Research Application Summary

Invasive Bracken fern (*Pteridium aquilinium* L. Kuhn): A potential risk to the production of legume crops in Western Tanzania

Bagarama, F.M.[1], Shenkalwa, E.[2] & Majule, A.E.[3]
[1,2]Tumbi Agricultural Research Institute, PB: 306, Tabora, Tanzania
[3]Institute of Resource Assessment (IRA), University of Dar es Salaam, P. O. Box 35097, Dar es Salaam, Tanzania
Corresponding author: bagaramaf@gmail.com

Abstract

This research established the risks posed to legume crop production by invasion of the degraded agricultural lands in western Tanzania by the bracken fern (*Pteridium aquilinium*). The test crops included the legumes beans (*Phaseolus vulgaris),* Pigeon pea (*Cajanus cajan*), groundnuts (*Arachis hypogea*) and soybean (*Glycine max*); and a cereal maize (*Zea mays*). These were planted in soil containing *P. aquilinium* root extracts and rhizospheric soil extracts. Germination of the studied seeds was negatively and highly significantly (P=0.001) affected by treatments. Germination of maize was less affected by *P. aquilinium* toxic compounds compared to legume seeds. The results of this study, partially explains the low plant population of some legume crops observed in *P.aquilinium* invaded fields in western Tanzania. Agronomic interventions are proposed for increasing land productivity under *P. aquilinium* invasion.

Key words: Agriculture vulnerability, allelopathy, invasive plants, Tanzania

Résumé

Cette recherche a établi les risques posés à la production des légumineuses par l'invasion des terres agricoles dégradées dans l'ouest de la Tanzanie par la fougère de Bracken (*Pteridium aquilinium*). Les cultures d'essai ont inclus les haricots légumineux (*Phaseolus vulgaris*), Pigeon pea (*Cajanuscajan*), les arachides (*Arachis hypogea*) et le soja (*Glycine max*), et une céréale, le maïs (*Zea mays*). Elles ont été plantées dans le sol contenant les extraits de racines de *P.aquilinium* et les extraits de sol rhizosphérique. La germination des graines étudiées était négativement et de façon hautement significative (P = 0,001) affectée par les traitements. La germination du maïs a été moins affectée par des composés toxiques de *P. aquilinium* comparativement aux graines de légumineuses. Les résultats de cette étude expliquent en partie la faible population des plantes de certaines cultures de

légumineuses observées dans les champs envahis par *P.aquilinium* dans l'ouest de la Tanzanie. Les interventions agronomiques sont proposées pour augmenter la productivité des terres sous l'invasion du *P. aquilinium*.

Mots clés: vulnérabilité de l'agriculture, allélopathie, plantes envahissantes, Tanzanie

Background

Invasive plants are among factors that negatively impact agricultural production. Invasive plants in natural and agricultural systems are capable of replacing native plant species, changing plant diversity and the ecological functions of agricultural systems. Invasive plants in agricultural systems are neglected as factors that increase vulnerability in agricultural systems. They conquer new habitats either as the result of ecological disturbance or climate change or both. The negative impact of invasive plants is exacerbated by allelopathic compounds that are released by the invading plant species. Bracken fern (*Pteridium aquilinium* L.Kuhn) is a common invasive plant characterised by the presence of allelopathic toxic compounds to associated plants. Studies in temperate countries have established that *P. aquilinium* negatively affects seed germination of many plant species through the release of toxic compounds into the soil, competition and its adaptation to frequent surface fires (Parkeman and Marrs, 1996). There is little information on the influence of *P. aquilinium* invasion on agriculture production in Africa and indeed in Tanzania where the weed is common especially in the highlands.

Literature Summary

Bracken (*Pteridium aquilinium* L.(Kuhn) is a perennial noxious weed of economic importance in many parts of the world (Pakeman and Marrs, 1992. The plant is known for changing the ecological functions of the invaded ecosystem. Previous studies show that anthropological disturbances is a pre-cursor for plant species invasion into natural and agrosystems (Hobbs and Huenneke,1992; Hobbs, 1991). *Pteridium aquilinium* is difficult to control because it reproduces both by spores and rhizomes (Pakeman and Mars, 1996); during fire, rhizomes of *P.aquilinium* are protected underground, allowing the fern to dominate recently burnt habitats.The high productivity of dense frond cover and deep litter produced by *P.aquilinium*, combine to reduce understorey vegetation (Marrs *et al*., 2000). The inhibitory effect of *P. aquilinium* to seed germination and growth performance of seedlings has also been reported (Dolling *et al*., 1996) Studies on *P. aquilinium* have been concentrated in

temperate countries, despite presence of this weed in some African countries. This study was carried out to assess the effect of *P. aquilinium* on the germination of seeds common in the farming systems in western Tanzania where it is common.

Study Description

This study was conducted in a greenhouse at Tumbi Agricultural Research Institute, Tabora, western Tanzania. Soil was sampled at the depth 0-20cm from a *Pteridium aquilinium* heavily invaded field at Kitahana village, Kibondo district, western Tanzania. Soil samples for seed germination test were collected after the onset of the rains and during the sprouting of new *P. aquilinium* fronds, a period considered to have the high concentration and movement of toxic allelopathic substances (Dollin *et al.*, 1994). The soil was air dried and sieved through an 8mm mesh .Two kilograms of soil were put in four plastic pots as replicates for seed germination. A 10% solution of rhizhospheric soil was prepared by mixing 500 g of soil carefully detached from the main and lateral roots of *P. aquilinium* roots. A 10% *P. aquilinium* root extract solution was prepared by mixing 500g of grounded roots in 5litres of distilled water.Ten seeds were planted per pot. Seeds were watered twice a day with a) distilled water b) 10% aqueous solution of ground *P. aquilinium* roots and, c) 10% aqueous solution of rhizospheric soil. Seeds of maize (TAN250), soybean (var. Uyole), beans (var. Lyamungo 90), groundnut (var. Pendo) and Pigeon pea (var. Tumia) were germinated for 7 days. Percentage germination was calculated for each of the crops. Germination data were were analysed using the General ANOVA statistical procedures with GENSTAT Discovery Programme.

Research Application

The germination of legume seeds studied was highly significantly ($P<0.001$) reduced by both aqueous extracts *of P. aquilinium* roots and rhizospheric soil compared to the control. There was a highly significant ($P<0.001$) interaction effect between crop and soil treatment. The worst performance was exhibited by pigeon pea whose percent germination was 12.5% and zero in root extracts and rhizospheric soil, respectively. Overall, the germination of the investigated seeds ranged from 45.0-100%, 0.0%-49.75, and 0.0-83% for the control, root extract and rhizospheric soil extract, respectively. Maize seed germination was only slightly affected by *P. aquilinium.*

Recommendation

Land preparation and the timing of planting are likely to be crucial factors in minimising the negative effects of *P. aquilinium* on planted seed. The negative effects of the aqueous

Table 1. Percent germination of seeds of various crops in soil with *P.aquilinium* aqueous extracts.

Crop	Control (water)	Root extracts	Zospheric soil extract	Mean germination (%)
Bean	95	12.5	0	35.83b
Pigeon pea	45	12.5	0	19.17a
Groundnuts	100	0	40	46.67c
Maize	100	49.75	83	77.58d
Soybean	90	0	12.5	34.7b
Means	86.00c	14.95a	27.10b	

extracts of the roots indicate that land preparation under *P. aquilinium* invaded fields should be carried out during the dry season before the sprouting of new fronds. It is also not recommended to plant legumes crops immediately after preparing land invaded by *P. aquilinium***.**

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