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Environmental Impacts of Insect Pests and Diseases on Vulnerability of Grass and Forest Ecosystems

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Abstract

This study was carried out in 15 locations with collective gardens, parks, athletics, courts and home gardens at Khatoum State with the aim of casting light on the effect of fungi and insects on the growth of turf grasses, Bermuda species, (*Cynodon dactylon*) in addition to natural vegetation and tree species, because these grasses, natural vegetation and tree species which are cultivated in private and public gardens, courts, athletics and green land entertainments in Khartoum State are gaining great importance locally and nationally. To study the fungus infection on these gardens, fifteen locations (gardens) were investigated, and therefore, four fungi species (FS) were isolated. These included *Fusarium nivale*, *Drechslera spicifera*, *Rhizoctonia solani*, and *Curviularialunata*. Complex infection with these fungi resulted in severe blight and death of the grasses leading to desertification of the infected areas. The symptoms of the branches wilt disease in the susceptible tree hosts include leaf yellowing, defoliation and formation of masses of black spores under the bark and the stem and finally death of the host trees. For the economical species such as *A. sengal* tree and the biological control techniques proposed by this study should be implemented. Farmers should use electronic swards rather than axes for pruning the branches and stems infected trees to reduce and amount of liberating air-borne spores.

Keywords

Pests, Diseases, Grass and Forest Ecosystems

1. Introduction

The impact of drought, overgrazing, severe forest cutting, fire, wind, flooding and expansion of crop cultivation are known as the leading natural and human activities that induce ecosystem functioning, environmental pollution and desertification. However, little attention has been given to fungi infection and insect infestation as ecosystem functioning factors. Hence the present study was carried out to cast light on the effect of fungi and insects on the growth of turf grasses (*Cynodon dactylon*) natural vegetation and tree species. Truf grasses are the most coverage of the green colour in the home and public gardens in Khartoum state. Bermuda species are the most grass species grown. Some gardens are showing blight diseases like symptoms. The branch welt disease caused by the fungus *Nattrassia maniferae* (Nattrass) was reported in Sudan by several authors. For instance, [5] had highlighted first report regarding fungus infecting citrus trees in Khartoum, [2] have described the disease as a destructive disease of ficus trees in Khartoum state. Moreover, described the disease infection in 29 tree species in three states namely: N. Kordofan, Gezira and Khartoum. Recently, [19] and [6] described the diseases in several Guava and citrus tree species from Puerto Rico and Al kadaro, North Khartoum orchards. Thus, fungi treatment is extremely important.

From 2012 to 2015, the Puerto Rico Island experienced a 39% reduction (i.e., 2556 tons to 1557 tons) in citrus

production due to diseases, forcing farmers to abandon their land or switch to other [16]. In 2012 the citrus industry was ranked second among fruit commodities in Puerto Rico, with over 7000 ha planted on 2800 farms (~700 producers), most of them located in the mountainous region of the island. Between 2013 and 2014, the citrus industry ranked third, with a net value of $6 million as reported by the Department of Agriculture of Puerto Rico [9-1].

In terrestrial ecosystems, insects function as herbivores, pollinators, seed dispersers, predators, parasites, nutrient cycling, detritivores or ecosystem engineers. Insects may be either beneficial or destructive in their influence on the ecosystem, for convenience insects effects either direct or indirect [10].

Firstly, in the past few decades, there have been several reviews of how insects can be controlled, in particular, herbivores, can affect ecosystem function as reported by [14, 8, 12] who have cauterized the indirect effects of insects which presented in (Figure 1) such as follows;

a) The effects operating through the soil, e.g. Collembola, play an essential role in the formation and breakdown of soil organic matter and, therefore, have a positive impact on the availability of plant nutrients.

b) *Effects through the disintegration of dead plant material,* e.g. the wood boring insects play an essential part in the disintegration of fallen branches and dead trees and thus hasten the return of organic matter to the soil.

c) *Effects through pressure on other elements in the flora*, in a forest community, defoliation of canopy trees can lead to marked ecological changes in the understory.

d) The direct effects of insects on the ecosystem may result either from continuous pressure or from sporadic outbreaks, the so-called insect epidemics. In the case of continuous pressure on a particular plant species, the effects are often subtle and extremely difficult to document.

Moreover, sporadic outbreaks of insects may be caused in a variety of ways. Almost always the basic cause is some change in ecological conditions through the effect of climatic variations. The direct effects of insects on natural vegetation can be subdividedby the origin of the insect species concerned, whether exotic or indigenous as classified as in presented bellow;

a) *The effect of an exotic insect on ecosystem*

Good studies on the effect of invasive insects on ecosystem processes are rare, and most examples concern the effect of herbivores on forest ecosystems through tree defoliation or mortality. Effects on North American oak forests by L. dispar defoliation have been extensively investigated [6].

b) *Effect of an indigenous insect on ecosystem*

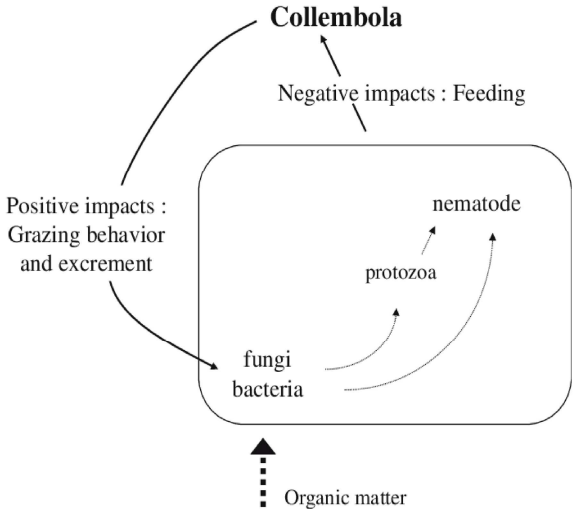
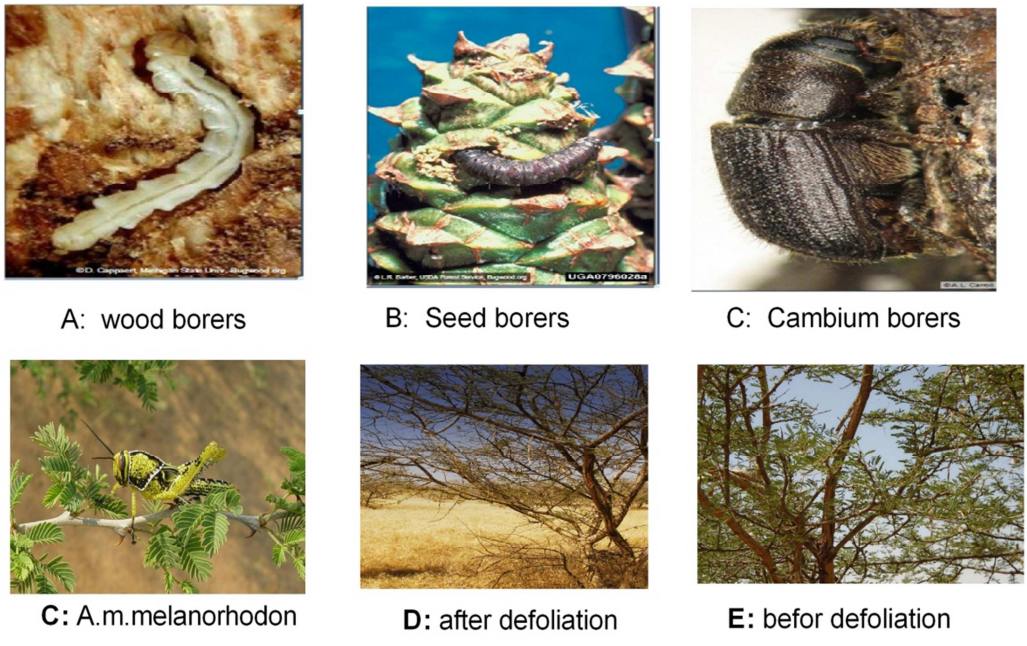


Figure 1. *Broken arrows represent material fluxes; solid arrows denote collembolan effects on nematodes.*

Secondly, still, hereis very scanty literature of how the effectiveness of indigenous insects on *the* ecosystem. For example, pests of forests and forest products in Sudan included several techniques as described in Figure 2:



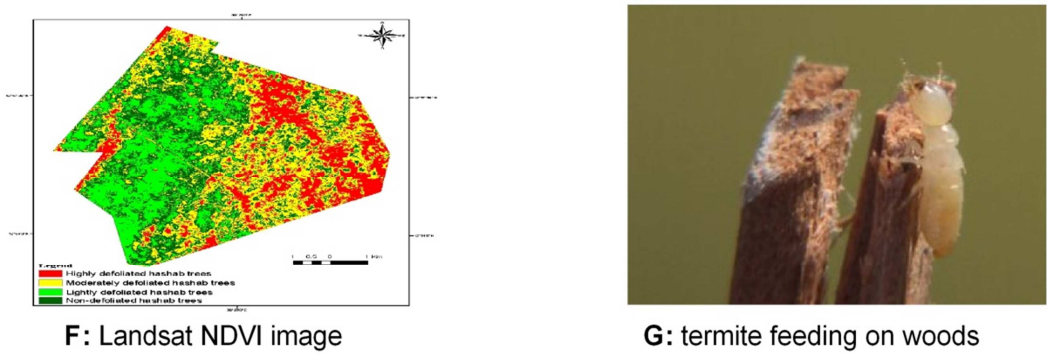


Figure 2. *Effect insect on A. sengal trees; A: wood borers (bostrychidae); B: seed borers (Bruchidae); C: m. melanorhodon 4th instar nymph on shoot (photo by Luong, CIRAD); D: after defoliation by tree locust; E: before defoliation by tree locust, F: Landsat NDVI image of Nawa location dated October 2008; and G: worker termite feeding on woods respectively.*

Insects and diseases are integral components of the forest ecosystem; they affect forest, stands, and even entire forests positively and negatively. These effects are termed impacts. The positive impacts are primarily ecological; negative impacts are those which alter values defined by forest management objectives or public perception [6]. During the last two centuries, the number of Alien phytophagous insect species that have established in forests of North America has increased exponentially [6, 11, 18]. Some have been especially devastating, either alone or in conjunction with pathogenic symbionts, causing wide-spread mortality of their hosts that has substantially altered forest structure and ecosystem processes. For example, gypsy moth (Lymantriadispar L.) and beech scale (Cryptococcus fagisuga Lind.) with its pathogenic fungal associates have severely impacted oak (Quercus spp.) (Davidson *et al.* 1999) and beech (Fagus grandifoliaEhrh.) [7-17].

2. Materials and Methods

The investigations of Bermuda grass diseases in Khartoum State were conducted in a survey including 15 locations with collective gardens, parks, athletics, courts and home gardens to isolate and identify the causal organisms. Leaf and root samples were taken to the lab, and the fungal growth in PDA media was isolated and identified using the method describedby [4]. Similarly, bark samples were taken from the trees showing the branch wilt disease symptoms and examined in the lab, and the spores obtained were examined.

3. Results

The disease symptoms on the Bermuda grasses first appear as circular yellow water-soaked spots that turn orange then coalesce to cover large areas of dead plants (Figure 3C) the results of the survey revealed the infection of the inoculation with four fungi species namely, *Fusarium nivale*, *Drechlera specifier*, *Curviulaialunata* and *Rhizoctonia solani*. Mechanical inoculation of healthy Bermuda grasses with *Fusarium* sp. caused small yellow water-soaked spots that enlarge and become blight. Inoculation with *auricularia* sp. developed leaf spot lesions. Inoculation with *Drechsler sp*. induced spots that developed into purplish spots. Mix infection will all the fungi caused small black, brown patches that coalesce to cover the whole plants that end up with dead dry grasses (Figure 4). The symptoms of the branch wilt disease included leaf chlorosis, leaf necrosis and leaf defoliation. The most apparent symptoms are peeling off of the barks of the branches and stems and heavy masses of black layers of black spores under the barks. Finally, the infected trees dry up (Figure 4A).

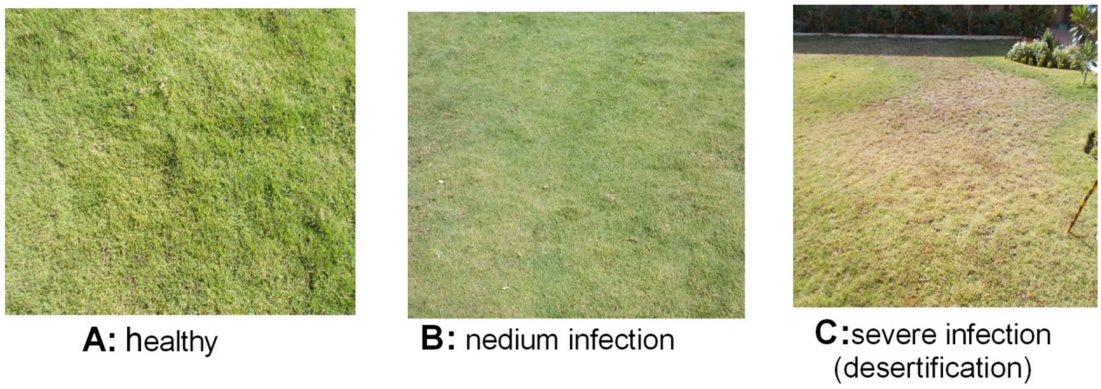


Figure 3. *A: Healthy. B: Medium infection. C: Severe infection (desertification).*

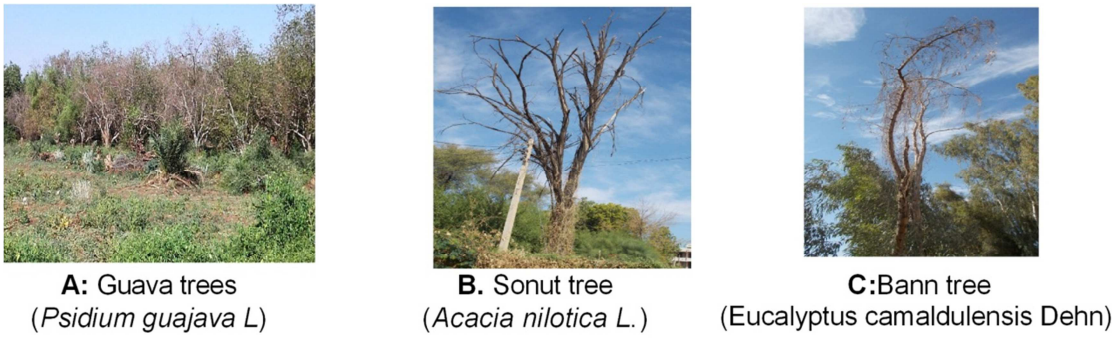


Figure 4. *Branch wilt disease; A: Guava trees (Psidium guajava L); B: Sonut tree (Acacia nilotica L.); C: Bann tree (Eucalyptus camaldulensis Dehn).*

4. Discussion

The present work has shown, for the first time in Sudan, the association of *Fusarriumnivale*, *Drechslera spicifera*, *Curvularia lunata* and *Rhizoctonia solani* with the blight disease of turf grasses (lawns) in Sudan, requirements for new lawns include proper land preparation and levelling, transplanting from new healthy seeded lawns and frequent watering. Fungicide spraying of the lawns when disease-like symptoms start to appear.

The widespread of the branch wilt disease infecting shade, fruit and forest trees needs further studies. The infection of the Arabic gum tree (*A. senegal*) is a special case as it is a highly economic cash crop tree. Moreover, the practice of tapping gum tree (for exudating the gum) creates ideal entrances for the air borne spores of the pathogen. Hence, breeding for resistance could be the solution in the future.

5. Conclusion

Fungi such *Fusarium nivale*, *Drechslera spicifera*, *Rhizoctonia solani,* and *Curviularialunata* have a devastating effect on the growth of grasses, natural vegetation and tree species that results in severe blight and death of the grasses leading to desertification of the infected areas. Forest insects and diseases are integral components of the forest ecosystem; complexes of each have coevolved with forest ecotypes and are involved in the dynamic processes of forest establishment, growth, senescence, and mortality. Insects and diseases which feed on, or use trees as substrates for their life processes, affect forest, stands, and even entire forests positively and negatively

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