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Tropical Legume III (TLIII)

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Published by the International Institute of Tropical Agriculture (IITA)
Ibadan, Nigeria

IITA is the lead research partner facilitating agricultural solutions for hunger and poverty in the tropics. It is a member of the CGIAR Consortium, a global research partnership that unites organizations engaged in research for sustainable development for a food secure future.

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ISBN 978-978-131-357-8

Citation: L.O. Omoigui, A.Y. Kamara, J. Batieno, T. Iorlamen, Z. Kouyate, J. Yirzagla, U. Garba, and S. Diallo. 2018. Guide to cowpea production in West Africa. IITA, Ibadan, Nigeria. 60 pp.

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

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Introduction

The importance of cowpea

Cowpea (*Vigna unguiculata* L. Walp.) is a grain legume, a major staple food crop for household nutrition in sub-Saharan Africa, especially in the dry savanna regions of West Africa. 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 is 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 West Africa where the important cowpea-growing countries are Nigeria, Niger Republic, Mali, Burkina Faso, Senegal, and Ghana. The bulk of production comes from the drier areas of the Guinea savanna, the Sudan savanna, and the Sahel agroecological zones of West Africa. Cowpea is generally adapted to poor

soils and its tolerance to drought, which makes its cultivation attractive to the drier regions of the West African savannas. Production in West Africa 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 West Africans (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 2017. During the same period production increased from 524 thousand t from 1980-1984 to about 3 million tons from the 2014–2017 period. The average yield/ha also followed the same trend from 409 kg/ha between 1980 and 1984 to about 851 kg/ha from 2014 to 2017 (FAO, 2017). Studies conducted by Kormawa et al. (2000) revealed that in Nigeria more urban households (72%) consume cowpea than any other grain legume, such as groundnut and soybean, an indication that there is a good domestic market, providing an important opportunity to increase incomes and employment and reduce poverty in rural areas. Despites its importance, cowpea production in the West African 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 West Africa (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 West Africa. The handbook is intended to guide farmers, extension personnel, students of agriculture in higher institutions, and researchers in Nigeria, Mali, Burkina Faso, Niger, Ghana, and other countries in West Africa 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, plow 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 Benomyl (50%) or Carbendazine, Captan, or Thiram at the rate of 3 g/kg (1 sachet) of seeds, or with Apron Plus at the rate of 10 g/4-5 kg of seeds (1 sachet), or Apron Star 42 Water Soluble (WS) at the rate of 10 g/8 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 West Africa, reproductive development is determined primarily by the response to photoperiod. Some genotypes are photoperiod- sensitive, while others are photoperiod-insensitive. Photoperiod is determined by daylength 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 mid-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. Breeders in West Africa 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 zones in West and Central Africa. With the effects of climate change, 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 WCA.

Agroecological zone	Commencement of rains	Rainfall duration	Cowpea growth habit	When to plant after rain 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
Forest Transition Zone	April	April–November	Indeterminate (medium and late maturity	First week of September

Choice of varieties

Select a variety that is suited to your agroecological 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 Burkina Faso, Ghana, Mali, Niger, and 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	
Striga infestation	*Striga* resistant	
Short rainfall (300500 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 to major pests and diseases	

Cowpea varieties recommended for some selected West Africa countries

Table 3. Cowpea varieties recommended for 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 *Fusarium* wilt and *Striga*, 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 *Striga*	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 *Striga*, 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 *Striga*. *Good for intercropping*	Sudan, and Northern Guinea savanna
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. *Good for intercropping*	Northern Guinea savanna
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 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 *Striga*	Sudan savanna and Sahelian region

Table 3. Contd.

Variety	Yield (t/ha)	Seed coat texture	Growth habit	Maturity	Other qualities	Agroecological zones
UAM14 130-20-4	2.2	Rough seed coat, brown color with brown helium, large seed size	Indeterminate	Medium (75–80 days)	Good for confectionary, Resistant to *Striga* and *Alectra. Good for intercropping*	Sudan and Guinea savanna
UAM14 127-20-	2.0	Rough seed coat, brown color with brown helium, large seed size	Indeterminate	Medium (75–80 days)	Good for confectionary, resistant to *Striga* and *Alectra, Good for intercropping*	Sudan and Guinea savannas
UAM14 123-18-3	2.0	Rough seed coat, brown color with brown helium, large seed size	Indeterminate	Medium (75–80 days)	Good for confectionary, resistant to *Striga* and *Alectra,*	Sudan and Guinea savannas
UAM14 126 19-2	2.5	Rough seed coat, white color with brown helium, large seed size	Indeterminate	Medium (75–80 days)	Good for confectionary, resistant to *Striga* and *Alectra.* Good for intercropping	Sudan and Guinea savannas
UAM15 127-1-7	2.0	Rough seed coat, brown color with brown helium, large seed size	Indeterminate	Medium (75–80 days)	Good for confectionary, resistant to *Striga* and *Alectra.* Good for intercropping	Sudan and Guinea savannas
UAM15 137-1-7	2.0	Rough seed coat, brown color with brown helium, large seed size	Indeterminate	Medium 75–80 days)	Good for confectionary, resistant to *Striga* and *Alectra.* Good for intercropping	Sudan and Guinea savannas

Table 4. Cowpea varieties recommended for Burkina Faso.

Variety	Yield (t/ha)	Seed coat texture	Growth habit	Maturity	Other qualities	Agroecological zones
KV442-3-25SH (Komcalle)	1.8	Rough seed coat, white color	Determinate	60–65days	Large seed size, resistant to *Striga*	All
KVx775-33-2G (Tiligre)	2	Rough seed coat, white color	Determinate	70–75 days	Large seed size, resistant to *Striga*	All
KVx771-10G (Nafi)	2	Rough seed coat, white color	Determinate	65–70 days	Large seed size, resistant to *Striga*	All
IT98K-205-8 (Niizwe)	1.2	Rough seed coat, white color	Determinate	60–65days	Large seed size, resistant to *Striga*	All
IT99K-573-2-1 (Yiisyande)	2	Rough seed coat, white color	Determinate	70–75 days	Large seed size, resistant to *Striga*	All
KVx 745-11P	0.8	Rough seed coat, white color	Determinate	70–75 days	Dual purpose (4 t/ha of fodder), resistant to *Striga*	All
KVx61-1	1.5	Rough seed coat, white color	Determinate	70–75 days	Good for confectionary, resistant to *Striga*	All
Gorom Local	1.5	Rough seed coat, brown color	Determinate	70–75 days	Good for confectionary, resistant to *Striga*	All

Table 5. Cowpea varieties recommended for Mali.

Variety	Fodder Yield (t/ha)	Grain Yield (t/ha)	Seed coat texture	Growth habit	Maturity	Other qualities	Agroecological zones
IT89KD-245 (Sangaraka)	1.5	3	Rough seed coat, white color with brown helium, large seed size	Indeterminate	Late (80–90 days)	Tolerant to drought, resistant to *Striga*, and adapted to intercropping,	Southern and Central region
IT93K-876-30 (Fakson)	1-1.5	Low	Rough seed coat, white color with black helium, medium seed size	Determinate	Medium (70–75 days)	Tolerant to drought, resistant to *Striga*, short cooking time	Northern and Central region
IT93K-876-12	1-1.5	Low	Rough seed coat, white color with black helium, medium seed size	Determinate	Medium (70–75 days)	Tolerant to drought, resistant to *Striga*, short cooking time	Northern, Central and Sahel region
IT89KD-374 (Korobalen)	1.5-2	Low	Rough seed coat, white color with brown helium, medium seed size	Determinate	Early (70–75 days)	Tolerant to drought, resistant to *Striga,* short cooking time	Northern, Central and Sahel region
IT90K-372-1-2 (Wilibali)	1.5	Low	Rough seed coat, white color with large brown helium, medium seed size	Determinate	Medium (70–75 days)	Tolerant to drought, short cooking time, resistant to *Striga*	Northern, Central and Sahel region
IT97K-499-35 (Jiguiya)	1-1.5	Low	Rough seed coat, white color with brown helium, small seed size	Determinate	Early (65–70 days)	Resistant to *Striga*	Northern, Central and Sahel region
PBL 112 (Dunan fana)	1.5-2	3-4	Rough seed coat, white color with black helium, large seed size	Indeterminate	Early (110–120 days)	Tolerant to drought and photoperiod	Southern region
CZ1- 94- 23-2 (Gana Shoni)	1.5	1	Rough seed coat, white color with black helium, medium seed size	Determinate	Medium (70–75 days)	Tolerant to *Striga*	Northern and Central

Table 5. Contd.

Variety	Fodder Yield (t/ha)	Grain Yield (t/ha)	Seed coat texture	Growth habit	Maturity	Other qualities	Agroecological zones
CZ1- 94-23-1 (Gana Shoba)	1.5	1	Rough seed coat, white color with brown helium, large seed size	Determinate	Medium (70–75 days)	Tolerant to *Striga*	Northern and Central
CZ11-94-5C (Czna Télimani)	1.5	Low	Rough seed coat, brown color with black helium, medium seed size	Determinate	Medium (70–75 days)	Tolerant to drought, resistant to *Striga*	Northern, Central and Sahel region
CZ06-3-1 (Acar 1)	1.5-2	Low	Rough seed coat, white color with brown helium, medium seed size	Determinate	Early (65–70 days)	Tolerant to drought, resistant to *Striga*, short cooking time	Northern, Central and Sahel region
CZ06-2-17 (Simbo)	1.5-2	1	Rough seed coat, white color with brown helium, medium seed size	Determinate	Medium (65–75 days)	Short cooking time, and adapted to intercropping, resistant to *Striga*	Northern, Central and Sahel region
PRL 73 (Yèrè Wolo)	2.0	3-4	Rough seed coat, brown color with brown helium, large seed size	Indeterminate	Late (110–120 days)	Resistant to nematodes Adapted to intercropping	Southern region
IT99K-573-1-1	2.5	Low	Rough seed coat, white color with black helium, large seed size	Determinate	Early (65–70 days)	Tolerant to drought	Northern, Central and Sahel region
CZ06-1-12 (Jiguifa)	1.5-2	2	Rough seed coat, white color with brown helium, medium seed size	Determinate	Medium (70–75 days)	Short cooking time, and adapted to intercropping, resistant to *Striga*	Northern, Central and Sahel region
CZ06-4-16	1.5-2	2	Rough seed coat, white color with brown helium, medium seed size	Determinate	Medium (70–75 days)	Short cooking time, and adapted to intercropping, resistant to *Striga*	Northern, Central and Sahel region
CZ06-1-05	1.5	Low	Rough seed coat, white color with brown helium, medium seed size	Determinate	Medium (65–70 days)	Short cooking time, and adapted to intercropping, resistant to *Striga*	Northern, Central and Sahel region

Table 6. Cowpea varieties recommended for Ghana.

Variety	Yield (t/ha)	Seed coat texture	Growth habit	Maturity	Reaction to Striga	Other qualities	Agroecological zones
Zaayura- Pali	2.5	Rough seed coat, white	Indeterminate	Medium (70–75 days)	Susceptible	Resistant to aphid and high fodder yield	Transition, Guinea and Sudan savanna ecologies
IT99K-573-1-1 (Wang-Kae)	2.4	Rough seed coat, white	Determinate	Medium maturity (70–75 days)	Resistant	Resistant to aphid, moderately tolerant to drought, short cooking time and tolerant to most of the diseases	Transition, Guinea and Sudan savanna ecologies
IT99K-573-2-1 (Kirkhouse Benga)	2.4	Rough seed coat, white	Determinate	Medium (70–75 days)	Resistant	Resistant to aphid, moderately tolerant to drought, short cooking time and tolerant to most of the diseases	Transition, Guinea and Sudan savanna ecologies
IT97K-499-35 (Songotra)	2.2	Rough seed coat, white	Determinate	Medium (70–75 days)	Resistant	Moderately tolerant to drought, short cooking time	Transition, Guinea and Sudan savanna ecologies
Padi-Tuya	2.4	Rough seed coat, white	Indeterminate	Medium (70–75 days)	Susceptible	Short cooking time and high fodder yield	Transition, Guinea and Sudan savanna ecologies
Zaayura	2.4	Rough seed coat, white	Indeterminate	Medium (70–75 days)	Susceptible	High fodder yield	Transition, Guinea and Sudan savanna ecologies
Soo-Sima	2.5	Rough seed coat, white	Indeterminate	Medium (70–75 days)	Susceptible	Resistance to aphid and high fodder yield	Transition, Guinea and Sudan savanna ecologies
Bawutawuta	1.8	Rough seed coat, white	Determinate	Medium (70–75 days)	Susceptible	Tolerance to drought	Transition, Guinea and Sudan savanna ecologies
Apagbaala	2.0	Rough seed coat, white	Determinate	Early (65–70 days)	Susceptible	Modestly tolerant to drought	Transition, Guinea and Sudan savanna ecologies
Diffeele	2.2	Smooth seed coat white	Indeterminate	Medium (70–75 days)	Susceptible	Resistant to aphid and high fodder yield	Transition, Guinea and Sudan savanna ecologies

Table 7. Cowpea varieties recommended for Niger Republic.

Variety	Seed coat texture	Maturity	Other qualities	Ecological zone
IT99K-573-1-1	Rough seed coat, white color with brown helium. Semi-indeterminate.	Medium maturity (70–75 days)	Multiple disease resistance especially to fusarium, tolerant to drought, and resistant to *Striga* and *Alectra*	Northern Guinea savanna, Sudan savanna and Sahelian agro-ecologies
IT99K-573-2-1	Rough seed coat, white color with brown helium. Semi-indeterminate	Medium maturity (70–75 days)	Resistant to *Alectra*, tolerant to *Striga* and drought	Northern Guinea savanna, Sudan savanna and Sahelian agro-ecologies
IT98K-205-8	Rough seed coat, white color with brown helium. Semi-indeterminate	Medium maturity (70–75 days)	Resistant to *Alectra*, tolerant to *Striga* and drought	Northern Guinea savanna, Sudan savanna and Sahelian agroecologies
IT89KD-374-57	White seeds with brown helium, semi-indeterminate. Grain yield: 1.5 t/ha	Medium maturity (70–75 days)	Tolérant to aphids and drought, susceptible to *Striga, Thrips,* and *Bruchids*	Sahel
IT90K-372-1-2	White seeds with brown helium, semi-indeterminate. Grain yield: 1.5 t/ha	Medium maturity (70–75 days)	Resistant to aphids and drought, susceptible to *Striga, Thrips,* and *Bruchids*	Sahel agroecological zone (300 to 600 mm)
IT96D-610	Brown seed color, Erect. Mean grain yield: 1.5 t/ha	Extra–early maturing (55–60 days)	Tolerant to drought, susceptible to *Striga* and *Bruchids*	Sahel agroecological zone (250 to 600 mm)
IT97K499-38	White seeds with black helium, semi-indeterminate. Mean grain yield: 1 t/ha	Early maturing (60–65 days)	Tolerant to *Striga* and drought, susceptible to aphids and pod sucking bugs	Sahel agroecological zone (250 to 600 mm)
IT97K499-35	White seeds with black helium, semi-indeterminate. Mean grain yield: 1 t/ha	Early maturing (60–65 days)	Tolerant to *Striga* and drought, susceptible to aphids and pod sucking bugs	Sahel agroecological zone (250 to 600 mm)
UAM09 1055-6 (Dan hajia)	White seed with brown helium, erect, mean grain yield 1.5 t/ha	Early maturing 55-60 days	Tolerant to *Striga* and Alectra	Sahel agroecological zone (250 to 600 mm)

Table 7. Contd.

Variety	Seed coat texture	Maturity	Other qualities	Ecological zone
KVX 30-309-6G	White-brownish seeds with brown helium. Semi-prostrate, good fodder production, adapted to mixed cropping. Mean grain yield: 1 t/ha	Medium maturing (75 days)	Resistant to bacterial blight and drought, susceptible to aphids, *Striga, bruchids,* and *thrips*	Sudan savanna and Sahel agroecological zone (300 to 800 mm)
TN121-80	White -brownish seeds with brown helium Semi-prostrate, adapted to mixed cropping Mean grain yield: 1.5 t/ha	Medium maturing (75–80 days)	Resistant to *Striga* susceptible to *aphids, bruchids*, stem borers, and bugs	Sahel agroecological zone
TN256-87	White seeds. Semi-prostrate, adapted to mixed cropping Mean grain yield: 1.5 t/ha	Medium maturing (75–80 days)	Susceptible to *Striga, aphids, bruchids,* highly susceptible to bacterial blight	Sahel agroecological zone
TN27-80	White seeds with brown spots. Semi-prostrate, adapted to mixed cropping Mean grain yield: 1.5 t/ha	Medium maturing (75–80 days)	Susceptible to *Striga, aphids, bruchids*, pod sucking bugs, and fungi	Sahel agroecological zone
TN28-87	White seeds with brown spots. Semi-prostrate, adapted to mixed cropping Mean grain yield: 1.5 t/ha	Medium maturing (75–80 days)	Susceptible to *Striga, aphids, bruchids,* and *thrips*	Sahel agroecological zone

Table 7. Contd.

Variety	Seed coat texture	Maturity	Other qualities	Ecological zone
TN3-78	White seeds with brown helium. Semi-prostrate, adapted to mixed cropping. Mean grain yield: 1.5 t/ha	Late maturing (80–85 days)	Late maturing (80-85 days), Susceptible to *striga, aphids, bruchids,* and *thrips*	Sahel agroecological zone
TN5-78	Brown seeds. Semi-prostrate, good fodder production. Mean grain yield: 1.5 t/ha	Medium maturing (75–80 days)	Resistant to bacterial blight, seed rot, *Striga*, and drought, Susceptible to *aphids, bruchids,* and *thrips*	Sahel agroecological zone
TN88-63	White seeds with black helium. Semi-prostrate. Mean grain yield: 1.5 t/ha	Medium maturing (75–80 days)	Resistant to bacterial blight, seed rot, day neutral, tolerant to *Striga* and drought, Susceptible to *aphids* and *bruchids*	Sahel agroecological zone
HTR	White seeds with dark brown helium. Prostrate. Mean grain yield: 1.5 t/ha	Medium maturing (75–80 days)	Resistant to *Striga* race of western Niger, good level of tolerance to drought; susceptible to *Striga* race of Maradi, Zinder, and Kano, Susceptible to *Macrophomina phaseolina*	Sahel agroecological zone

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 maturing and extra-early varieties (55–75 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 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 flat beds, depending upon the field preparation. Planting can be done manually or mechanical planters can be used if available.

Seed requirement

About 15–30 kg of seeds, depending on the variety, seed size, and cropping system, are 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 8. 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 *mudus*)
Semi-erect	Indeterminate	Early and medium	Sole	75 cm between rows and 30 cm within rows (75 × 30 cm)	20 kg (8 *mudus*)
Semi-erect	Indeterminate	Early and medium	Intercrop	75 cm between rows and 25 cm within cereal stands (75 × 25 cm)	30 kg (12 *mudus*)
Prostrate	Indeterminate	Medium and late	Sole/ intercrop	75 cm between rows and 50 cm within rows (75 × 50 cm)	15 kg (6 *mudus*)

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 4–6 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 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 9 presents the recommended rate of fertilizer for cowpea production. However, a soil test is the best way to determine soil nutrient levels.

Table 9. 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 ($P_2 0_5$)	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	Phosphorus is not mobile in the soil. It is, therefore, necessary that P is placed 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 ($H_2 P0_4$) 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 and sedges and the broadleaf types. These compete with desired crop plants for light, water, nutrients, and space. Generally, infestation as a serious problem in cowpea production and is more severe at the initial period (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. The type of weed control measures that is adopted should be based on the nature of the problem and the resources available to the farmer; it could be applied during pre-planting or immediately after planting. At present, the most commonly employed methods to control weeds in cowpea are manual, mechanical, or chemical. Adequate weed control is necessary for good growth and high yields.

Manual control: Manual weed control is the most common method used by farmers in cowpea production. 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 field situation. Poor weed control or delay in weeding causes 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 10 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. Application is recommended of a mixture of Paraquat (300 ml) and Pendimethalin, Stomp, or Butachlor (200–250 ml) depending on the soil type in a tank of 20 liter capacity applied immediately after planting or the following day. Paraquat 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 10. Some recommended herbicides and application rates for weed control in cowpea.

Product trade name	Brand or common name	Liters/hectare (L/ha)	Quantity per sprayer load	Conditions of use	Remarks
Paraquat (For total weed control	Gramoxone, Paraquat, Proxone, Weedex, Weedof, Slasher, Agroxone, Dizmazone, Paraforce, etc	34 liters	250–350 ml in 15-L sprayer or 350–450 ml in 20 liter knapsack sprayer	Contact herbicide. Apply on non-cultivated land or before planting	Plant after the weed is burnt. Do not mix Gramoxone with glyphosate for use
Glyphosate (For total weed control	Round-up, Kill-off, Touch-down, Delsate, Sarosate, Glycel, Force-up, Cleenweed, Glyphosate, Rhonasate	4 liters	300 ml in 15-L or 450 ml in 20-L sprayer	Systemic herbicide. Apply on emerged weeds before land preparation	Apply where difficult weeds such as sedges are common. Wait for 10 days after application before preparing the land and plant with or without land preparation
Pendimenthalin (Used as pre-emergence and post-emergence to control annual broadleaf weeds, grasses, and sedges)	Stomp@440, Pendelin	2 liters in light sandy soils, 3 liters in sandy clay loam, 4 liters in sandy clay	150–350 ml in 15-L knapsack sprayer or 200-450 ml in 20-L knapsack sprayer	Apply immediately after planting or a day later but before weeds emerge	Apply where difficult weeds such as *Rottboellia* are common. Controls *Rottboellia.* Do not plant or replant any crop other than those mentioned for one year after application
Paraquat plus pendimenthalin (500 EC) (For pre-plant and pre-emergence weed control	Same as above	3 liters of Paraquat plus 3 liters of Pendimenthalin	250 ml Paraquat plus 250 ml Pendimenthalin in 15- liter sprayer or 350 ml of Paraquat plus 350 ml of Pendimenthalin in 20-L sprayer	Same as above	Apply immediately after planting or the next day
Paraquart plus Butachlor. For pre-plant and pre-emergence weed control	Paraquat: same as above Butachlor: Teer, Butaforce, Butaclear, Butacrop, Butarice, Risene, Butacot, etc	3 liters of Paraquat plus 4 liters of Butachlor	250 ml Paraquat plus 350 ml Butachlor in 15-L sprayer or 350 ml Paraquat plus 450 ml Butachlor in 20-L sprayer	Same as above	Apply immediately after planting or the next day
Paraquat plus Dual Gold (Control pre-plant and pre-emergent weeds	Paraquat: same as above Dual Gold	3 liters of Paraquat plus 2 liters of Dual Gold	250 ml Paraquat plus 200 ml Dual Gold in 15-L sprayer or 350 ml Paraquat plus 250 ml Dual Gold in 20-L sprayer	Same as above	Apply immediately after planting or the next day

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 West Africa. *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 region. 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 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* are available in the West Africa sub-region.

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 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 diseases of cowpea in the northern and Guinea savanna zones of West Africa. Most of the CLS damage 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 rainy season of relatively hot conditions and high humidity.

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 grain yield losses of more than 64-100% in some areas of West Africa. 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 shrivelling. 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 application of chemicals Cultivation of resistant cowpea varieties is the most promising strategy to control the disease.

Bacterial blight infected cowpea leaves.

Virus diseases

Cowpea are 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, severe reduction in leaf size, and stunting of plants resulting in yield losses ranging from 10 to 100%. Mixed infection with more than one virus is common under field conditions. Seven viruses are recognized to infect cowpea in West Africa. 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 West Africa, 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 which 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 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 honey dew 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 development of aphid populations. Chemical control can be effective when appropriate chemical insecticides are used. See Table 10 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 10 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% in different parts of West Africa. Current management of *thrips* relies on chemical control with insecticides or the use of a tolerant variety. See Table 10 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, that 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 stem, peduncles, flower buds, flowers, pods, and seeds. The damage symptom is the holes from feeding bored on the buds, flowers, or pods. 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 10 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 10 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, and 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 a 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 10.

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 seedling stage, 14–21 days after planting using “Imiforce” insecticide. Other recommended insecticides and the application rates are presented in Table 10.

Second spraying: Conduct the second spraying 10 days afterwards 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 10.

Third spraying: Conduct the third spraying when necessary, 10 days after the second spraying for medium varieties and when there is 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 10.

Table 11. Some recommended insecticides for control of insect pests in cowpea.

Product trade name	Brand or common name	Application rate	Estimate for one sprayer load	Mode of action	Remarks
Lamda-cyhalothrin 2.5% EC (Insecticide) Lamda-Cyhalothrin Glysprin	Karate 2.5 EC, Kartodim 315EC	0.4– 0.8 L/ha 0.8–1 L/ha	35–70 ml in 15-L sprayer or 50-80 ml in 20-L sprayer 50–60 ml in 15-L knapsack sprayer or 70-80 ml in 20-L knapsack sprayer	Contact and stomach insecticide Systemic action	Controls flying and soil-dwelling insects such as whiteflies and *aphids* Controls sucking pests such *Maruca* and pod sucking bugs
Perfekthion	Rogor	1–1.5 L/ha	60–80 ml in 15-L sprayer or 80-100 ml in 20-L sprayer	Systemic action	Controls plant sucking insects such as *Maruca* and pod sucking bugs
Lambda-Cyhalothrin + Chlorantraniliprole	Ampligo	12 sachets (180 ml)/ha	1 sachet (15 ml) in 20-L knapsack sprayer	Contact and systemic action	Controls sucking and chewing insects such *Maruca* and pod sucking bugs
Cypermethrin plus Dimethoate insecticide	Best Action, Cyperdiforce, Superplus, Sherpaplus		80–100 mL in 15-L sprayer or 100-120 ml in 20-L sprayer	Systemic action	Controls plant sucking insects such *Maruca* and pod sucking bugs
Profenofos plus Cypermethrin	Sharp Shooter	1-1.5 L/ha	100–120 ml in 20-L knapsack sprayer depending on severity of infestation	Broad spectrum	Kills insects such as *aphids, thrips,* whiteflies. and *Maruca*
Imidaclorid	ImiForce 220 GL SL (comes in 250 ml plastic bottles)		15 ml in 15-L knapsack sprayer or 20 ml in 20-L sprayer	Systemic action as well as contact and stomach poison	Active against *aphids* 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 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 most common methods of applying insecticides are the following:

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

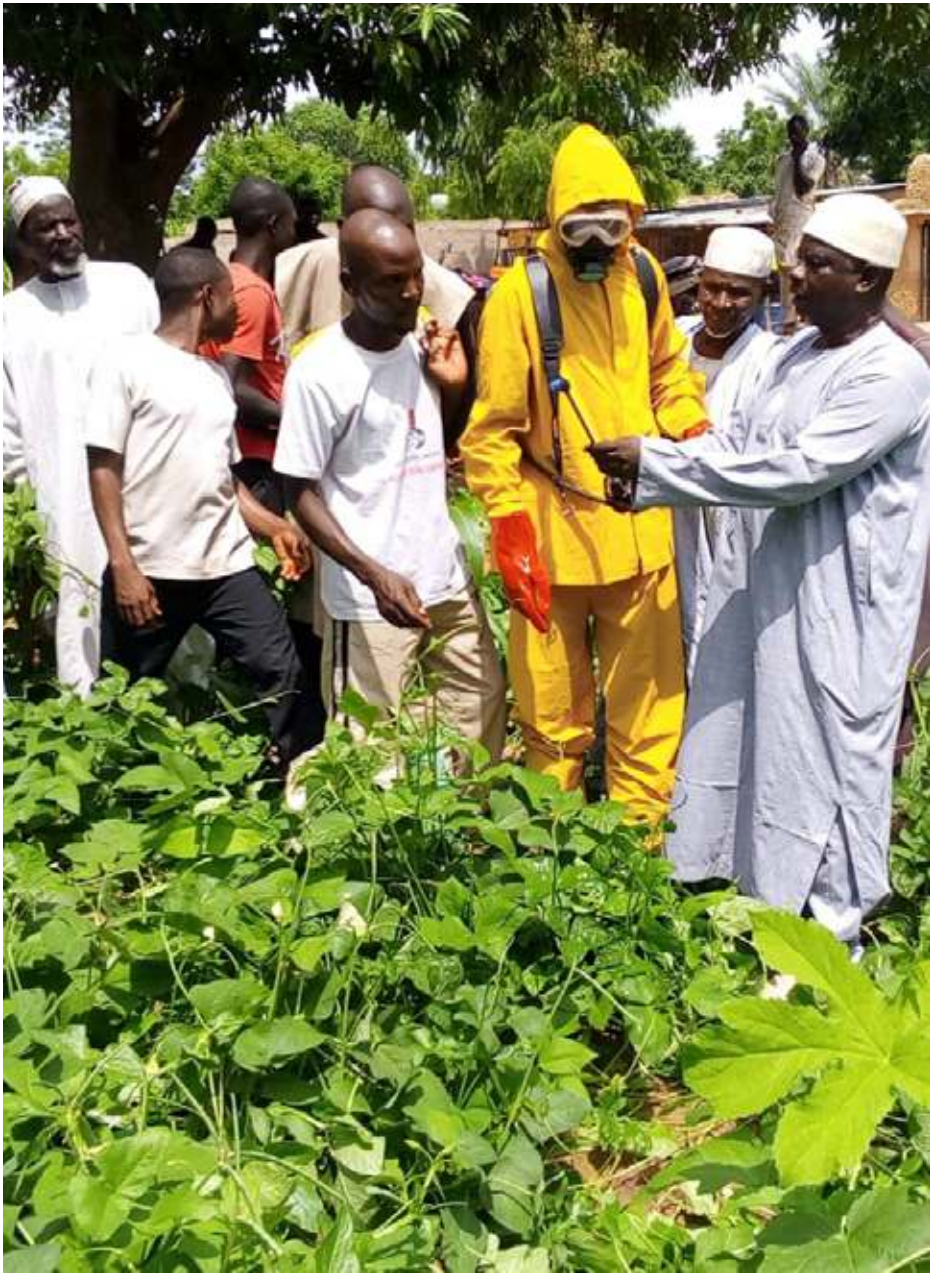

Figure 4. A Research officer giving instruction on type of nozzle to use.

- 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 also can 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 measures to be taken in the event of swallowing or 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 applying a product inadvertently. 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 especially dug 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 a hilly area the hole should be dug on the lower side of such areas.

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 tears or worn 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 for dry seeds

Cowpea must be harvested as soon as the pods are fully mature and dry to avoid infestation in the field because most of the storage pests are field-to-store pests. Harvesting is done by hand picking the pods (Fig. 5a). 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. 5b). Thereafter, thresh the pods and winnow to separate the seeds from the chaff or haulms. The seeds are further cleaned to remove debris and broken ones and packed in plastic bags for storage.

Figure 5. Harvesting mature pods of IT90K 277–2.

Figure 6. Sun-drying of harvested cowpea pods 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 7b) 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 field-to-store pest; 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 characteristic holes made by the larvae. The holes 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 *mudu* (1 kg) of grain. Store seeds in polythene triple bagging, hermetic storage, and keep rodents away.

Long-time storage for seeds and grains 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 West, Central and East Africa 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 grains 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. Fumigants are gases and therefore self-dispersing and non-persistent. The fumigant can provide protection for up to six months, provided the storage container is airtight. For dust formulation, Pirimiphos Methyl (Actellic) can be used for cowpea, at a rate of 200–500 g per 1000 kg grain. Dust is a mixture of insecticide with inert powder. It is mixed with the grain at the time of storage before the produce is bagged. The produce to be mixed with the dust insecticide must be dry and evenly mixed. Dust can also be used on floors around the bottom and top of the storage containers. When properly used, dust insecticide could provide protection for between 6 and 9 months. After storage the produce must be thoroughly cleaned of the dust or exposed to the sun before it can be used for consumption. Actellic EC can be mixed with water to be sprayed on grain prior to storage at the rate of 0.5–1 liter in 5–10 liters of water per 1000 kg of grains. The grain must be thoroughly mixed with the spray liquid and properly dried before being bagged for storage.

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 or animal house.
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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