Cowpea

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The cowpea, *Vigna unguiculata* (L.) Walp, also known as southern pea, blackeye pea, lubia, niebe, coupé, or frijolé is an annual legume. Early evidence favored the Indian subcontinent as its point of origin (Vavilov, 1951). Later investigations indicated an African origin (Faris, 1963). The cowpea was introduced into the United States about 1700. The genus contains some 170 species of herbaceous, erect, semiupright, prostrate-spreading, and twining-climbing forms. This important tropical and subtropical legume is grown for both green and dry seed and for forage. It is an excellent source of protein. It can be successfully grown under a greater diversity of climatic, soil, and cultural conditions than most other legume crops.

I. PARENTAL MATERIAL

The genus *Vigna*, along with *Phaseolus* and *Dolichos*, is included in the tribe *Phaseoleae*. Three subspecies of *Vigna unguiculata* are now recognized: *unguiculata* (cowpea), *cylindrica* (catjang) and *sesquipedalis* (asparagus-bean) (Gunn, 1973). The three subspecies can be crossed, and free gene exchange is possible. Crossing with other cultivated or wild species of *Vigna* has had little success due to failure of either pollen germination or union of gametes. *Vigna unguiculata* is apparently a well-isolated species with limited potential for intergeneric or interspecific crossing.

Partial germplasm collections are maintained in the United States at Experiment, Georgia, and in India, Nigeria, and other countries. The International Institute of Tropical Agriculture, Ibadan, Nigeria has the largest collection, with some 8,000 accessions.
II. PLANT CULTURE

A. Field

Cowpeas can be grown on a wide range of soil types; however, highest yields are usually obtained on sandy loams and lighter clay soils. Cowpeas will perform reasonably well on soils with low fertility. Phosphorus application of up to 100 kg/ha of K₂O is recommended for sandy soil, with lesser amounts, 30 to 60 kg/ha, on loam and clay. High rates of nitrogen are detrimental and can result in excessive vegetative growth, delayed maturity, pod shattering, and reduced nitrogen fixation. Soils low in organic matter should receive no more than 45 kg/ha of nitrogen, as no yield benefits are realized with higher applications. The practical approach to optimum yields would be to provide conditions and cultivars which maximize symbiotic nitrogen fixation as the nitrogen source (Zary et al., 1978).

Cowpeas are known to be relatively drought tolerant, and the amount of supplemental irrigation water needed is not great. Excessive moisture can increase vegetative growth, resulting in reduced yields; however, it is critical that adequate moisture be available at flowering, otherwise pod set will be light and seeds per pod will be reduced.

Bush types are usually planted in rows 75 to 100 cm apart and within-row spacing of 7 to 10 cm at a seeding rate of 17 to 28 kg/ha. Wider spacing of 30 to 60 cm is required for vining types. Seed may be broadcast at rates up to 100 kg/ha when it is grown for forage. In field nurseries, cultivars and breeding lines should be grown in plots separated sufficiently to minimize cross-pollination by bumblebees. Spacing of one plant per 30 cm is recommended for initial evaluation.

Optimal photoperiod for induction of flowering in cowpeas is 8 to 14 hours (Wienk, 1963). The major portion of Vigna cultivars are day-neutral, but a few are definitely short-day types. Maturities range from less than 60 days up to 7 to 8 months, depending on genotype and environment (Rachie and Roberts, 1974).

Optimum temperatures for seed germination, pod set, and dry matter production are 27 to 29 °C day/22 to 24 °C night (Rachie and Roberts, 1974). Relative humidity exerts a very strong influence on pod set, because flower shedding can be significant with high temperatures and a low relative humidity. Sprinkler irrigation is an aid to maintenance of proper humidity during the flowering period. Light level is of little consequence in field production of cowpeas.

B. Growth Chamber and Greenhouse

When growing cowpeas in a growth chamber or greenhouse, every effort should be made to provide cultural and environmental conditions that closely parallel the field optimum. It is especially important that conditions be monitored during germination, and immediately before, after, and during the crossing period. Improper watering is perhaps the single most im-
portant factor resulting in poor growth and susceptibility to pests and dis-
eases of plants grown in the greenhouse. It is also advisable to utilize a
systemic insecticide, such as Temik, in a soil-less growth media. Photo-
periods of 8 to 14 hours with temperatures of 27 °C day/22 °C night are de-
sirable for satisfactory growth and development of most cultivars. Low
light level during the winter, coupled with cool temperatures, can cause
etiolation and reduce flowering and subsequent seed set following hybrid-
ization. Low light and high humidity can cause mildew problems; however,
high humidity, along with moderate temperature, tends to favor seed set of
hand-manipulated flowers. It is most desirable to carry out crossing in late
spring, summer, and early fall.

III. FLORAL CHARACTERISTICS

The cowpea is self-pollinated and the process is complete before the
flower opens. Cross-pollination is usually less than 1%, but will vary some-
what with the cultivar and, more particularly, with the bumblebee or wild
honeybee population.

Flowers are born on racemose inflorescences at the ends of peduncles
that arise from leaf axils. There are four to six units of flowers per in-
florescence. Each unit is a simple raceme with 6 to 12 flower buds (Ojehomon,
1968a). The flower is large, has a straight keel, and is yellowish-white to
purple in color. There are 10 stamens, 1 free and 9 fused; the ovary is multi-
loculate, and the style is bearded along the inner side, ending in an oblique
stigma (Fig. 1). There is a high rate of abortion in cowpea, which can shed

Fig. 1—Mature bud, with corolla removed to expose the 10 stamens, 9 with fused filaments
and 1 free. The style has hairs on one surface and a stigma at its tip. The stylar hairs are not
receptive to pollen.
70 to 88% of its 100 to 500 flower buds prior to anthesis. Of the remaining
buds, about half may abort prematurely under certain environmental con-
ditions, so that only 6 to 16% of the total flower buds produce mature fruits
(Ojehomon, 1968b). The fruit is a cylindrical to flat pod, at times septate
and dehiscent.

IV. ARTIFICIAL HYBRIDIZATION AND SELF-POLLINATION

A. Equipment

Equipment required for hybridization includes fine forceps, a small
vial of alcohol, 2.5 \times 3.0-cm marking tags of assorted colors, and soda
straws or transparent adhesive tape.

B. Preparation of the Female

Flowers that will open in 1 day should be selected for hybridization.
Flowers showing a colored corolla 2 to 2.5 times the length of the calyx will
generally be at the proper stage for crossing (Fig. 2). The stigma is receptive

Fig. 2—Flower bud at the proper stage for emasculation.
the day before anthesis and generally to noon on the day of anthesis, depending on temperature and relative humidity. Under very dry conditions, the stigma rapidly loses receptivity.

Emasculación can be accomplished in two ways, depending on pollination methodology. If pollination is to take place in conjunction with emasculation, the standard is separated with forceps along the suture, unfolded, and spread back along with the wings (Fig. 3). The keel is removed with forceps, exposing the stamens and stigma. The stamen should be removed by firmly grasping the filaments and proceeding carefully to insure that all 10 are removed, no anthers burst, and all contact with the stigma is avoided. After emasculation, the stigmatic surface should be checked for the presence of pollen before cross-pollination is attempted. Forceps should be dipped in alcohol between emasculations. Scrupulous care in sterilizing hands, in addition to equipment used in emasculation and pollination, is absolutely essential.

If pollination is to take place on the day following emasculation, an incision can be made with a razor blade at the junction of the corolla and calyx, and the corolla removed with forceps. The stamens are often removed in this process, but generally will need to be removed with forceps. A

Fig. 3—Pushing back the wings and standard petals to expose the keel during emasculation.
Fig. 4—Placement of a soda straw over an emasculated bud.

Fig. 5—Mature flower from which pollen is available.
short length of soda straw is then pushed over the pistil, the upper end being
pinched together with adhesive tape (Fig. 4). This reduces desiccation of the
remaining plant tissue. A tag should be placed on the peduncle of the flower
with the designation of female parent. The male parent is added to the tag
after pollination has been made.

C. Pollination

With the soda straw technique, pollination takes place the morning
following emasculation. When the soda straw technique is not used for
emasculaton, pollination should follow immediately.

Flowers from the male parents should be picked the morning of
anthesis (Fig. 5). If pollen from these flowers is to be used for late afternoon
pollination, they can be refrigerated in separate bags until needed. The
pollen usually will remain viable in the flowers; however, storage for any
length of time necessitates placement of anthers in small vials which are
then placed in a desiccator over sulfuric acid or calcium chloride.

The pollen will accumulate in the keel, and in most cultivars, it is possible
to squeeze pollen out of the keel like toothpaste from a tube, and trans-
fer it directly to the stigmatic surface of the emasculated flower of the de-
sired female parent (Smartt, 1976) (Fig. 6). As soon as the pollen has been
applied, the soda straw should be replaced and left until fertilization has
taken place (Fig. 4). If pollination is undertaken with emasculation, the

Fig. 6—Squeezing of pollen from the keel for direct transfer to the stigmatic surface of the de-
sired female parent.
wings and standards are returned to the closed position after pollen transfer and secured with a 3 cm strip of adhesive tape to prevent desiccation and contamination by visiting insects (Fig. 7). Regardless of technique used, a tag should be attached at the time of emasculation. After pollination, female parent, male parent, and date should be recorded on the tag. Tags of varying colors may be used to code parents or to identify given crosses, such as F₁, BC₁, BC₂. The tape falls off when the petals separate from the pod. The soda straws will be pushed off by the developing pod. Under favorable conditions, a success rate of 50% can be expected (Fig. 8).

D. Factors Affecting Efficiency

Parents to be crossed should be located relatively close together, with individual plant spacing of 0.5 m within rows. Altering of flowering dates generally is not necessary because most cultivars flower over a sufficiently long period of time to obtain the desired crosses. Unused flowers should be removed daily to extend the flowering period and delay plant senescence. If

![Image](image-url)  
Fig. 7—Wings and standards returned to closed position following pollen transfer, and secured with adhesive tape to prevent desiccation.
flowering time of a parent is uncertain, it might be advisable to make successive plantings so that material of both is available at the critical time. Crosses involving short-day cultivars can be accomplished best during the winter months. Day-neutral types can be grown during the short day, making possible any desired combination.

Where plots are set up for progeny testing and seed increase, pod and seed color patterns have been quite useful for preventing chance mixtures. For roguing purposes, flower color is of value, as the cream types are a golden yellow color, the blackeye a light blue, and the purple hulls show a much more intense anthocyanin accumulation. If plots are rogued by flower color and subsequently by pod color markings, seed mixtures will be minimized. Inheritance patterns of genetic markers, as well as other cowpea characters, have been summarized (Rachie and Roberts, 1974).

A simple classification of the *Vigna* on the basis of pod and seed color has been developed by Brittingham (1946). A system of identifying cultivars through the use of seed shape and color markings has been provided by Ligon (1958).

Fig. 8.—Successful cross approximately 10 days after pollination.
V. NATURAL HYBRIDIZATION

The cowpea is highly self-pollinated and not suitable for hybrid seed production. Some effort has been expended at the IITA in the identification and development of male-sterile cultivars (Rachie et al., 1975). At this time, hybrid cowpea seed is not produced commercially.

VI. SEED DEVELOPMENT, HARVEST, AND STORAGE

Success of a cross is apparent as early as 2 to 3 days following pollination, and harvest of pods can take place in 3 weeks. The period of development from seed sowing to ripe pods ranges from 60 to 80 days in most cultivars.

The seed is viable and will dry out perfectly if taken from pods that are flacid and beginning to dry. Collection at this time will avoid possible loss from pod shattering, either from natural maturation or accidental striking when pods are dry.

Pods should be placed in individual kraft bags at harvest, and when sufficiently dry they should be crushed and threshed. This process can be accomplished either by hand, for individual pods or small quantities, or with a small mechanical thresher for increase plots. The seeds and debris can be separated either by use of seed sieves, wind, or an electric fan.

Individual seed lots should be placed in seed envelopes or suitable seed bags, preferably cloth with drawstring closure. The most satisfactory storage method is in cloth bags at 5 C. Before the seed is placed in storage, it should be fumigated with carbon bisulfide to prevent weevil infestation. The fumigation can be accomplished in large, airtight metal chambers. For small quantities, fumigation can be carried out in steel or plastic barrels covered with paper or plastic. Small seed lots can be stored at 14 C in sealed containers. Weevils will not hatch at this temperature; however, the eggs remain viable and will hatch soon after the seed is removed from storage. Fumigation with carbon bisulfide will kill both adult weevils and eggs.

VII. TECHNIQUES FOR SPECIAL SITUATIONS

The success of crosses is relatively low. With interspecific crosses, it might be desirable to perform bud pollination or employ artificial auxins to delay flower abscission for a few hours. Naphthalacetic acid in talc dusted into emasculated flowers reduces blossom drop and can result in 30% success in hand crosses (Rachie and Roberts, 1974).

Hormones also can be used when slow growth of pollen tubes results in failure of seed set. A saturated solution of indolebutyric acid and indoleacetic acid in glycerine can be used. The solution should be applied at the time of pollination on the abscission zone of the flower bud.
REFERENCES


