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Effects of sowing date and fungicide application on yield of early and late maturing peanut cultivars grown under rainfed conditions in Ghana

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Abstract

Late leaf spot is one of the important factors limiting peanut productivity in Ghana. It is essential to demonstrate the extent of yield losses caused by leaf spot and to develop suitable crop management practices. The objectives of this research were to study the effects of time of sowing, cultivar lifecycle, and fungicide sprays on disease incidence, biomass and pod yield of peanut crops grown under rainfed conditions in northern Ghana. Two peanut cultivars, Chinese (90 days duration) and F-mix (120 days duration) were grown for three seasons (1999–2001) at Nyankpala and for two seasons (2000, 2001) at Wa with three sowing dates (early, mid and late, relative to start of rainy season) with (+F) and without (−F) fungicide application. Disease rating, main-stem defoliation, total biomass, pod yield and seed yield were recorded at harvest maturity. Early sowings soon after onset of rains resulted in greater biomass and pod yields compared to late sowing for both cultivars. The long duration cultivar F-mix produced greater yields than short duration cultivar Chinese under both with and without fungicide treated environments. However, incidence and severity of disease, as measured by disease scores and main-stem defoliation at the end of season, were similar in both cultivars. This suggests that the greater yield obtained by the long duration cultivar was not due to disease tolerance or escape but due to its longer growing season. Application of foliar sprays of fungicide was effective in controlling leaf spot and improved peanut biomass and pod yields by 39% and 75%, respectively, when averaged across cultivars and years. Long duration cultivar F-mix, sown early and treated with fungicide under optimum and timely crop management practices, produced 4500–5000 kg ha^{-1} pod yield over five site years, i.e. more than three to four-fold increase over present average yields in Ghana.

Keywords: Leaf spot; Sowing date; Fungicide; Disease incidence; Main-stem defoliation; Yield

1. Introduction

Peanut (*Arachis hypogaea* L.) is an important food and forage crop because of its high protein and oil content. Peanut seed is used as a source of cooking oil and in confectionary products for human consumption. Peanut hay (vine) is an important animal feed, particularly for the subsequent dry season when green forage is not available. In addition, peanut seed and hay are often sold in local markets, providing income to the resource-poor farmers. Pod yield of peanut crops in Ghana averages only 840 kg ha^{-1} which is low compared to yields of 2500 kg ha^{-1} in developed countries (FAO, 2002). The lower yields in Ghana and other parts of West Africa are particularly attributed to foliar diseases. Early leaf spot caused by *Cercospora arachidicola* Hori and late leaf spot caused by *Cercosporidium personatum*

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(Berk. & Curt) Deighton, are among the major diseases of peanut worldwide, including West Africa (Subramanyam et al., 1991; ICRISAT, 1992; Waliyar et al., 2000). Leaf spot symptoms can appear on any above ground parts of peanut plant including leaves, petioles, stipules, stems and pegs in the later stages of disease (Subramanyam et al., 1992). Spots first appear on the upper surface of lower leaves as small necrotic pinhead size spots that enlarge and become light to dark brown or black circular spots ranging from 1 to 10 mm in diameter (Smith, 1984). At later stages these spots coalesce and result in defoliation, causing significant losses in biomass and yield. Early leaf spots are brown to reddish brown in color and always have a yellow halo. Most of the early leaf spot spores are formed on the upper leaf surface giving it a slightly raised surface, while lower leaf surface is usually smooth. Late leaf spots are characterized by dark brown to black spots and usually does not have yellow halo. Most of the late leaf spot spores are formed on the lower surface giving it a rough and tufted appearance, where as upper leaf surface is generally smooth. Leaf spot can cause yield losses of 50–70% in West Africa (Waliyar, 1991; Waliyar et al., 2000) and up to 50% worldwide (Smith, 1984; McDonald et al., 1985). Quantitative data on yield losses caused by leaf spot in peanut are scarce in Ghana. It is important to demonstrate the extent of yield losses caused by leaf spot and to develop suitable crop management practices for peanut crops in Ghana.

Crop management practices such as time of sowing and duration of cultivar life cycle may influence the severity of leaf spot, biomass and pod yield of peanut. Sowing when environmental conditions are less favorable for disease incidence and/or progress can provide partial management of the disease (Boote, 1982; Smith, 1984). Leaf spot can be managed by applying fungicides during the most vulnerable periods of fungal infection, i.e. when excessive moisture and humidity occur (Smith and Littrell, 1980). Application of fungicides should begin before infections occur. A few studies have shown that application of fungicides can reduce the severity of leaf spot and improve yields in West Africa (Kannaiyan and Haciwa, 1990; Waliyar et al., 2000). In many West African countries including Ghana, use of fungicidal sprays is not common due to lack of credit, low yield potential under rainfed conditions, and difficulty in obtaining fungicides (McDonald et al., 1985). In recent years, fungicides have become available in certain parts of West Africa. Therefore, it is important to re-confirm benefits of fungicide application on peanut yields under the rainfed and presumed low yield potential production in Ghana. It has been suggested that the most effective way of disease management should involve combinations of agronomic practices such as time of sowing, cultivar selection and application of fungicide (Middleton et al., 1994). Information on the interaction of these management practices on peanut production in Ghana is not available. Therefore, the objectives of the present research were to study the effects of time of sowing (early, middle and late season), cultivar lifecycle, and fungicide sprays on disease incidence, biomass and pod yield of peanut crops grown under rainfed conditions in northern Ghana.

2. Materials and methods

2.1. Experimental details

This research was conducted at the Savanna Agricultural Research Institute farm at Nyankpala (9° 42′ N latitude, 0° 92′ W longitude, and 184 m altitude), and Wa (10° N latitude, 2° 50′ longitude, and 323 m altitude) which are representative sites in Northern Ghana. Soil type at the experimental sites in Nyankpala and Wa was sandy loam. The previous crop grown before the start of the experiment was grain-sorghum (*Sorghum bicolor* (L.) Moench) in Nyankpala and maize (*Zea mays* L.) in Wa. During the experimental period of 3 years, only peanut crops were grown during the season and fields remained fallow during the off-season.

Two peanut cultivars, Chinese (90 days duration) and F-mix (120 days duration) were grown for three seasons (1999–2001) at Nyankpala with three sowing dates (early, mid and late) with (+F) and without (−F) fungicide application. Sowing dates were 16 June, 6 July, and 27 July in 1999, 24 May, 13 June, and 4 July in 2000, and 30 May, 25 June, and 19 July in 2001, respectively. Similar treatments were imposed at Wa for two seasons (2000, 2001), the respective sowing dates were 17 June, 6 July, and 27 July during 2000 and 14 June, 26 June, and 10 July during 2001. The experiments were laid out in a split–split plot designs with sowing dates as main plots, cultivars as sub-plots and fungicide sprays as sub–sub plots (8 by 4 m^2). The treatments were replicated four times.

2.2. Plant husbandry

Crop management practices during all the years were similar except as specified for treatments. The fields were ploughed and harrowed and treatment plots were laid out before sowing. The field was planted as a flat bed. The seeds were sown at a depth of 5 cm at a spacing of 10 cm between plants and 50 cm between rows. Gap filling was done 5 days after emergence to maintain uniform plant population in all treatments. The crops were kept weed-free by manual weeding using hoes at regular intervals. No fertilizers or seed dressing chemicals were used. Control plots were not sprayed with fungicide, while the treated plots were sprayed alternatively with the fungicides tebuconazole (Folicur)