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Economic impact associated with Leaf blight damage in buffelgrass seed production in central Sonora, Mexico

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Abstract

Buffelgrass (*Pennisetum ciliare*) leaf blight is a disease caused by the fungus (*Pyricularia grisea*), which may kill plants and reduce the quantity and quality of foliage and seeds. The study was conducted on three ranches during 2016-2017 in Sonora, Mexico, to determine the effect of leaf blight on seed production and the economic impact on ranchers. Pastures damaged by the pathogen were selected to evaluate the number of affected plants, plant density, raw and clean seed production, seed cost, net gain from seed sales, and economic loss. Data were analyzed using ANOVA ($P \leq 0.05$). Precipitation was 10 to 40% above the average at all sites and in all years of the study. From 46 to 59% of the buffel grass plants showed some damage. Null to very light plant damage was found in 31.5-36.6% of the plants, slight damage in 21.3-42.8%, and moderate damage in 25.7-42.1%. The production of raw seed was affected ($P \leq 0.05$) by the damage from the fungus and varied from 61.4-81.8 kg/ha for no damage, 46.2-53.8 kg/ha for light damage, and 28.6-36.9 kg/ha for moderate damage. The cost of clean seed for sale averaged $90.00 Mexican pesos during 2017 and 2018, and the clean buffelgrass seed produced differed ($P \leq 0.05$) among treatments. It averaged 41.27, 30.9, and 17.3 kg/ha for areas with no damage, light damage, and moderate damage, respectively, representing a net profit from seed sales of $3,714.3, $2,781.0, and $1,557.0 pesos/ha for areas with no damage, light damage, and moderate damage, respectively. Therefore, the loss caused by fungal damage was $933.0/ha in areas with light damage and $2,157.3/ha in areas with moderate damage. We concluded that leaf blight affects the seed production of buffelgrass, and necessary measures must be taken to reduce plant and seed damage.

Introduction

Buffelgrass leaf blight is a disease caused by the fungus (*Pyricularia grisea*), (*Magnaporthe oryzae*) or (*Magnaporthe grisea*) which reduces the quantity and quality of the foliage and the amount and quality of seed produced by the grass. The grass has been successfully established in more than 2 million hectares in Mexico and in more than 30 million hectares in different regions of the world (Ibarra et al., 1989; Cox et al., 1988). In Northeast Mexico and Southeast United States reductions between 10 and 50% in grass production are reported (Rodriguez et al., 1999; Diaz et al., 2007). More recently, under the climatic conditions of Northwestern Mexico, leaf blight damage has been also reported with severe foliage and seed damage (Ibarra et al., 2022). Perrott and Chakraborty (1999), report similar results in foliage and seed damage by the fungus in buffelgrass in rangelands at Queensland Australia.

The buffel blight fungus is very small and cannot be seen with the naked eye, it lives in the ground and in the base of the plants, can last several years there and it is moved by wind, water, livestock and man (Ibarra *et al*, 2022). Severe damage can reduce the amount of dry forage by 25 and 62% and between 20 and 55% the nutritional quality of the grass. During severe attacks total buffelgrass seed production may be reduced by 45 and 60% and in years even with less humidity, less severe attacks may appear, and they can kill from 20 and 35% of the grass seed. Several million ha of desert brushland has been planted with buffelgrass to restore productivity. Forage production and cattle numbers in these areas have five to ten-fold (Martin *et al*., 1995) and a decline in forage production by fungus damage will reduce meet production and ranchers' income. Information that shows how *Pyricularia* will affect buffelgrass forage production as well as seed quantity and quality does not exist. The objective of this study was to measure how much buffelgrass forage and seed will be affected by the fungus at different ranches in central Sonora Mexico.

Methods

The study was conducted on three ranches during 2016-2017 in Sonora, Mexico, to determine the effect of leaf blight on seed production and the economic impact on ranchers. Ranches selected were la Loma, located 15 km west of Santa Ana; El Águila ranch, located 20 km south of Santa Ana, Sonora; and Pozo Crisanto ranch, located 86 km north of Hermosillo. Pastures damaged by the pathogen were selected to evaluate the number of affected plants. Evaluated variables were number of young and adult plants affected, plant density, gross seed production, clean seed production, percentage of loss in harvested seed, seed cost, net profit from seed sales and economic loss due to fungus damage. The number of damaged and undamaged adult and young plants was determined by quantifying the total number of plants present in 10 quadrats of 10 x 20 m in each ranch. In each plot, the degree of damage was quantified in three categories. The scale used was created using the three categories: (1) No damage or very slight damage, when the plants showed green foliage and no chlorotic or spotted symptoms typical of the pathogen were present and less than 10% damage was shown in the total of foliage, (2) Light damage, when the plants showed between 11 and 30% of the leaf material damaged, and (3) Moderate damage, when the plants showed between 31 and 50% of foliage with damage. Data were analyzed using ANOVA ($P \leq 0.05$ (Steel and Torrie, 1980)). To estimate the cost of clean buffel grass seed, three of the main harvesters and seed producers in the state were interviewed in order to ask the cost of selling it during the production periods of 2017 and 2018, which resulted in $90.00 per kilogram for sale, with an average germination that varied from 27.9 to 37.8% and a viable seed percentage from 79.5 to 92.0%, the same information was compared with the Department of Machinery Division of the Cattlemen Union of Sonora, (UGRS, 2017). The net profit from the sale of seed in each farm was estimated by multiplying the kg of clean seed/hectare harvested in each farm, by the cost of the clean seed assigned previously. The economic loss in seed production associated with *Pyricularia*

damage was determined by difference, comparing its production in areas with light and moderate damage against the production achieved in areas without damage.

Results

Precipitation was 10 to 40% above the average at all sites and in all years of the study. From 46 to 59% of the buffel grass plants showed some damage. Leaf blight caused significant damage ($P \leq 0.05$) to buffelgrass plants at all evaluation sites (Table 1). Null to very light plant damage was found in 31.5-36.6% of the plants, slight damage in 21.3-42.8%, and moderate damage in 25.7-42.1%. More importantly, even new buffelgrass seedlings 5 to 10 cm tall show severe fungus damage.

Although on average 38.9% of the total plants in the grasslands showed no to very light damage, 61.1% showed light to moderate damage. Adult plants, which generally represent the largest volume of coverage of the occupied land, showed a varied intensity of damage. Lightly damaged plants represented between 31.5 and 48.7% of the plants in all farms, with moderate damage between 19.8 and 42.8% of the plants were detected and with intense damage between 25.7 and 42.1% of the plants.

The production of raw seed was affected ($P \leq 0.05$) by the damage from the fungus (Table 2) and varied from 61.4-81.8 kg/ha for no damage, 46.2-53.8 kg/ha for light damage, and 28.6-36.9 kg/ha for moderate damage. Clean seed was also affected by the pathogen. The cost of clean seed for sale averaged $90.00 Mexican pesos during 2017 and 2018, and the clean buffelgrass seed produced was different ($P \leq 0.05$) among treatments. Clean seed averaged 41.27, 30.9, and 17.3 kg/ha for areas with no damage, light damage, and moderate damage, respectively, representing a net profit from seed sales of $3,714.3, $2,781.0, and $1,557.0 pesos/ha for areas with no damage, light damage, and moderate damage, respectively. Therefore, the loss caused by fungal damage was $933.0/ha in areas with light damage and $2,157.3/ha in areas with moderate damage.

Table 1. Degree of leaf blight damage in adult buffelgrass plants in three locations during the summers of 2016 and 2017 in the central region of Sonora, Mexico.

Degree of Damage	Ranches			Average
	La Loma	El Águila	El Pozo	
None to very Light	31.5 b*	36.6 b	48.7 a	38.9
Light	42.8 a	21.3 c	19.8 c	28.0
Moderate	25.7 c	42.1 a	31.5 b	33.1
Total	100	100	100	100

* Means between treatments with different lowercase letters are different ($P \leq 0.05$).

Table 2. Production of raw seed of buffelgrass (kg/ha) affected in various intensities by leaf blight during the summers of 2016 and 2017 in three cattle ranches in the central region of Sonora, Mexico.

Degree of Damage	Ranches			Average
	La Loma	El Águila	Pozo Crisanto	
None to very Light	81.8 a*	71.9 a	61.4 a	71.7
Light	53.8 b	46.2 b	48.4 b	49.5
Moderate	36.9 c	28.6 c	34.6 c	33.4
Average	57.5	48.9	48.1	

* Means between treatments with different lowercase letters are different ($P \leq 0.05$). The average is the result of two years of harvest.

Discussion

The results of this study agree with those reported by FAOSTAT (2010); Baker et al. (1997), Yoon et al., (2011) and Shirasawa et al. (2012), on the susceptibility of the grass family such as corn and rice, reporting that the plants are not equally damaged by *Pyricularia,* varying from 10 to 15% of the annual yield losses. In the case of common American buffelgrass, the results in this study show a reduction in foliage of 61% in plants that present light to moderate damage. In Tamilnadu, India, in rice cultivation this is one of the most devastating diseases in susceptible cultivars, causing a yield loss of up to 90% (Mehrotra, 1998; Jaiganesh et al., 2007).

Blight affects the foliage of plants, directly interrupting the synthesis of chlorophyll production, which influences the seed production capacity and quality of the affected plants (Díaz et al., 2007), Consequently, the spikes do not develop completely, since the florets do not have complete caryopses or are empty. On the other hand, it has been shown that the quality of the seed is affected due to the physiological disorders suffered by the plant, reporting losses of up to 11% of chlorophyll, 20 to 26% in biomes, 13% in protein and 30% in the digestibility (González, 2002). This is very important, especially for producers who sow or use the seed for the rehabilitation of buffel pastures, since, in the grass seed, the pathogen is found that can be transmitted and transported to other areas where it does not exist and runs the risk of contaminating

Conclusions and implications

Common buffelgrass plants were damaged by leaf blight, but not all plants in the prairie were similarly affected, seedlings from 5 to 10 cm tall were also severely attacked by the pathogen. We concluded that leaf blight affects the seed production of buffelgrass, and necessary measures must be taken to reduce plant and seed damage. Ranchers with buffelgrass pastures under similar conditions can expect a 25.1 to 58.0% decrease in annual seed production, representing approximate losses of $933.00 to $2,157.00 pesos per hectare per year.

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