Chapter 18
Miscellaneous Problems

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Introduction

Many other factors besides plant pathogens, insects, nematodes and nutritional disorders may damage beans severely during their growth. Parasitic plants such as dodder can attack bean plants and reduce yields. Various environmental conditions including frost, high temperatures, wind and drought can injure bean seedlings or mature plants. Variation in soil properties and drainage may produce marked differences in plant appearance and vigor within localized areas of a field. Genetic and physiological abnormalities may cause obvious or subtle changes in plant development. Improper pesticide and fertilizer applications, or toxic air pollutants may cause chemical damage.

Symptoms induced by these types of factors sometimes are confused with those caused by other problems described elsewhere in this book. Proper identification of the causal agent often requires a complete history of all past and current factors relevant to bean production in a specific region. This chapter will describe briefly some miscellaneous problems which may occur during dry bean production in Latin America and other parts of the world.

Biotic Problems

Parasitic plants such as dodder are known to cause damage to cultivated crops, including dry beans (17, 18, 20, 21). *Cassytha filiformis* is reported to parasitize bean plants under controlled conditions (20), and *Cuscuta epithymum* (clover dodder) is a general parasite of legumes (21). Dodder produces slender, nearly leafless vines (Fig. 1, page 330) which may be white, yellow, orange or reddish purple. When a vine contacts a host such as a bean plant, it wraps around the plant part and develops haustoria or suckers through which the dodder may obtain nutrients from the bean plant. The dodder vines then may extend from plant to plant and can seriously reduce yield (18). Pieces of the dodder vine and seeds can be

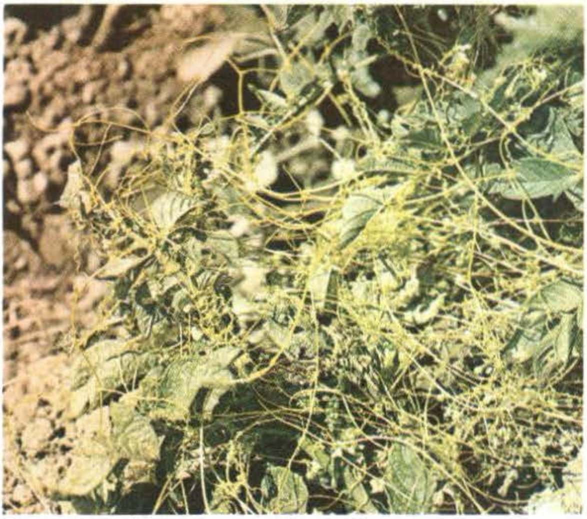

Fig. 1 - Parasitism of potatoes by dodder.

disseminated by animals, man, farm implements and surface irrigation water. Control measures include sanitation before the dodder produces seeds, burning residue to destroy seeds, and rotation with resistant crops such as cereals, soybeans or cowpeas (17, 21).

Algae also are known to occur on many tropically grown plants; however, there are no reports of damage caused to beans.

Climatic and Physical Problems

Beans are grown under a wide range of environmental conditions, but certain cultivars may be better adapted to growing conditions unique to specific production areas. However, cultivars that are reasonably well-adapted to a specific growing region may then be affected by extremes or variations which occur for one or more environmental factors during the course of a production season.

Moisture

Plants may be subjected to high or low moisture stresses which can influence physiological processes, plant development and susceptibility to plant pathogens. A low soil moisture content can damage plants due to the unavailability of water for plant roots, the accumulation of toxic ions such as magnesium and boron, stomatal closure, restricted uptake of CO_2, and temporary or permanent plant wilt (13).

High soil moisture and flooding may leach important nutrients required for normal plant development, reduce oxygen content, induce general plant chlorosis, and increase levels of toxic by-products from anaerobic metabolism. If combined with high temperatures, they may increase the rate of respiration (13, 18, 25).

High soil moisture or relative humidity may induce intumescence in cultivars with abundant foliage and pods which are not directly exposed to the sun. Raised dark green spots may appear on leaves or pods due to the elongation and multiplication of cells, and the spots may burst (edema) if high moisture conditions persist (25).

Leaves may be damaged by the impact of large droplets of water during rainstorms, which may cause leaf wilt or defoliation (14). Hail and lightning damage also may occur during rainstorms and stunt plant development, provide wounds for secondary disease agents, and cause plant death (14, 18).

Temperature

Beans also are affected by soil and air temperatures, and sudden changes may influence the plant's ability to absorb soil moisture. Low temperatures may produce chilling or frost damage (Fig. 2), which appears as dark watersoaked areas on wilted leaves or plants, or they may stunt general plant development if these low temperatures persist for an extended period. High temperatures may induce flower abortion (21), increase the rate of evapotranspiration, and cause plant wilt if there is an insufficient supply of

Fig. 2 - Frost damage to climbing bean cultivar grown in association with maize.

soil moisture or limited root growth. High temperatures and winds may compound plant stresses from low soil moisture by physically inducing soil aggregation, cracks and subsequent root damage (13). Seedlings may develop basal lesions at the soil line if the soil surface layer becomes too hot (13, 18, 21, 25).

Sunscald

Sunscald of bean leaves, stems, branches and pods may occur during periods of intense sunlight (ultraviolet wave length), especially following conditions of high humidity and cloud cover (18, 25). High temperatures also may induce sunscald damage (18). Symptoms appear as small water-soaked spots on the exposed side of the plant. The spots become reddish or brown, may coalesce, and form large necrotic or discolored lesions on affected plant structures (Fig. 3). These symptoms may resemble those caused by the tropical spider mite and air pollutants.

Bean development also can be influenced by light intensity, quality and duration (photoperiod). Reduced light can cause etiolation as plants produce succulent growth with long stem internodes, and often reduced chlorophyll content and flower production (13, 18). Cultivars which are sensitive to photoperiod do not flower normally, and often produce few pods late in the growing season when planted at high latitudes. Plants often appear healthy and green unless low temperatures cause abnormalities (personal communication, Dr. D.R. Laing, CIAT Bean Physiologist). High light intensity can scorch or burn leaves and pods (russet), cause flower and pod abortion, and increase damage caused by chemical spray droplets or air pollution, especially that caused by photochemical pollutants (13, 25).

Fig. 3 - Sunscald damage on bean pods.

Wind

Wind speed and direction can affect plant development. Evapotranspiration rates may be increased by consistent winds and aggravate plant moisture stress (13). Violent plant movement may damage roots and predispose them to subsequent root rot problems, break stems and branches, and cause plant lodging, especially if soil moisture is high (13).

Beans also can be damaged by the abrasive action of wind and air-borne soil particles (2, 25). Yield losses of 8% occurred when seedlings sustained leaf damage (Fig. 4), and a 14% yield loss occurred when flowering plants sustained the loss of buds and blossoms, after a 20-minute exposure to winds (15.5 m/sec) in the field (2).

Fig. 4 - Primary leaf damage caused by wind and air-borne soil particles.

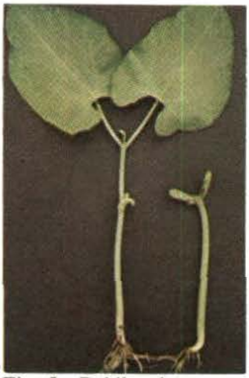

Fig. 5 - Baldhead symptoms induced by physically damaged seed.

Physical

Bean plants can be damaged physically during cultivation, application of pesticides, or preparation of irrigation furrows if not properly managed and if bean plants have produced too much vegetation. Wounds on leaves and other plant parts can provide entry sites for various bean pathogens, especially bacteria.

Bean seeds may be mechanically or physically damaged during harvesting, threshing, processing and planting operations, especially when the seed moisture content is low (4, 21, 25). External seed damage may consist of cracked seed coats and cotyledons. Internal damage may consist of detached cotyledons or injury to the hypocotyl, radicle or epicotyl and plumule. When the growing tip is injured or killed, seedlings produce the typical baldhead symptom from which plants may survive only by

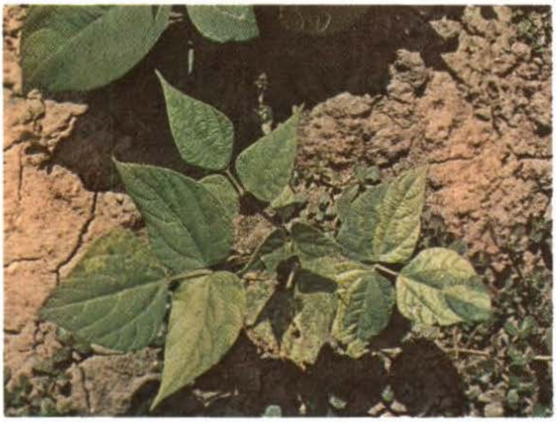

Fig. 6 - Leaf variegations caused by a genetical abnormality.

producing buds in the axils of the cotyledons (Fig. 5). A similar symptom, snakehead, may occur from damage by insects or common bacterial blight. Seedlings which survive the effects of mechanical damage often are stunted and yield poorly (4, 25).

Physiological and Genetical Problems

Beans occasionally exhibit physiological and genetical abnormalities which may be confused with symptoms induced by plant pathogens or abiotic factors. Albino seedlings may occur but usually die within a few days, due to their lack of chlorophyll. Leaf variegations may appear as mosaic patterns of green, yellow and white tissue (Fig. 6), and can cause an abnormal development of the plant and pods. Individual leaves or branches may be affected, or the entire plant may express variegations (21, 25). General plant chlorosis and pseudo-mosaic symptoms can be heritable traits. Small chlorotic spots (Yellow Spot) may appear on primary and trifoliate leaves of certain cultivars which still develop normally, and the trait is heritable (25).

A heritable seedling wilt, not caused by root rot, has been reported to occur when primary leaves become pale, bronzed, curl slightly and senesce, resulting in plant death. Internal necrosis is also a heritable trait which produces brown necrotic spots on the flat surface of cotyledons (25). Cripples or abnormal plant development can occur and also may be caused by a genetic abnormality.

Seed coat splitting may take place in certain cultivars and appears to be heritable. Symptoms consist of the uneven growth of cotyledons and the seed coat, which cause the exposed cotyledons to extend beyond the seed coat and appear cone-shaped, roughened and serrated (25). Other factors, such as moisture and temperature, may be involved.

Fig. 7 - Insecticide damage to bean leaves.

Fig. 8 - Paraquat spray-drift damage to beans.

Chemical Problems

Chemical Toxicities

Chemical damage may affect beans during the growing season, especially during germination and seedling development if chemicals are not applied according to manufacturers' recommendations. Toxic concentrations of various chemicals and fertilizer may be placed too close to seeds, creating problems if chemicals do not dissolve and leach rapidly throughout the root zone (13, 25). Insecticides (Fig. 7), Paraquat spray-drift (Fig. 8) and 2,4-D spray-drift (Fig. 9) can produce distinctive necrotic or morphological symptoms on affected leaves or plant parts. Other physiological disorders may be caused by chemicals which contain impurities or products metabolized by soil microorganisms into toxic by-products, or aggravated by specific soil and environmental conditions.

Root injury by herbicides and pesticides may be increased by soil moisture stress, deep planting, soil compaction and mechanically damaged seed (22). Chemically damaged roots often are predisposed to subsequent infection and greater yield loss by root rot pathogens (12, 22, 23, 24).

Air Pollution

Air pollution has become an important problem in many parts of the world where beans are planted near small or large industries which release

Fig. 9 - Damage by 2,4-D spray-drift.

gaseous by-products produced during their processing operations. Other gaseous by-products generated by transportation vehicles or natural environmental processes also can contribute to air pollution. Air pollutants which affect beans include ozone, peroxyacetyl nitrate (PAN), sulfur dioxide, fluorides, solid particles and chlorine. Air pollutants also can influence the interactions between beans and plant pathogens.

Ozone (O_3) is a common air pollutant formed by electrical discharge during thunder storms, the action of sunlight on oxygen, gases liberated by combustion engines and as a by-product of photochemical reactions (6). Yield losses greater than 50% have been reported on dry beans (16). Ozone damage appears on the upper leaf surface first as small watersoaked or necrotic lesions which may coalesce and become bronze or reddish-brown (Fig. 10), resembling sunscald damage (6, 8, 16, 19). Premature senescence and defoliation then may occur, especially when ozone concentrations reach 100 ppb (16). The severity of plant damage is affected by the ozone concentration, cultivar sensitivity, leaf age, light (Fig. 11), temperature, humidity, soil moisture and texture, and plant nutrition (1, 6, 16).

Peroxyacetyl nitrate (PAN) is formed by the photochemical interaction between hydrocarbons emitted by the incomplete combustion of petroleum products and oxides of nitrogen. PAN damage appears on the lower leaf surface inititally as a watersoaked, shiny or silvery symptom (Fig. 12), which eventually becomes bronzed. Symptoms may resemble those induced by frost, sunscald or various insects (6), such as the tropical spider mite.

Sulfur dioxide (SO_2) is formed during the combustion of fossil fuels and can act directly as an air pollutant or combine with water to form sulfuric acid mist (6). SO_2 damage may appear on the upper or lower leaf surface as a dull dark-green watersoaked area which eventually turns necrotic or bleached (Fig. 13) (6, 8). SO_2 damage generally is more serious on younger leaves than on older ones (6), especially when temperature and relative humidity are high (18).

Other air pollutants exist which can damage beans, but generally they are not as common as ozone, PAN or SO_2. Hydrogen fluoride may damage young leaf tips and margins which become necrotic and may cause the leaf edges to curl downwards. Chlorine gas can induce dark green leaf spots or flecks on the upper leaf surface, which later become light tan or brown and may resemble ozone damage. Chlorine also may cause interveinal bleaching similar to SO_2 damage. Hydrochloric acid can cause yellow brown to brown, red or nearly black necrosis (flecks or spots) surrounded by a cream or white border of leaf margins or interveinal tissue on the upper leaf surface. HCl also may cause a glazing on the lower leaf surface which resembles PAN damage. Nitrogen oxide and nitrogen dioxide can cause

Fig. 10- (above) Ozone flecking (50 pphm for 3 hr.) of bean leaves.

Fig. 11 - (above) Ozone damage (42 pphm for 1 hr.) to bean plants exposed in shade (left) and sun (right) at 22°C.

Fig. 12 - (right) Peroxyacetyl nitrate (PAN) damage to Pinto bean on right.

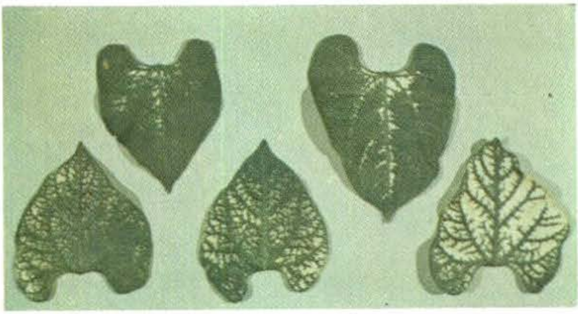

Fig. 13 - (left) Sulfur dioxide damage (1 pphm for 1 hr.) to Pinto bean.

chlorotic or bleached symptoms on the upper leaf surface. These symptoms may extend to the lower leaf surface and resemble SO_2 damage. Necrotic lesions induced by NO_2 may fall out from the leaf, leaving a shot-hole appearance (6).

Air pollutants are reported to interact with each other or with plant pathogens to alter the type or intensity of damage to beans. Additive, synergistic or antagonistic interactions have occurred between ozone-PAN and ozone-SO_2, depending upon the concentration of each pollutant and sensitivity of plants (8, 9, 10). Various pollutants influence plant pathogens and the resulting symptoms on infected or exposed plants (6).

Rust and halo blight infection can be altered by an interaction with fluorides. For example, smaller, but more numerous rust pustules developed more slowly in the presence of fluorides than in non-exposed and inoculated controls (7). Prior inoculation with bean common mosaic virus reduced the extent of ozone damage when sensitive beans were subsequently exposed to the pollutant (5).

Air pollution damage by ozone has been reduced on various crops, including tobacco and onions, by applying antioxidants such as Dichlone and the dithiocarbamates (10). Bean damage by oxidants has been reduced by application of Benomyl (11, 15) and N-[2-(2-oxo-1-imidazolidinyl) ethyl] -N^1- phenylurea or EDU (3). Other control measures may include the identification and development of cultivars which are less sensitive to damage by the various pollutants or their interactions.

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