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IMPORTANT DISEASES AND PESTS OF BEAN (PHASEOLUS VULGARIS), LIMA BEAN (PHASEOLUS LUNATUS) AND PIGEON PEA (CAJANUS CAJAN) IN AFRICA

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Summary

Bean, lima bean and pigeon pea are important food crops which often provide a major source of protein in the diets of inhabitants of many countries of African south of the Sahara. Diseases and pests are important factors contributing to the erratic, low yields and poor quality of these and other food legumes in Africa. Beans are adversely affected by several pests and pathogens at various stages of plant development which seriously reduce seed yields and quality. On the African continent pests appear to cause greater damage to pigeon peas than diseases, particularly those which attack the pods and seeds. Our knowledge of the pests and diseases of lima bean in Africa is very meagre. Control of the diseases and pests which limit the cultivation of bean, lima bean and pigeon pea in Africa is essential if yields and quality are to be increased. Different control measures are presently being utilized to reduce the damage caused by various pests and pathogens. Breeding and selection of varieties that are resistant to one or more of the important pests and pathogens of these crops appear to offer the most attractive means of control for the long term.

Introduction

Beans (*Phaseolus vulgaris*)

Beans are one of the most important food legumes cultivated in countries of Africa south of the Sahara. They are the main pulse crop grown in several countries of eastern Africa, particularly Burundi, Ethiopia, Kenya, Malawi, Rwanda, Tanzania and Uganda. Although statistical data are lacking, the area planted annually to beans in these countries is estimated to exceed 1,500,000 hectares with an average yield of 500 to 750 kilograms per hectare (FAO, 1971).

Bean may be grown in pure stands, but are most commonly interplanted with other crops, such as coffee, bananas or maize where the plot size of plantings is frequently less than 0.3 hectare (Leakey, 1970). The climate is particularly important in defining the areas where beans can be cultivated successfully. In Africa they are generally grown under rain-fed conditions in the cooler, highland regions (above 300-500 meters) and rarely in the hot, humid lowland tropics (Acland, 1971). Beans are primarily grown as a rain-fed crop by small farmers who plant from one to two crops annually. Planting dates generally coincide with periods of rainfall (Acland, 1971).

Diseases and pests are often one of the most important factors affecting the production of beans in many countries, contributing greatly to low yields and poor quality.

Diseases

Numerous diseases affect beans in Africa (Stanton, 1966). However, those of greatest importance are anthracnose (*Colletotrichum lindemuthianum*), rust (*Uromy-*

myces phaseoli var. *typica* (*U. appendiculatus*), angular leaf spot (*Phaeoisariopsis griseola*), halo blight (*Pseudomonas phaseolicola*) common bacterial and fuscous blight (*Xanthomonas phaseoli* and *X. phaseoli* var. *Fuscans*, respectively), and common mosaic virus (Acland, 1971; Leakey, 1970; Robinson, 1960; Wallace, 1939).

Disease incidence varies greatly from season to season. Most of the major diseases of bean in Africa are favoured by high moisture in the form of rain or dew. Some diseases, such as anthracnose, halo blight and angular leaf spot are prevalent during cool weather, whereas common bacterial blight is most devastating when temperatures are warm (Leakey, 1970, 1972). Rust can be serious over a range of temperatures if adequate moisture is present.

The decrease in yield attributable to soil-borne fungi and nematodes that attack the roots of bean plants is generally unknown, although it is undoubtedly significant.

In nature, the host range of all major bean pathogens is confined to beans and closely related species. Many of these pathogens remain viable for long periods in dormant seed, crop debris, or soil.

Transmission

Seed transmission is probably one of the most important mechanisms in spread and survival of all major bean pathogens, except rust. Spread of the seed-borne pathogens in a field can often be very rapid, even with a low incidence of seed infection, when environmental conditions are favourable for disease development (Leakey, 1970). These diseases are also transmitted by one or more of the following methods: wind, insects, rain, irrigation water, machinery, people and animals.

The indiscriminate movement of bean seed between regions, countries or continents should be avoided since many of the bean pathogens are seed-borne. There is a constant threat and danger of introducing new bean pathogens into Africa, such as bacterial wilt (*Corynebacterium flaccumfaciens*), or new races of endemic pathogens on infected seed (Caresche *et al.*, 1969).

Control

Various control measures may be required before, during or after the planting season to reduce the losses caused by different bean pathogens. Some of these include the use of clean (pathogen-free) seed, resistant varieties, crop rotation, altering the planting dates, removal of infested crop trash, rogueing diseased plants, eradication of alternate hosts, and application of chemicals to the seed, soil or foliage (Leakey, 1970; Mukasa, 1970*a*; Zaumeyer Thomas, 1957).

One of the most effective methods of controlling certain bean pathogens is by growing disease-resistant varieties (Leakey, 1970). Bean lines have been developed by research efforts in various parts of the world that are resistant or tolerant to several of the diseases limiting bean production in Africa, like anthracnose, rust, bacterial blights and bean common mosaic virus. Bean improvement programs in Africa should attempt to incorporate these various sources of resistance into their germplasm collections, where they can be used in breeding agronomically acceptable, disease-resistant bean varieties. Resistant bean lines should always be observed for their reaction to diseases under local conditions. Bean lines resistant to a particular disease in one area may be susceptible in another due to different strains or races of the pathogens. Various races of anthracnose, rust and common bacterial blight have already been identified from different bean growing regions of Africa (Acland, 1971; Howland and Macartney, 1966; Leakey and Simbwa-Bunnya, 1972; Schuster *et al.*, 1973). New races will undoubtedly be identified for these and other pathogens of bean.

Pests

Beans are subject to attack by various insects at all stages of plant development from the time of seedling until harvest and storage (Acland, 1971; Bohlen, 1973; Davies, 1970*a*). One of the most widespread and destructive pests of bean in African countries is a group of bean flies which cause serious damage to young bean plants:

(Greathead, 1968). At times, these pests can completely destroy a crop. The three species (*Melanagromyza phaseoli, M. spencerella* and *Ophiomyia centrosematic*) lay their eggs on the leaves, stem or hypocotyls of newly emerging bean seedling. The larvae burrow down the stem into the tap root and pupate in the stem or soil close to the surface. Plants attacked by bean flies are often less vigorous, yellow and stunted. Insect damage to the hypocotyl may cause the plants to break off at or near ground level in strong winds. Excessive damage by feeding larvae often results in wilting and death of the plant. The host range of the bean fly complex comprises several species in the Leguminosae, including lima bean, pigeon pea, cowpea (*Vigna unguiculata*) and soyabean (*Glycine max*) (Greathead, 1968). There appears to be a difference in the susceptibility of bean varieties to attack by flies and in the ability of plants to develop adventitious roots in response to insect feeding (Greathead, 1968). An effective method of controlling these pests is to treat been seeds with an insecticide, such as aldrin or dieldrin, prior to planting (Acland, 1971).

Heavy infestations of the black bean aphid (*Aphis fabae*), especially at higher elevations during the dry season, can severely damage a bean crop (Ingram, 1969). In addition to the damage caused to the plant by the feeding aphids, these insects also act as vectors of one or more virus diseases which affect beans in Africa (Kuljarbu, 1975). Winged aphids move the virus from plant to plant and between plantings. Spread of the virus from a small initial source of infection, such as seed, can be rapid if the population of winged forms is high. In the field, these aphids also colonize other legumes.

Another extremely important group of bean pests is the beetles in the family Bruchidae that destroy seeds in storage (Acland, 1971; Davies, 1959, 1960, 1970). Two species, *Acanthoscelides obtectus* and *Zabrotes subfaciatus*, are generally considered to be important pests of bean, although they also cause serious damage to seeds of other legumes as well (Davies, 1970*b*, 1972; Howe and Currie, 1964). Both bruchid species often lay their eggs on the developing seeds or pods in the field and complete their life cycle after the seeds are placed in storage (Davies, 1959; Nyiira, 1970). With favourable environmental conditions, these pests can multiply very rapidly on dormant seeds in storage. Some bean varieties appear to be more resistant to attack than others (Davies, 1963). Damage is usually reduced greatly if seeds are stored under dry conditions at temperatures (below 22°C) which are suboptimum for development of the insects (Davies, 1970*b*, Howe and Currie, 1964). Both pests can be controlled effectively by treating seeds with various insecticides (Acland, 1971; Davies, 1959, 1963, 1970*b*).

At times, beans can be seriously damaged by other pests, including the bean pod borer (*Maruca testulatis*, pods), American bollworm (*Heliothis armigera*) flowers, pods and seeds), bean leaf beetles (*Ootheca* spp., leaves cutworms (*Agrotis* spp., young seedlings), and thrips (*Taeniotrips sjostedti*, flowers) (Bohlen, 1973, Davies, 1970*a*, Leakey, 1970).

Lima Beans (*Phaseolus lunatus*)

Introduction

Little is known concerning the distribution, varieties, yields or diseases and pests of lima beans in Africa. Lima beans can be grown over a fairly wide range of environmental conditions, with lines adapted to the warm humid tropics (Whyte *et al.*, 1953). Climbing varieties are generally cultivated in preference to bush types by farmers in small plantings (Mukasa, 1970*b*); Stanton, 1966). Green pods are harvested throughout the growing period of the plant which is composed of annual and perennial varieties (Mukasa, 1970*b*); Stanton, 1966; Sutton, 1969). These seeds are usually consumed in the fresh state.

Lima beans are relatively free of important diseases and pests, although they are susceptible to many of the same maladies that cause devastating losses to beans *P. vulgaris*) in Africa (Rachie and Rockwood, 1972; Riley, 1960).

Diseases

A seed-borne, foliar disease caused by *Ascochyta phaseolorum* may be serious at times, especially during periods of prolonged wet weather (Mukasa, 1970*b*). After the initial introduction of the pathogen on infected seed, the spores of the fungus are spread from plant to plant by splashing rain. Several other food legumes in addition to lima bean are infected under field conditions by the pathogen (Sutton and Waterston, 1966). In the absence of resistant varieties, disease losses can be minimized by planting clean seed and practising crop rotation.

A virus-like disease transmitted by white flies (*Bemisia tabaci*) affects lima beans in West Africa (R. J. Williams, personal communication Williams, 1975). Whitefly-transmitted diseases of lima bean, pigeon pea and beans are often a limiting factor in the cultivation of these crops in the lowland tropics of Latin American and the Caribbean (Bird *et al.*, 1972). It will be important to determine the relationship of the West African whitefly-transmitted disease to those that occur in the western hemisphere and other parts of the world, particularly India. Distribution of the disease in Africa needs to be clarified. Investigations on the spread, host range, survival, and control of the pathogen are urgently required.

Pigeon Peas (*Cajanus cajan*)

Introduction

Pigeon peas are a drought-resistant crop that are often cultivated as a perennial on soils of low fertility (Acland, 1971; Gooding, 1962; Stanton, 1966; Whyte *et al.*, 1953). They are commonly grown as a rain-fed crop in dry, lowland areas where there may be considerable fluctuations in temperature and humidity. In Africa pigeon peas are frequently inter-planted with other crops, such as maize and sorghum (Acland, 1971; Savile and Wright, 1958; Stanton, 1966). Countries with the largest areas under cultivation are reported to be Malawi, Tanzania and Uganda where yields average about 500 kilograms per hectare (FAO, 1971).

The crop appears to have a great deal of potential in Africa. An in-depth research program has been initiated by the International Institute of Tropical Agriculture in Nigeria to develop high-yielding, disease and insect-resistant varieties for African countries (Rachie and Rockwood, 1972).

Diseases

Information is limited on the diseases that affect pigeon peas in Africa, and seriously lacking on the adverse effects of infection on yields and quality.

Potentially important diseases of this crop are wilt (*Fusarium udum*), rust (*Uredo cajani*), powdery mildew (*Leveillula taurica*), and nematodes (*Meloidogyne* spp.) (Acland, 1971; Gooding, 1962; Stanton, 1966).

Pigeon peas are also attacked by diseases of the foliage (*Cercospora cajani*, *Mycovellosiella cajani*, *Cercoseptoria cajanicola*, and *Thanatephorus cucumeris*), stem (*Pythium* sp.), roots (*Armillaria mellea*, *Rhizoctonia solani* and *Macrophomina phaseoli*), and seeds (*Nematospora coryli*) (Ebbels, 1973; Rachie and Rockwood, 1972; Riley, 1960).

In countries where pigeon peas are an important food crop, particularly India, Puerto Rico and Trinidad, varieties have been developed that have resistance to prevailing strains of rust, wilt and powdery mildew (Gooding, 1962; Stanton, 1966).

In India and various countries of the Caribbean, pigeon peas are affected, often seriously, by virus or virus-like diseases, some of which are transmitted by white flies (*Bemisia tabaci*) (J. Bird, personal communication) and mite (*Aceria cajani*) (Williams *et al.*, 1968). It is not known whether these diseases occur on pigeon peas in Africa. Every effort should be made to exclude them from the African continent.

Pests

Insect damage is probably the most important factor limiting yields and quality of pigeon peas in Africa (Rachie and Rockwood, 1972). Various pests seriously damage plants in the field and destroy seeds in storage. Two of the most important pests of this crop in Africa are the American bollworm (*Heliothis armigera*) and the cowpea bruchids (*Callosobruchus chinensis* and *C. maculatus*) Acland, 1971; Davies, 1970*b*; Koehler and Rachie, 1971).

The American bollworm is a very destructive pest of various food and cash crops, including legumes. On pigeon pea, adult females oviposit on flower buds and the larvae feed on the buds and seeds of developing pods. Damage to seeds in the field can be extensive. Serious losses can be prevented by applying insecticides to plants from the time of flowering to harvest (Koehler and Rachie, 1971).

The cowpea bruchids are extremely damaging pests to stored seeds of different pulse crops (Davies, 1959, 1970b; Howe and Currie, 1964). Infestations often begin in the fields where adult insects lay their eggs on developing pods. The pest completes its life cycle after infested seeds have been harvested. Both species can also breed and multiply on dormant seed in storage. Adult insects are capable of flying from seed storage areas to nearby fields of pulse crops where they can oviposit on developing pods and vice versa (Davies, 1959, 1970*b*). Serious damage can result to seeds in storage in a very short time when environmental conditions (high temperature and high humidity) are favourable for the development and multiplication of these pests. Damage can be reduced by storing seeds in a cool, dry environment. Chemical control should begin in the field before insects have had an opportunity to infest the pods and continue after mature seeds have been placed in storage (Davies, 1959, 1970*b*).

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