P-ISSN: 2305-6622; E-ISSN: 2306-3599

International Journal of

Agriculture and Biosciences

www.ijagbio.com; editor@ijagbio.com

Research Article

# Distribution and Importance of *Striga hermonthica* on Tef [*Eragrostis tef* (Zucc.) Trotter] in Tigray Regional State of Ethiopia: A Preliminary Survey

Shugute Addisu and Gebrekidan Feleke

Ethiopia Institute of Agricultural Research, Debre Zeit Agricultural Research Center, Bishoftu, Ethiopia
***Corresponding author:** ashugute@yahoo.com; gebrekidan336@gmal.com

**Article History:** 20-1276 Received: 21-Jan-21 Revised: 20-Mar-21 Accepted: 03-Apr-21

**ABSTRACT**

Historically, the issue of Striga was associated with the cereal culture in Tigray, primarily with crops such as sorghum, maize and finger millet. This parasitic weed has recently extended its host range and is becoming increasingly common in other crops such as tef and many wild grass types. A survey was conducted in the main cropping season of 2016/17; to determine the distribution and significance of *Striga hermonthica* infestation in tef production areas and to record the degree and intensity of *Striga hermonthica* infestation on tef production. The survey was carried out along the main road, which is accessible for a vehicle; at an interval of about 5-10km. The average of Striga population density (number /m2) was taken at each sampling area of 2m x 2m sampling. 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 $m^2$ was recorded at Tahtay Maychew (49) followed by Lailay Maychew (46), Tahtay Koraro (45) and Adwa (41), 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. All stakeholders should therefore collaborate through participatory approaches and take appropriate measures to minimize and manage the spread of Striga hermonthica infestation on tef.

**Key words:** Distribution, *Eragrostis tef, Striga hermonthica,* Tef.

## INTRODUCTION

*Striga hermonthica* is the main important production constraints of cereals in Ethiopia (Fassil, 2002). It has spread dramatically in the past few decades, now occurring in almost all low and mid-altitude cereal growing regions (Wondimu and Rezene, 1987). 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 (Fasil and Parker,1987; Atsbha *et al*., 2016). *Striga hermothica* 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 (Gebremedhin *et al*., 1998; Wondimu *et al*., 1999). 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

**Cite This Article as:** Addisu S and G Feleke, 2021. Distribution and importance of *Striga hermonthica* on tef [*Eragrostis tef* (Zucc.) trotter] in tigray regional state of ethiopia: a preliminary survey. Int J Agri Biosci, 10(2): 69-73. www.ijagbio.com 

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.

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.

## 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 arc 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 (Fassil, 2002).

### 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. 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. 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 $4m^2$. 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 $/m^2$) 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 (Schmitt, 1981).

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 (Table 2). This could be the cropping system of the farmers predominantly cereal-based like tef, sorghum, maize, wheat and finger millet. 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 (Olivier *et al*., 1998). Similarly, Welsh and Mohamed (2011) 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 (e.g., finger millet, tef).

In another view, the region is characterized by abnormal distribution and intensity of rainfall, poor fertility and structure of the soil (Tewodros *et al*., 2009) and the level of Striga infestation is strongly correlated with the

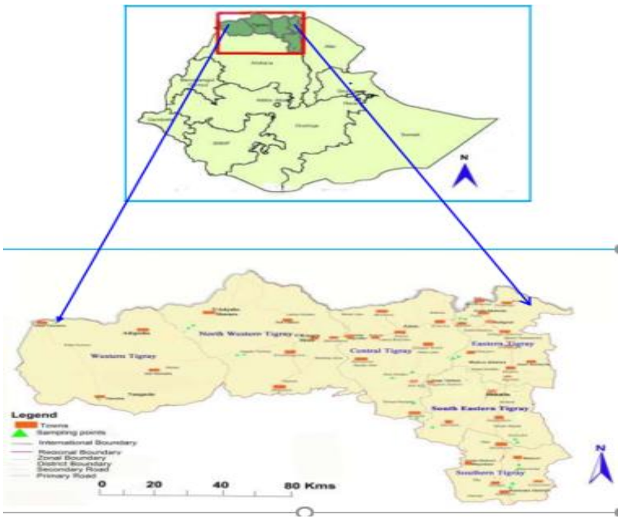


**Fig. 1:** Map of the study area.

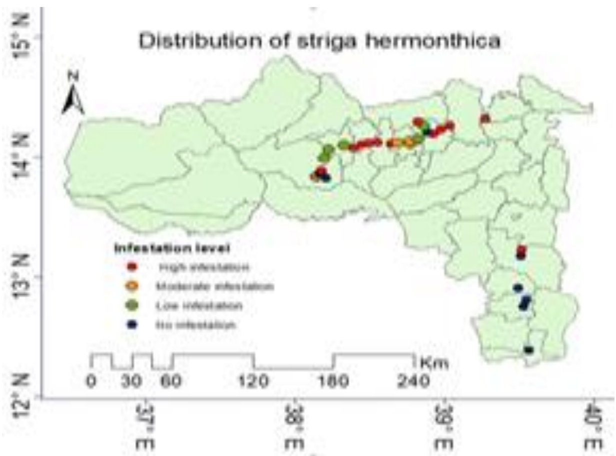


**Fig. 2:** *Distribution of Striga hermonthica on tef in Tigray region.*

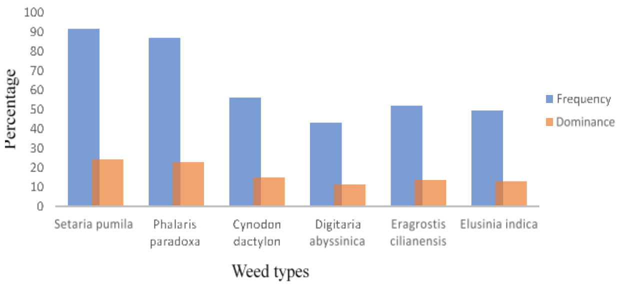


**Fig. 3:** Frequency and dominance of weed types infesting tef field in survey areas.


**Fig. 4:** Striga hermonthica infestation at heading and harvesting stage of tef in surveyed areas.

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

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

decline of soil fertility (Samaké *et al*., 2005; Parker, 2008). Therefore, the highest Striga infestation might be an association with moisture retention, nutrient holding capacity and rate of organic matter decomposition of the soils. This is in agreement with the findings of (Atsbha *et al*., 2016) who states that the highest level of Striga infestation was found at Tigray which had got low soil organic matter and available phosphorous and sandy texture of the soils. The result of the survey also indicated that the highest Striga density per $m^2$ was recorded at Tahtay Maychew (49), Lailay Maychew (46), Tahtay Koraro (45), Asegede Tsimbela (44), and Adwa (41) respectively (Table 2). Whereas, the lowest density of Striga was recorded at Endamehoni. This could be due to the differences in the use of inputs (like nitrogen fertilizer) and cropping history of the study areas. Frequent cereals-based cropping system directly associated with the densities of *Striga hermothica* on crops. In addition to this, the climatic conditions with a pronounced dry season and the predominant soils, which are mostly sandy soil of shallow depth, are highly suitable for Striga population.

Apart from Striga, some weed species were identified; which mostly belong to Poaceae family. The frequency of the occurrence of individual weed species ranged from 43.1% up to 91.5%, while the infestation level ranged from 11.3% up to 24.2%. Among these *Phalaris paradoxa* and *Setaria pumila* weeds were the most frequent and dominant weed species in the survey areas (Figure 3). Weed species having frequency and dominance occurred rarely and at low density, levels were not included in the data. Weed species which had frequency and infestation levels greater than 30% and 5%, respectively, were considered as major weeds because they constituted 50 to 90% of the total weeds infesting the cereal fields.

In all ecological zones, farmers designated Striga with a precise name which is associated with it' 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 (Figure 3). Most farmers believed and field observation indicated that *Striga hermonthica* was more severe when tef is either heading or harvesting stage as shown in Figure 4.

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

**Table 2:** Distribution and infestation level of *Striga hermonthica* on tef fields in some districts Tigray Region

| Zone | District | Area (km$^2$) | Sample position | | | Mean *Striga*/m$^2$ | *Striga* Incidence |
|---|---|---|---|---|---|---|---|
| | | | Latitude | Longitude | Elevation (m) | | |
| Central | Adwa | 673.07 | 14.15 | 38.82 | 2030 | 13 | low |
| | | | 14.19 | 38.93 | 2090 | 41 | high |
| | | | 14.21 | 38.88 | 1982 | 0 | no infestation |
| | | | 14.23 | 38.98 | 2093 | 39 | high |
| | | | 14.26 | 38.86 | 2065 | 10 | low |
| | Ahferom | 1339.84 | 14.26 | 39.03 | 2189 | 37 | high |
| | Lailay Maychew | 570.75 | 14.11 | 38.77 | 2084 | 21 | moderate |
| | | | 14.11 | 38.64 | 2105 | 46 | high |
| | | | 14.12 | 38.69 | 2097 | 18 | moderate |
| | | | 14.13 | 38.77 | 2106 | 23 | moderate |
| | Tahtay Maychew | 597.58 | 14.12 | 38.55 | 2190 | 49 | high |
| | Mereb Lehe | 1221.80 | 14.29 | 38.82 | 1802 | 38 | high |
| South | Endamehoni | 630.64 | 12.75 | 39.53 | 2434 | 2 | very low |
| | | | 12.81 | 39.55 | 2441 | 1 | very low |
| | Alamata | 696.17 | 12.39 | 39.57 | 1525 | 3 | very low |
| | Ambalaje | 757.87 | 12.91 | 39.49 | 2647 | 0 | no infestation |
| North West | Asegede Tsimbela | 2354.65 | 13.82 | 38.21 | 1668 | 2 | very low |
| | | | 13.84 | 38.14 | 1603 | 17 | moderate |
| | | | 13.85 | 38.16 | 1630 | 22 | moderate |
| | | | 13.86 | 38.17 | 1650 | 2 | very low |
| | | | 13.86 | 38.17 | 1651 | 0 | no infestation |
| | | | 13.86 | 38.18 | 1674 | 3 | very low |
| | | | 13.89 | 38.18 | 1717 | 44 | high |
| | | | 13.99 | 38.20 | 1815 | 7 | low |
| | Medebay Zana | 1062.38 | 14.10 | 38.45 | 1990 | 33 | high |
| | | | 14.12 | 38.50 | 2044 | 39 | high |
| | Tahtay Koraro | 645.54 | 14.06 | 38.23 | 1862 | 18 | low |
| | | | 14.07 | 38.39 | 1967 | 45 | high |
| | | | 14.10 | 38.33 | 1924 | 11 | low |
| East | Ganta Afeshum | 527.91 | 14.32 | 39.27 | 2027 | 34 | high |
| South East | Hintalo Wajirat | 1735.59 | 13.18 | 39.51 | 2186 | 3 | very low |
| | | | 13.23 | 39.51 | 2065 | 12 | high |

Note: no infestation=0, very low=10%, low =10-15%, moderate=40% and high= 50-75%.

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 & sorghum, resulting in an increasing Striga seed in the soil.

## Conclusions 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 1525-2647m.a.s.l. However, its infestation was not even across the survey areas. The highest Striga shoot count per m$^2$ 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.

## REFERENCES

Atsbha Gebreslasie, Taye Tessema, Ibrahim Hamza and Demeke Nigussie, 2016. Association of Striga Infestation to Basic Chemical and Physical Properties of the Soil in Tigray Region, Northern Ethiopia. Advances in Physics Theories and Applications, 53: 222.

Fasil Reda and Chris Parker, 1987. Review of Glass House and Laboratory Experiments on Striga. Pp 38-45. In:

Rezene Fessehaie and C. Parker eds. Problems and Control of Parasitic Weeds in Ethiopia. Proceedings of the Second Ethiopian Weed Science Workshop. 29-30 September 1. 988, Addis Abeba, Ethiopia. EWSC, Addis Abeba.

Fassil Reda, 2002. Striga hermonthica in Tigray Northern Ethiopia; Prospects for control and improvement of crop productivity through mixed cropping. Doctorate Thesis of the Institute of Ecological Science, Vrije Universiteit Amsterdam.

Gebremedhin Weldewahid, Beyenesh Zemicheal and Ibrahim Fitiwy. 1998. The status of the Striga problem in Tigray. In: Fasil Reda and D.G. Tanner eds..1998. Arem 4: 28-36. EWSS. Addis Abeba.

Olivier A, Glaszmann JC, Lanaud C and Leroux GD, 1998. Population structure, genetic diversity and host specificity of the parasitic weed Striga hermonthica Scrophulariaceae in Sahel. Plant Syst Evol 209: 33-45.

Parker, C. 2008. Observations on the current status of Orobanche and Striga problems worldwide. Pest Management Sci. 65: 453-459.

Samaké O, Smaling EM, Kropff A, Stomph MJ and Kodio A, 2005. Effects of cultivation practices on spatial variation of soil fertility and millet yields in the Sahel of Mali. Agriculture, Ecosystems and Environment. 109: 335-345.

Schmitt U. 1981. Untersuchungen Zur Verbreitung und Becampfung von Orobanche crenata Forsk. An Ackerbohnen in Marokko Diss. Univ. Bonn.

Tewodros Mesfin, Gebreyesus Berhane, Wortmann CS, Olani Nikus, and Martha Mamo, 2009. Tied ridging and fertilizer use for sorghum production in semi-arid Ethiopia. Nutr Cycl Agro-ecosystem, 85: 87-94.

Welsh AB and Mohamed KL, 2011. Genetic diversity of Striga hermonthica populations in Ethiopia: evaluating the role of geography and host specificity in shaping population structure. Int J Plant sci, 172: 773-782.

Wondimu Welde Hanna, Shemelis Hassen and Ayenalem Ayele. 1999. The distribution of Striga in Oromia region. In: Fasil Reda and Tanner, D.G. eds. Arem 5: 75-84. EW SS, Addis Abeba.

Wondimu Wolde-Hanna1 and Rezene Fessehaie. 1987. The Striga Problem in State Farms. p. 7-9. In: Rezene Fessehaie and C. Parker eds. Problems and Control of Parasitic Weeds in Ethiopia. Proceedings of the Second Ethiopian Weed Science Workshop. 29-30 September 1988, Addis Abeba, Ethiopia. EWSC, Addis Abeba.