Alternative Field Crops Manual

University of Wisconsin-Extension, Cooperative Extension
University of Minnesota: Center for Alternative Plant & Animal Products and the Minnesota Extension Service

Cowpea

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I. History:

Cowpea (*Vigna unguiculata* L. Walp.), an annual legume, is also commonly referred to as southern pea, blackeye pea, crowder pea, lubia, niebe, coupe or frijole. Cowpea originated in Africa and is widely grown in Africa, Latin America, Southeast Asia and in the southern United States. It is chiefly used as a grain crop, for animal fodder, or as a vegetable. The history of cowpea dates to ancient West African cereal farming, 5 to 6 thousand years ago, where it was closely associated with the cultivation of sorghum and pearl millet.

Wordwide cowpea production has increased dramatically in the last 25 years. United States production of dry cowpea has declined from 3/4 million acres to a few thousand over the same period. The blackeyed cowpea type is grown primarily in California and is marketed as California blackeyed peas.

II. Uses:

Cowpea seed is a nutritious component in the human diet, as well as a nutritious livestock feed. Nutrient content of cowpea seed is summarized in Table 1.

Table 1. Nutrient content of mature cowpea seed (average of eight varieties).

Protein	24.8%
Fat	1.9%
Fiber	6.3%

Carbohydrate	63.6%
Thiamine	0.00074%
Riboflavin	0.00042%
Niacin	0.00281%

[1]From Bressani R. Chap. 28 in Cowpea Research, Production and Utilization, Wiley and Sons.

The protein in cowpea seed is rich in the amino acids, lysine and tryptophan, compared to cereal grains; however, it is deficient in methionine and cystine when compared to animal proteins. Therefore, cowpea seed is valued as a nutritional supplement to cereals and an extender of animal proteins.

Cowpea can be used at all stages of growth as a vegetable crop. The tender green leaves are an important food source in Africa and are prepared as a pot herb, like spinach. Immature snapped pods are used in the same way as snapbeans, often being mixed with other foods. Green cowpea seeds are boiled as a fresh vegetable, or may be canned or frozen. Dry mature seeds are also suitable for boiling and canning.

In many areas of the world, the cowpea is the only available high quality legume hay for livestock feed. Digestibility and yield of certain cultivars have been shown to be comparable to alfalfa. Cowpea may be used green or as dry fodder. It also is used as a green manure crop, a nitrogen fixing crop, or for erosion control. Similar to other grain legumes, cowpea contains trypsin inhibitors which limit protein utilization.

III. Growth Habits:

Cowpea is a warm-season, annual, herbaceous legume. 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. Cowpea generally is strongly taprooted. Root depth has been measured at 95 in. 8 weeks after seeding.

Cowpea seed ranges in size from the very small wild types up to nearly 14 in. long and the number of seeds per pounds range from 1600 to 4300. Seed shape is a major characteristic correlated with seed development in the pod. Seeds develop a kidney shape if not restricted within the pod. When seed growth is restricted by the pod the seed becomes progressively more globular.

The seed coat can be either smooth or wrinkled and of various colors including white, cream, green, buff, red, brown, and black. Seed may also be speckled. mottled, or blotchy. Many are also referred to as "eyed" (blackeye, pinkeye purple hull, etc.) where the white colored hilum is surrounded by another color.

Emergence is epigeal (similar to common bean, and lupin) 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.

The trifoliolate leaves develop alternately. Leaves are smooth, dull to shiny, and rarely pubescent. Commonly, the terminal leaflet is longer and larger than the lateral leaflets. There is a wide range in leaf size and shape.

Cowpea generally is day neutral. Flowers are borne in multiple racemes on 8 to 20 in. flower stalks (peduncles) that arise from the leaf axil. Two or three pods per peduncle are common and often four or more pods are carried on a single peduncle. The presence of these long peduncles is a distinguishing feature of cowpea and this characteristic also facilitates harvest. The open display of flowers above the foliage and the presence of floral nectaries contribute to the attraction of insects. Cowpea primarily is self pollinating.

Cowpea pods are smooth, 6 to 10 in. long, cylindrical and generally somewhat curved. As the seeds approach the green-mature stage for use as a vegetable, pod color may be distinctive, most commonly green. yellow or purple. As the seeds dry, pod color of the green and yellow types becomes tan or brown.

IV. Environment Requirements:

A. Climate:

Cowpea is a warm-season crop well adapted to many areas of the humid tropics and temperate zones. It tolerates heat and dry conditions, but is intolerant of frost. Germination is rapid at temperatures above 65°F; colder temperatures slow germination.

Cowpeas are grown under both irrigated and non-irrigated regimes. The crop responds positively to irrigation but will also produce well under dryland conditions. Cowpea is more drought resistant than common bean. Drought resistance is one reason that cowpea is such an important crop in many underdeveloped parts of the world. If irrigation is used, more vegetative growth and some delay in maturity may result. Application rates should insure that the crop is not overwatered, especially in more northern latitudes, as this will suppress growth by lowering soil temperatures. The most critical moisture requiring period is just prior to and during bloom.

B. Soil:

Cowpea performs well on a wide variety of soils and soil conditions, but performs best on well-drained sandy loams or sandy soils where soil pH is in the range of 5.5 to 6.5.

V. Cultural Practices:

A. Seedbed Preparation:

Soils should be cultivated deeply enough to insure that no barrier to penetration of the soil by the taproot (such as a hardpan) exists. Cowpea may be adversely affected by soil crusting under certain soil and environmental conditions.

B. Seeding Date:

Cowpea should not be planted until soil temperatures are consistently above 65°F and soil moisture is adequate for germination and growth. Seeds will decay in cool, wet soils. In the Minnesota-Wisconsin area, optimum seeding dates usually correspond to those for fieldbean (May 15-30).

C. Method and Rate of Seeding:

Traditionally, cowpea in the United States has been seeded in rows spaced 30 to 36 in. apart with seeds spaced 2 to 4 in. in the row. Recently, higher plant populations achieved by using narrow rows 12 to 20 in. have been used in commercial plantings. For forage purposes, the crop may be seeded in rows or broadcast (solid-seeded). Seed should be planted 1 to 1 1/2 in. deep and good seed-soil contact is important. The amount of seed to sow per acre depends on seed weight, germination percentage, and plant spacing. Recommended field seeding rates range from 18 to 22 lb/acre for viney, indeterminate types to 40 to 50 lbs for large-seeded determinate types. Optimum plant spacing depends on vine type. Highly determinate types may be planted 2 to 3 in. apart. Viney indeterminate types require more space, and a final stand with 8 to 9 in. between plants in 30 in. rows is considered to be a minimally acceptable population.

D. Fertility and Lime Requirements:

Cowpea, like all legumes, forms a symbiotic relationship with a specific soil bacterium (*Rhizobium* spp.). *Rhizobium* makes atmospheric nitrogen available to the plant by a process called nitrogen fixation. Fixation occurs in root nodules of the plant and the bacteria utilize sugars produced by the plant. Although cowpea *Rhizobium* is normally widespread, seed inoculation with *Rhizobium* specific to cowpea would be beneficial in areas where it is not present. Always use *Rhizobium* of the cowpea type.

Excess nitrogen (N) promotes lush vegetative growth, delays maturity, may reduce seed yield and may suppress nitrogen fixation. The plant will perform well under low N conditions due to a high capacity for N fixation. A starter N rate of around 27 lb/acre is sometimes required for early plant development on low-N soils.

A soil test is the best way to determine soil nutrient levels. In general, at least 27 lb P/acre and 40 lb K/acre are. recommended on soils of medium fertility but individual soils will vary in fertilizer requirements. Band fertilizer 3 to 4 in. deep and 2 to 3 in. away from the seed, or broadcast and disc in all fertilizer, including nitrogen, before planting.

E. Variety Selection:

The International Institute for Tropical Agriculture (IITA) in lbadan, Nigeria is the center for world-wide collection and testing of cowpea germplasm. The Institute has developed high yielding, short season, multiple disease-resistant varieties that are ready for harvest in 60 days. Several of the U.S. State Agricultural Experiment Stations conduct cowpea variety development programs. Cowpea researchers at the University of Minnesota have released two extra-early-maturing varieties, MN 13 and MN 150 (Table 3). Crude protein and digestibility of the whole plant are reported to be similar to alfalfa with yields ranging from 1.3 to 1.8 ton/acre after 60 days of growth.

Table 2. Dry-matter yields of cowpea cultivars and breeding Hues grown under two plant populations in 1981 and 1992 at Becker and Waseca, Minnesota.[1]

Cultivar	Plant Population (1000 plants/acre)			
	53		106	
	1981	1982	1981	1982
	(lb/acre)			
Colossus	3000	2580	2968	2525
MN139	1746	-	2402	-
Au704	2475	-	3659	-
Calif. Blackeye #5	2745	2483	3775	3312
Alabama Giant Blackeye	2215	-	3165	-
Freezegreen	1753	-	1996	-
MN150	-	1598	-	2050
LSD 5%	442	NS	442	NS

[1]From Marsh, D.B., L. Wawa. and G. C. Martin, HortScience 22(2~241-243.

Cowpeas have been grouped into the following market classes based on seed type and color:

Black eye and purple eye—The immature pods shell easily because the hull (pod wall) is pliable and the seeds come out of the pod clean and free. The shelled peas are attractive, mild flavored and suitable for processing. The white hilum is surrounded by black, pink, or light-red.

Brown eye—Pods vary in color from green to lavender and have a wide range of lengths. The immature seeds, when cooked, are a medium to dark brown color, very tender, and have a delicate flavor.

Crowder—Seeds are closely crowded in the pods and tend to be globular in shape.

Cream—Seeds of these types are generally cream colored and have no noticeable "eye" (the hilum is inconspicuous).

Clay—These are generally older varieties that are medium to dark brown in color and kidney shaped. They are no longer commonly grown.

White acre—The peas are kidney shaped with a blunt end. This type is a semi-crowder, generally tan in color and somewhat small. Pods are quite stiff.

Table 3. Days to harvest, seed type, seed yield-, and canopy size of cowpea cultivars on an irrigated sandy loam, Becker, Minn., 1993.

Entry	Days to harvest	Seed type	Seed yield[1] (lb/acre)	Weight of 100-seed (g)	Canopy ht (in.)	Canopy width (in.)
MN 13	96	Holstein	2001	15.7	22	18
MN 150	96	Calico	1951	15.0	25	21
Calhoun P. Hull	116	Calico	1783	17.0	21	45+
Colossus	116	Brown	1640	28.4	19	33
Pinkeye P. Hull	116	Blackeye	1152	16.9	15	45+
Mississippi Silver[2]	-	Brown	-	-	22	45+
Texas Cream 82		Cream			17	45+
Calif Blackeye #5[2]		Blackeve			22	59+

[1]Yield is dry seed average weights of 3 single row, 20 ft. plots for each entry. Rows were spaced 30 in. apart. Pods were air-dried for 2 months before threshing and weighing.
[2]These cultivars did not reach pod and seed maturity before Frost.

F. Weed Control:

Adequate weed control is necessary for good growth and high yields.

1. Mechanical: Use of the rotary hoe and row cultivator in cowpea is similar to that of soybean. One or two rotary hoeings followed by timely cultivation should be done when no herbicides are used. One or more cultivations should also be done when herbicides are used.

2. Chemical: The term " cowpea" is not found on most herbicide labels. Rather, the crop is referred to as blackeyed peas, southern peas, pinkeyed peas or crowder peas. Farmers planning on producing cowpeas should check with their State Agricultural Extension Service for advice on chemical weed control.

G. Diseases and their Control:

Root rot and damping off are caused by three different fungi. Symptoms vary and include rapid death of young succulent plants, discoloration of taproots, longitudinal cracks of the stems, stunting, wilting and poor yields. Complete control of root rot and damping off is difficult, and no variety of cowpea is resistant to root rot. Persistent damp weather prior to development of the first true leaf and also the crowding of seedlings due to poor seed spacing may increase damping off. The following control practices help reduce losses from these diseases:

Fungal and viral diseases can be reduced by:

- treating high quality seed with fungicides labeled for cowpeas.
- applying cowpea-labeled fungicides in the furrow.
- avoiding throwing soil against plant steins during cultivation.
- a four or five year rotation with other crops.
- seeding into warm, well-prepared soils.

- planting certified seed of resistant varieties.
- controlling weeds.
- the removal of virus-affected plants.

Southern blight is caused by a fungus that attacks roots and stems of cowpeas. The occurrence of southern blight is not restricted to the South. The first visible symptom of southern blight is a progressive, yellowing and wilting of the foliage beginning on the lower leaves. The plant dies within a few days after the rust symptoms appear. A brownish vascular discoloration inside die stem may extend several inches above the soil line. During warm, moist conditions, the coarse, white mycelium of the fungus makes characteristic fan-shaped patterns of growth on the stem at the soil line. In this white-mat of the fungus, numerous smooth, round, light-tan to dark-brown mustard seed-like bodies called sclerotia are formed. In addition to the cultural practices listed above, bury previous crop debris and the sclerotia, at least 6 in. deep as far ahead of planting as possible.

Several viruses can attack cowpea. A characteristic symptom of the mosaic virus disease is an intermixing of light and dark-brown areas. Mottled areas are irregular in outline and may follow the main veins. Infected leaves are generally smaller than healthy ones, and often there is a slight puckering and curling of leaf edges. Infected plants usually are more dwarfed and bushy and yields are reduced. Mosaic diseases can also result in malformed pods. Plants infected during seedling stages may be barren and fail to produce. The best way to prevent large yield losses from virus diseases is to grow tolerant varieties.

Fusarium wilt usually causes the lower leaves on one side of the plant to turn yellow. Infected plants usually are stunted and wilted as the organism develops in the food and water conducting tissues. Brick red tissue can be observed in the stem when it is split lengthwise. The best control of Fusarium wilt is the use of resistant varieties. When resistant varieties are not used, it is important that root-knot nematode control practices be followed since nematodes increase plant susceptibility to Fusarium wilt.

H. Insects and Other Predators and Their Control:

Root-knot nematodes cause the root to appear knotted and galled. Above ground nematode symptoms appear as nutrient deficiencies, with stunting and often wilting because the root system is incapable of absorbing adequate amounts of water and nutrients. Do not confuse nematode root symptoms with the nodules of nitrogen fixing bacteria. Nodules are attached to sides of roots, and galls are within the roots. Root-knot nematodes can also be harmful to the cowpea because root injuries make the plants much more susceptible to attack by Fusarium wilt. In addition to detecting the presence of nematodes by observing galled roots, they can be detected by a soil test for nematodes. If nematodes are present certain practices help reduce nematode populations. These practices include crop rotation, fallowing, sanitation, weed control, and planting resistant varieties.

Cowpea curculio is a small weevil that causes blister-like spots on the surface of the pod. These spots result from adults puncturing the pod to feed on or to lay eggs. Punctures from feeding result in small malformed peas, and the results of egg laying are many legless grubs that destroy developing peas.

Aphids are small, green, soft-bodied insects that feed by piercing the plant tissue and withdrawing plant juices. Infestations of this pest develop on leaves and the fruiting stems.

Their feeding, especially on the fruiting stem reduces the amount of plant nutrients available for pod and pea development. Infested foliage turns yellow and dies. Aphids excrete large quantities of a sugary substance called honey dew which supports the growth of sooty mold. Sooty mold, a fungus, is dark in color, which reduces the amount of sunlight that reaches the leaf. Mild damp weather favors development of aphid populations.

Green stink bugs cause damage by puncturing the pods and feeding on developing peas. In the Southern States, the lesser cornstalk borer and possibly other borers may be a problem, especially where cowpeas border fields of maturing corn or sorghum. Lesser cornstalk borer damage may be significantly reduced by clean cultivation at least two weeks prior to planting. In more northerly areas, some damage may be experienced from the European corn borer.

I. Harvesting:

Cowpea can be harvested at three different stages of maturity: green snaps, green-mature, and dry. Depending on temperature, fresh-market (green-mature) peas are ready for harvest 16 to 17 days after bloom (60 to 90 days after planting). Harvest date for green snap pods is normally specified by the processor. Mechanical harvest requires the use of a snap bean or green pea harvester. Most domestic cowpea production is mechanically harvested, however, hand harvested cowpeas suffer less damage and the harvest season may continue over a 1 to 3 week period. One person can hand harvest 12 to 20 bushels of cowpea pods per day. Cowpea pods are packed, 25 pounds net, in bushel hampers or mesh bags (not burlap sacks).

Mature green cowpeas are normally harvested mechanically by some type of mobile viner. Dry cowpeas may be windrowed to facilitate drying or straight combined using a small grain or soybean combine.

J. Drying and Storage:

Harvested green cowpeas will "heat" resulting in spoilage unless kept cool. Post-harvest, provide shade and adequate ventilation is necessary on the way to the cooler. Cowpeas cooled below 45¡F may show chilling injury.

Dry cowpea seed is cleaned, graded, fumigated and packed in small plastic bags for sale to consumers.

VI. Yield Potential and Performance Results:

Cowpea yield information from warmer climates, where the crop has been grown successfully, does not necessarily indicate a performance level that might be realized in the Upper Midwest. A comparison between Wisconsin-Minnesota-adapted and southern types is shown in Table 3. Seed yield potential under dryland and irrigated conditions for Minnesota compared with other crops is indicated in Table 4. These data indicate that other grain legumes such as soybean and common dry edible bean may outyield cowpea (for dry seed yield) under many conditions in the Upper Midwest, therefore the price of cowpea should be greater to compete in these crops. However, cowpea may be valued as an annual forage crop in these regions.

Table 4. Seed yield and characteristics of four cowpea selections compared with navybean, soybean, and adzuki bean at Rosemont and Becker, MN. 1984-85.

Cultivar	Days to Maturity	Height in.	Lodging (1-9)	Leaf retention (%)	Wt 100 seed (g)	Seed yield				
						Irrigated		Dryland		Average of 4 trials
						Becker 1984 (lb/acre)	Becker 1985 (lb/acre)	Becker 1995 (lb/acre)	Rosemont 1995	
82E9	117	17	1.5	28	17.9	1797	2192	1570	1352	1725
MN 1	110	16	2.8	16	10.8	2077	1609	1107	1392	1546
MN 7	112	16	2.9	16	10.7	2163	1791	1149	1673	1694
MN 9	110	15	1.8	is	11.4	2054	1685	1056	1553	1587
Fleetwood navybean	105	-		57	19.1	2907	3640	958	1657	2366
Evans soybean	128	-		0		3164	2499	2730	2910	2826
Takam adzuki	124	26	3.7	13	11.1	2929	4095	2378	1772	2794

[1]Data courtesy of R. O. Robinson, University of Minnesota Experiment Station.

Average yield data for cowpea grown in Texas, 1978 and 1979 respectively, showed significant variability, ranging from 625 and 1400 lb/acre for green cowpeas and 570 and 1000 lb/acre for dry seed.

Grading standards for mature-green cowpeas require that pods of similar varieties should be fairly well formed and filled, neither overmature nor excessively young. Pods should be free from decay, worm holes, scars, discoloration, wilting, dirt, or other material. U.S. No. 1 grade requires that 95% of the pods be at least 5 in. long. U.S. Commercial grade has no minimum length.

VII. Economics of Production and Markets:

An Upper Midwest market for fresh green or dry cowpeas has yet to be developed. Dry cowpea production are likely to incur costs similar to the costs of dry edible bean production. Fresh green cowpea requires a specialized pea harvester, therefore, growers may need a contractual relationship with a processor/harvester for those services. Small acreages of cowpea may be hand harvested and may find a niche in a specialty/gourmet market. Hand harvesting for a fresh green cowpea market will require substantially greater labor and management inputs. Prospective growers need to investigate potential markets prior to planting. The distance to market, availability of labor and short term storage along with vagaries of the market and of the grower's individual situation should be considered.

VIII. Information Sources:

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- Keys to Profitable Southern Pea Production 1981. Texas Agricultural Extension Service L-1862. Texas A & M University.
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Cowpea

Cowpea, *Vigna unguiculata* (L.) Walp., is a grain legume grown in savanna regions of the tropics and subtropics. The majority is grown in West and Central African countries. Its value lies in its high protein content, its ability to tolerate drought, and the fact that it fixes atmospheric nitrogen which allows it to grow on, and improve, poor soils.

In fresh form, the young leaves, immature pods, and peas are used as vegetables, while snacks and main meal dishes are prepared from the dried grain. All the plant parts that are used for food are nutritious, providing protein, vitamins, and minerals. Cowpea grain contains about 25% protein, making it extremely valuable where many people cannot afford protein foods such as meat and fish. After the cowpea pods have been harvested, the rest of the plant can be used as animal feed.

The ability of cowpea plants to tolerate drought and poor soils makes it an important crop in savanna regions where these constraints restrict other crops.

All of these factors make cowpea a vital crop to millions of resource-poor people. However,

it is very susceptible to pests and diseases, which reduce yields.

Statistics

FAO estimates that 3.3 million tonnes of cowpea dry grains were produced worldwide in 2000. Nigeria produced 2.1 million tonnes of this, making it the world's largest producer, followed by Niger (650 000 tonnes) and Mali (110 000 tonnes). Total area grown to cowpea was 9.8 million hectares, about 9.3 million hectares of these in West Africa. World average yield was 337 kg per hectare; average yield in Nigeria was 417 kg per hecatre, and in Niger was 171 kg per hectare.

How cowpea is grown

Traditionally in West and Central Africa, cowpea is grown on small farms, often intercropped with cereals such as millet and sorghum. Pesticides are generally not used, because they are too expensive or not available. The cowpea and cereal are usually planted in alternating rows, although recent research at IITA has shown that planting four rows of cowpea to two rows of cereal is more productive. The cereal is planted first, followed by the cowpea. The fast growth and spreading habit of traditional cowpea varieties suppress weeds, and soil nitrogen is increased which improves cereal growth. The two crops are harvested at different times, spreading available labor.

Constraints to cowpea production

The major pests attacking cowpea plants are flower thrips (*Megalurothrips sjostedti*), pod borer (*Maruca vitrata*), and pod sucking bugs. Storage weevils (*Callosobruchus maculatus*) damage stored cowpeas. Fungal diseases affecting cowpea include stem and root rots and leaf spot diseases. Viruses cause mosaic diseases and mottle symptoms in cowpea. The parasitic weed *Striga gesneroides* can severely damage cowpea plants. Losses due to pest attack or disease can be as high as 90%.

IITA's work on cowpea

IITA's mandate includes a worldwide responsibility for cowpea research. This work is based at Kano in northern Nigeria, in the heart of the cowpea-growing zone.

IITA has developed high-yielding varieties for both sole and intercropping, with resistance to major diseases, insect pests, nematodes, and parasitic weeds. Over 60 countries have released improved cowpea varieties from IITA. In the 30 years that IITA scientists have worked on cowpea, total cowpea production worldwide has increased from 1.2 million to 3.3 million tonnes per year.

Researchers are continuing to develop new varieties with high grain and fodder yields that can be used in traditional farming systems. Varieties with resistance to parasitic weeds such as *Striga*, which cause very high losses in some regions, are under testing in farmers' fields. Early maturing varieties with increased drought and shade tolerance are also being developed.

Molecular biologists at IITA are also working to develop improved cowpea varieties, through transfer of useful genes such as those encoding plant and bacterial proteins that kill insect pests of cowpea. This is still at the experimental stage, and rigorous field testing will be carried out before transgenic cowpeas are released.

As well as developing improved varieties, researchers are looking at ways to increase production through improved cropping practices. Agronomic trials have investigated effects

of row spacing, plant density, time of sowing, cowpea variety, and livestock integration, and modifications have been suggested to improve yields.

IITA holds the world's largest collection of cowpea germplasm in its genebank, more than 16 000 accessions, or plant samples.

More information

The following IITA research projects include work on cowpea:

Improving cowpea-cereal systems in the dry savannas

Improving maize-grain legume systems in West and Central Africa

Integrated management of legume pests and diseases

Conservation and use of plant biodiversity