

Distribution and Importance of *Striga Hermonthica* on Tef [*Eragrostis Tef* (Zucc.) Trotter] in Tigray Regional State, Ethiopia

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Abstract

In Tigray, the problem of *Striga* was historically associated with the cereal culture mainly crops such as sorghum, maize and finger millet. Recently, this parasitic weed is expanding its host range and becoming increasingly important on other crops including tef and several wild kinds of grass. A Survey was conducted in 2016/17 main cropping season; to assess the distribution and importance of *Striga hermonthica* infesting on tef production areas and to record the *Striga hermonthica* infestation level and severity on tef production. The survey was done around 5-10 km interval along the main road which are accessible for a vehicle. At each sampling area, 2m × 2m sampling was taken to estimates of the average *Striga* population density (number/m²). As a result, the distribution and severity of *Striga* were highest in the Central followed by the Northwest and Eastern Zones. The overall *Striga* incidence in 32 tef field samples from districts with *Striga* was 90.6%. The highest density of *Striga* shoots per m² was recorded at Tahtay Maychew followed by Lailay Maychew, Tahtay Koraro and Adwa respectively. In addition to *Striga* infestation, *Setaria pumila* and *Phalaris paradoxa* were the most frequent and dominant weed species in the surveyed areas of tef. Therefore, to minimize and manage the spread of *Striga hermonthica* infestation on tef all stakeholders should collaborate through participatory approaches and adopt appropriate measures.

Keywords: Distribution; *Eragrostis*; *Striga hermonthica*; Tef

Introduction

Striga hermonthica is the main important production constraints of cereals in Ethiopia. It has spread dramatically in the past few decades, now occurring in almost all low and mid-altitude cereal growing regions. Of the various species of *Striga* which attack crop plants across the country, *Striga hermonthica* is endangering for sorghum and maize production; mainly in areas where these crops are grown intensively. *Striga hermonthica* is mostly harmful in the dry and low soil fertility areas, particularly farmers who can't fulfil the inputs required to minimize losses caused by this weed. Recent evidence indicates that the situation in our country is only getting worse. As a result, the lives of many millions of people are threatened by this single species alone. Tef is infested by annual broadleaf weeds, grasses, and sedges throughout the regions where it is grown. Also, it is infested by parasitic weeds species particularly by the *Striga hermonthica*, which is commonly known as witchweed. In Ethiopia, the occurrence of *Striga* on sorghum, maize, and finger millet has been reported in detail, little attention was given to the problem of *Striga* on tef. The reason for the lack of appreciation of the severity of the problem might have been the absence of information about the extent and distribution of *Striga* infestation on tef. However, during a sideways survey of sorghum, maize, and finger millet, *Striga* infested tef fields have been observed in some regions such as Northern Wello Zone in Amhara, Western, Central and Southern Zones of Tigray and West Hararge Zone in Oromia region of Ethiopia. The outcomes of those survey confirmed that *Striga hermonthica*, having become widespread on sorghum, maize, and finger millet has been brought

into contact with tef as planted after those crops. This may be the nature of genetic versatility of *Striga hermonthica* can colonize new host species. However, all authors noted that weed survey made in all areas were largely based on visual observation which do neither indicate the magnitude nor the economic importance of *Striga* on tef, wheat and barley [1].

The occurrence of *Striga* on tef is a recent development and yet it happens to be a rapidly growing problem of major concern. The increased susceptibility of tef could probably be due to either of the new strain evolving with a special ability to attack the crop or accidental exposure of very susceptible tef cultivars to a highly virulent *Striga* population.

In either case, a strong effort has to be made to make farmers and development workers aware that special attention should be given to *Striga* problem on tef. Unlike the case of tef, where some controversy still exists as to the importance of the *Striga* problem, the importance and distribution of *Striga* on sorghum, maize, and finger millet in Ethiopia are well documented. It was, therefore, important to resolve this issue through an extensive survey in the major tef growing areas of the country. Hence, this survey targeted specific locations where tef is affected by *Striga* to assess the distribution and importance of *Striga hermonthica* infesting on tef production areas and to record the *Striga hermonthica* infestation level and severity on tef production in the respective administrative districts of the study areas [2].

Materials and Methods

Descriptions of the study areas

The survey was carried out in the Northern parts of Ethiopia particularly in Tigray Region which is located between 12°15'-14°49' N latitude and 36°27'-40°00' E longitude.

The region covers an area of 80,000 km most of which is highland plateau interspersed with low lying hills and flatlands with an altitude range of 1,500-3,000 m.a.s.l. The climate is characterized by high variability of temperature with elevation and, the temperature falls up to 0.6°C every 100 m altitude.

Overall temperature ranges from 5°C to 40°C. Rainfall is highly variable in the region and with some exceptions, it ranges from 400 mm-800 mm. which makes the region usually faces moisture deficit problem. The predominant soil types are lithosols, red clay loam, nitosols and sandy clay loams with characteristic low organic matter content and low moisture-holding capacity.

Tef, sorghum, maize, barley and wheat are some of the widely grown food crops in the region. Cotton and sesame are cash crops mainly produced by commercial farms in the western lowlands. The two most important kinds of cereal are tef and sorghum covering 22.5% and 14.5% of the cropland, respectively.

Data collection and sampling techniques

The data collection for the survey was started from September up to November for two consecutive years (2016-2017). It started with an informal, exploratory survey to get some basic preliminary information and insights on the survey sites and the extent of the problems at hand. Then after, the survey areas were designated based on the area under tef cultivation and previous reports of *Striga* infesting tef.

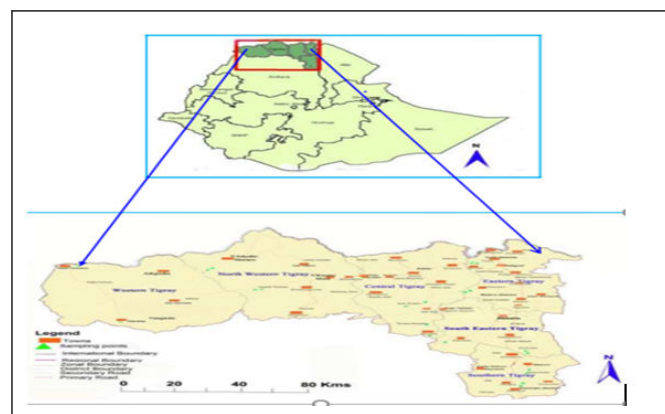


Figure 1: Map of the study area

Field samples were taken from selected districts at regular intervals 5-10 km along the main roadsides. Small roads were also used to cover areas as much as possible [3].

Fields were selected to be representative of typical tef growing conditions found in each district. The incidence of *Striga* was measured by counting *Striga* shoots on four random samples of 4 m².

The longitude and latitude of each stop were fixed using a GPS 60 GARMIN to facilitate mapping of *Striga* distribution on tef in the region. Estimates of the average *Striga* population density (number/m²) and *Striga* incidence for each district were extrapolated from field samples.

A total of 32 fields were observed in different districts. The *Striga* infestation level in tef fields was estimated using a rating scale from 0 to 6 according to Schmitt.

Rating scale	Infestation	Definition
0	Not infested	No <i>Striga</i> emerged
1	Very low	10% of <i>Striga</i> cover the sample field
2	Low	15 -20% of <i>Striga</i> cover the sample field
3	Moderate	40% of <i>Striga</i> cover the sample field
4	High	50 -75% of <i>Striga</i> cover the sample field
5	Very high	90 - 95% of <i>Striga</i> cover of the sample field
6	Destroyed	Host plants dead, no yield

Table 1: A Rating scale for *Striga hermonthica* weed species.

Subsequently, a random sampling procedure was used to select farm household respondents to supplement the field survey and obtain information on areas that were accessible to the field survey.

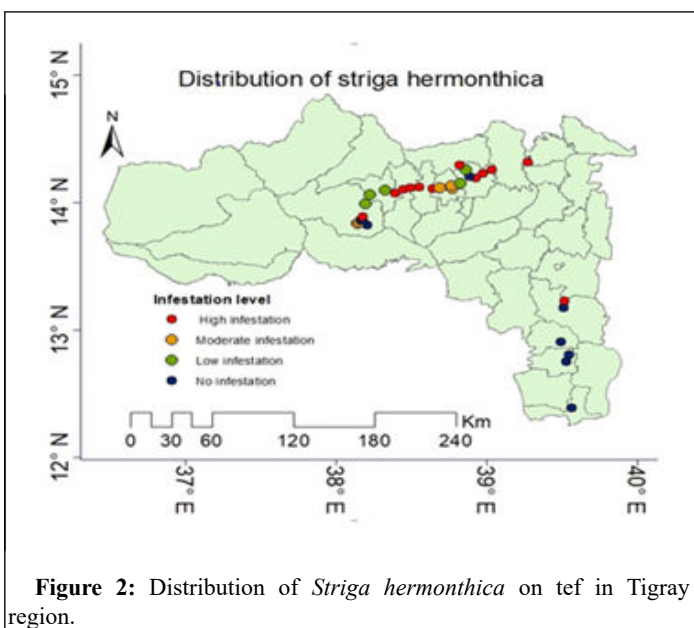
The questionnaire consisted of open-ended and structured questions on the importance of *Striga* on tef, spread and trend of *Striga* incidence on tef, abandoned tef production fields due to *Striga* and how long *Striga* has been a problem on tef. All the collected data were

analyzed using descriptive statistical methods.

Results and Discussion

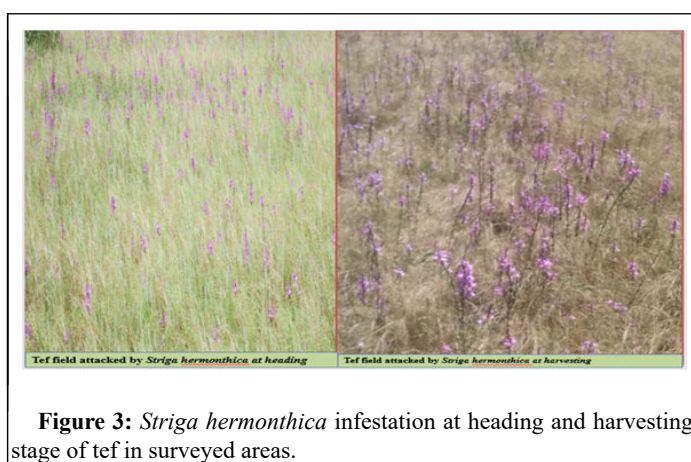
The surveillance covered 13 districts in the Central, South, South-east, North-west and East Zone of Tigray regional state of Ethiopia (Figure 2). Based on the survey result, *Striga hermonthica* was distributed throughout the study areas. Out of a total of 32 samples of

tef fields in different districts; 29 fields (90.6%) were found to be infested with *Striga* (Figure 2). However, the incidence and infestation level of *Striga* were greatly varied among field samples within a district and also among districts in varying degrees from slight to heavy infestation. Accordingly, the distribution and severity of *Striga* were highest in the Central followed by the Northwest and Eastern zones. Almost above half of the districts were found to have more than 40% of their tef fields infested with *Striga*. This could be the cropping system of the farmers predominantly cereal-based like tef, sorghum, maize, wheat and finger millet [4]. Thus, the introduction of tef into sorghum/millet-based cropping systems can contribute to a reduction of *Striga* seed density in the soil but the effect may not be lasting. This phenomenon is most likely due to changes in the genetic composition of the *Striga* population. The frequent cropping of tef results in the selection and gradual reproduction of races which are phenologically and physiologically adapted to tef thereby increasing *Striga* reproduction on this crop. This is in agreement with the observation that when a sorghum field infested with *Striga hermonthica* is replaced by other crops, the new crop will be infested by *Striga* after a few years; this is dependent on the intensity of *Striga* seed in soil. Similarly, Welsh and Mohamed also reported that *Striga hermonthica* populations associated with historically important and widely grown host crops such as sorghum and pearl millet may have coexisted with their hosts for a longer period than populations associated with unconventional hosts [5].



In all ecological zones, farmers designated *Striga* with a precise name which is associated with its effect, known as 'akilt' and 'akenchra.' This showed that farmers had awareness of this pest and perceived *Striga hermonthica* as the most damaging weed and most difficult weed to control; especially for sorghum production. Other weeds ranked as serious constraints were *Phalaris paradoxa* and *Setaria pumila*. Occasionally, *Eragrostis cilianensis*, *Elusinia indica*, *Digitaria abyssinica* and *Cynodon dactylon*, were considered major weeds by some farmers. All weeds which farmers perceived as their most important problem were encountered in most fields during field monitoring. Most farmers believed and field observation indicated that *Striga hermonthica* was more severe when tef is either heading or harvesting stage.

Farmers also agreed that *Striga* weed emerges in early September (after any control measure Like 2, 4-D and hand weeding) and stays up to harvest and showed stunted growth, wilting of the crop and finally abnormal stand of tef in the field. Farmers perceived that the use of fertilizers, fallowing, crop rotation, timely weeding, and intercropping tef with legumes may help in *Striga* management when used singly or in combination. However, farmers hardly implement *Striga* control methods mainly due to limitations associated with the technology itself or because the technology is not available to them or because of a lack of detailed information about these control options. Most farmers followed sole cropping of cereals due to personal preference and economic considerations such as the price of the crop also influence the farmers' choices and almost all of the farmers growing tef after finger millet and sorghum, resulting in an increasing *Striga* seed in the soil (Figure 3).



Conclusion and Recommendations

The survey results confirmed that *Striga* incidence and distribution is highly increasing in Tigray region from year to year and from locality to locality, widening its host range. Recently, tef is considered as an occasional host of *Striga* because the infestation on tef is considerably high when it follows a severely infested crop, mainly sorghum. The unchecked rapid spread of *Striga* could threaten tef production in light of the inherent sensitivity of tef to this parasite weed. The survey result showed that almost all fields of tef in the surveyed areas were infested by *Striga* population and causing substantial tef yield losses. *Striga hermonthica* was spread over all the surveyed areas with altitudes ranging from 1525-2647 m.a.s.l. However, its infestation was not even across the survey areas. The highest *Striga* shoot count per m² was recorded at Tahtay Maychew district. Whereas, the lowest density of *Striga* was recorded from Endamehoni. Farmers have many sources of experience on *Striga* control measures mainly from their parents, visual observation, crop damage and from traditional knowledge to minimize its negative effect. However, their work realized that no effective and sustainable *Striga hermonthica* control method. In general, the status of *Striga hermonthica* in the region is severe and the survey result indicated that the situation could get worse unless an inter-institutional effort is done to train and increase the awareness of extension staff and farmers. Therefore, the problem of *Striga hermonthica* on tef crop must be addressed by all the concerned body in terms of varietal resistance and host range study, use of nitrogenous fertilizer and farmyard manure, time of planting, need for diversification into pulse crops and screening of herbicides to control or eradicate this weed.

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