeds of more than 6 km/hr.

Day temperature: Do not spray during the hottest time of the day because the smaller droplets tend to evaporate into the air. The sprayed chemical will not reach the target, and this will result in a waste of money.

Crop stage: Crop stage and density have an influence on the choice of volume rate applied. The bigger the crop, the higher the spray volume rate in L/ha that must be applied to get good spray coverage (Fig. 4).

Method of spraying insecticides

The following methods are the most common ways to apply insecticides:

- Knapsack (high-volume) sprayers. Examples are CP-3 or CP-15. SP 15, Dami 16D, Jacto 20/16.



Figure 4. A Research officer giving instruction on type of nozzle to be used.

- ULV (Ultra-low-volume) sprayers (with yellow nozzle). This could be adopted in areas where water is a serious problem, as in the Sahel savanna of West Africa.

Apply any of the recommended insecticides early in the morning or late in the evening.

- Use conical nozzles when spraying insecticides with knapsack sprayers.

Handling, storage, and transport of insecticides

Insecticides are toxic to both pests and humans. If used improperly, insecticides can poison people, pets, and livestock. They can also damage beneficial insects, birds, fish, and other wildlife, harm desirable plants, and may contaminate soil and groundwater. Some of the precautions that must be taken during transport, storage, and handling of insecticides are highlighted below.

Label

Read the label carefully; it should be written in either English or French, and indicate the contents, safety instructions, and possible actions to be taken if the insecticide is swallowed or causes contamination. Insecticides should always be stored in their original labelled containers with the labels clearly visible.

Spraying

The discharge from the sprayer should be directed away from the body. Leaking equipment should be repaired and the skin should be washed after any accidental contamination.

Storage

Pesticides should be stored in a safe, secure, and well-identified place that is not accessible to unauthorized people or children. Insecticides should never be kept in a place where they might be mistaken for food or drink. Keep them dry but away from fires and out of direct

sunlight. Insecticides must be stored in tightly-sealed containers. Check containers periodically for leakage, corrosion breaks, tears, etc. Make sure that storage areas for insecticides are well-ventilated to prevent the accumulation of toxic fumes. Always store different types of insecticides in different areas, to prevent cross-contamination and the possibility of inadvertently applying a product. Never store pesticides in old bottles or food containers where they could be mistaken for food or drink for humans or animals.

Transport

Insecticides are most safely transported in the beds of trucks. They should never be transported in the passenger compartment of any vehicle nor in the same compartment as food, feed, or clothing. Pesticide containers made of paper, cardboard, or similar materials should be protected from moisture during transport.

Disposal

Left-over insecticide suspension can be safely discarded by being poured into a pit latrine or a hole in the ground, dug especially at least 100 m away from streams, wells, and houses. It should not be unloaded where it may enter water used for drinking or washing, fish ponds, or rivers. In hilly areas, the holes should be dug on the lower slopes.

Protective clothing

Spray workers should wear overalls or shirts with long sleeves and trousers, a broad-brimmed hat, a turban or other headgear, and sturdy shoes or boots. The mouth and nose should be covered with a simple device such as a disposable paper mask, a surgical-type disposable or washable mask, or any clean piece of cotton. The cotton should be changed if it becomes wet. The clothing should be of cotton for ease of washing and drying. It should cover the body without leaving any openings. In hot and humid climates, the wearing of additional protective clothing may be uncomfortable, and pesticides should, therefore, be applied during the cooler hours of the day.

Maintenance

Clothing should be kept in a good state of repair and should be inspected regularly for torn or thin damaged areas through which skin contamination might occur. Protective clothing and equipment should be washed after use with soap, separately from other clothing. Gloves need special attention and should be replaced when there is any sign of wear and tear. After use, gloves should be rinsed with water before they are taken off. At the end of each working day, they should be washed inside and outside. Spray equipment should be regularly cleaned and maintained to prevent leakages.

Harvesting of dry pods

Cowpea must be harvested as soon as the pods are fully mature and dry to avoid an infestation in the field because most of the storage pests are from-field-to-store pests. Harvesting is done by handpicking the pods (Fig. 5). For early maturing and erect varieties, one picking may be sufficient. For indeterminate and prostrate varieties, the dried pods can be picked two or three times as they do not mature at the same time because of the staggered flowering period. After harvest, sun-dry the pods on a platform or tarpaulin for proper drying before threshing (Fig. 6). Thereafter, thresh the pods and winnow to separate the seeds from the chaff or haulms. The seeds are further cleaned to remove debris and those that are broken and packed in plastic bags for storage.



Figure 5. Harvested mature pods of IT99K 573-1-1.



Figure 6. Sun-drying of harvested cowpea pods to reduce moisture before threshing.

Postharvest processing

Storage

Clean out the store thoroughly before a new crop is loaded. Old residues should be burned. Only well-dried and properly cleaned seeds should be stored (Figs 7a and 7b). The safe moisture content for storage is 7–8%; such seeds make a cracking sound when crushed between the teeth. High moisture content and high humidity during storage decrease seed viability. There are various hermetic products for storage; the main one is PICS bags (multi-layer, made of 2 polyethylene bags), but plastic bottles and clay pots are also used.



Figure 7. Cowpea seeds (a) not properly cleaned and (b) properly cleaned.

Storage pests and their control

One of the biggest challenges that confront grain farmers and merchants is how to effectively store their products. The most important storage pest of cowpea is the weevil (bruchid) called *Callosobruchus maculatus*. Severe infestation can lead to total grain loss in storage. It is a pest from-field-to-store; adult beetles lay eggs on pods (in the field) or on seeds (in storage). After hatching, the larvae develop within seeds and eat up the cotyledon, thereby causing extensive damage. Adults emerge from the seeds through holes made by the larvae that make it easy to recognize infested seeds (Fig. 8). Adopt store hygiene and fumigation and use airtight containers to control bruchids.



Figure 8. Poorly stored cowpea seeds (damaged by weevils).

Short-time storage for grain without the use of chemicals

Store the grain in airtight containers, such as sealed oil drums, locally constructed tanks, high-density plastic sacks or butyl rubber bags, or mix 5 ml of groundnut oil with 1 small *mu*du (1 kg) of grain. Store seeds in polythene triple bagging, hermetic storage, and keep away rodents.

Long-time storage for seeds and grain without the use of chemicals

Good storage prevents losses and maintains grain quality. Before new produce is brought in, repair all cracks in walls, floors and roofs to deny pests any hiding places; dust the stores/ granaries with appropriate contact insecticides such as Permethrin or Pirimiphos Methyl before storing produce. The method known as the Purdue Improved Cowpea Storage (PICS) bag uses non-chemical, hermetic storage. The PICS bag is composed of three layers: two inner layers of high-density polyethylene and an outer layer of ordinary woven polypropylene. This triple bag technology has been introduced in Nigeria, where farmers are exposed to harmful chemicals while protecting their cowpea grain against insects. The PICS method works by sealing cowpea in an airtight container; this which kills all the adult insects and most of the larvae within days. At the same time the triple bags keep the remaining larvae dormant and unable to damage the seeds (Fig. 9). With the introduction of the PICS bag, cowpea can be stored without the use of hazardous chemicals, and rodents kept away.



Figure 9. Cowpea storage in triple PICS bag.

Long-time storage for seeds and grain with chemical

Repair all cracks in walls, floors, and roofs to deny hiding places to insect pests and fumigate the stores/granaries with the appropriate contact insecticides such as Permethrin or Pirimiphos Methyl before storing produce.

Phosphine has been widely used as a grain fumigant for the control of storage pests for many years. Aluminum phosphide is marketed as Phostoxin, Cyclotoxin, Forcetoxin, Protex, Gastoxin, etc. Fumigants are gases and, therefore, self-dispersing and non-persistent. The techniques work by holding grain in a gas-tight enclosure in a gaseous atmosphere that will kill or limit agents of biodeterioration (Dramani 2010). The chemical is applied at the rate of 1 tablet per 100 kg sack of cowpea in an air-tight container but not directly on the grain. Place the tablet in a paper envelope or wrap it securely in tissue paper and placed in the middle of the grain. Through fumigation, in which the insecticide in gaseous form penetrates the stored product, insects are killed when they inhale the poisonous gas. The fumigant can provide protection for up to six months, provided the storage container is airtight.

Please note that insecticides that need a long time to degrade and leave residues in the products are unsuitable for use on stored produce.

Precautions when using chemicals to store cowpea

1. Do not use Phostoxin directly without wrapping it or in a container that is not airtight.
2. Do not store cowpea treated with Phostoxin in a living room for humans or a building for animals.
3. Remove and dispose of the Phostoxin residue and expose grain in the open air for 1–2 hours before use.

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