Determination of *Orobanche* spp. distribution and occurrence in North Gondar, Ethiopia

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ABSTRACT

The survey was done on major pulse crop growing districts with the objective of assessing the distribution and occurrence of Orobanche spp. in the highlands of North Gondar. Representative Farmer's fields from selected seven districts were assessed in every 5-10 km interval along the road ride to record the incidence, prevalence and severity of Orobanche spp. In all surveyed districts of N. Gondar Orobanche crenata was found with the highest prevalence and incidence of 85.71% and 10.71%, respectively on fields covered with Linseed. Among districts, the highest prevalence of 66.67% was recorded on both Chilga and Gonder zuria districts. In addition to this, a maximum severity of 3 out of 6 (i.e. majority of host plants infected with two shoots) was recorded only on two fields out of all fields surveyed of the seven districts. During the survey, it was found that Xanthium strumarium was its wild host. Finally, awareness creation and establishment of quarantine system should be done to minimize the dissemination of parasitic weed seed to other areas within the administrative zone and the region. Likewise, different management options should be developed in the future not only to minimize the yield loss due to Orobanche crenata but also to manage its wild hosts like Xanthium strumarium.

Keywords: *Orobanche crenata*, Pulse crops, *Xanthium strumarium*

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INTRODUCTION

The genus *Orobanche* L. (broomrape) comprises some one hundred parasite species associated with various host plants and growing throughout the world (Kojic et al., 2001). *Orobanche* spp. have threatened legume crops since antiquity and affect the livelihood of many nations (Joel et al., 2007). Heavy Orobanche infestation does not only lead to a complete crop failure, but make field soils Orobanche-sick over a long period of time, preventing the reasonable production of legumes and vegetables in the infested fields for many years to come (Evidente et al., 2011).

Orobanche species are parasitic on a wide range of plant families (Asteracea, Fabaceae, Solanaceae, Apiaceae, Cucurbitaceae) (Linke et al., 1989; Suh et al., 2014). Yield losses range

from 5 to 100% depending on the region and crop. In addition, a single broomrape plant can release more than 500,000 seeds, which are known to remain viable for decades in the soil. This provides the parasite with a great genetic adaptability to environmental changes, including host resistance, agronomical practices and herbicide treatments (Joel et al., 2007).

The growth of the parasite depends on water, mineral and organic compounds from the host. Due to the withdrawal of water, minerals and organic compounds by the parasites, the growth of the host is retarded, and crop yields are lowered or reduced to zero under conditions of severe infestation. Growth of *Orobanche* spp. shoots becomes very rapid during that period and it causes lack of carbohydrate in the host roots. Depending on environmental conditions, the underground phase of the life-cycle of *O. crenata* ranges from 30 to approximately 100 days. The life cycle from seed germination to seed production is about 3-5 months (Suh et al., 2014).

Orobanche species exert their greatest damage prior to their emergence; therefore, the majority of field loss may occur before diagnosis of infection. Annual food crop losses due to *Orobanche* spp. infestation was estimated at about $1.3 to 2.6 billion (Ghannam et al., 2007). *Orobanche* species are distributed worldwide from temperate climates to semi-arid tropics except for *Orobanche crenata* whose distribution is restricted to the Mediterranean regions, the Middle East and East Africa (Evidente et al., 2011).

Parasitic weed like *Orobanche* is one of the production constraints of food legume crops in the country and the distribution of this parasitic weed increases from time to time in Ethiopia. Thus, the survey was done with the aim of assessing the distribution and occurrence of *Orobanche* in the high lands of North Gondar zone.

MATERIAL AND METHODS

Description of the study area: Field survey was conducted in the main cropping season of 2014/15 on the major pulse growing areas of North Gondar. It is located 12.4500° N latitude and 37.0000° E longitude. North Gondar is bordered on the South by Lake Tana, West Gojjam, Agew Awi and the Benishangul-Gumuz Region, on the West by Sudan, on the North by the Tigray Region, on the East by Wag Himra and on the southeast by South Gondar. Pulse crops mainly grown at Debark, Dabat, Wogera, Gondar zuria, Taqusa and Chilga districts.

Survey of *Orobanche* spp. in North Gondar: Representative farmer's fields were assessed in every 5 km interval along the road ride to determine the distribution and occurrence of *Orobanche*. The incidence *Orobanche* were taken by classifying in to three categories: Low (less than 20% infestation), Medium (20-50% infestation) and high (more than 50% infestation) and the severity was measured using a 0-6 scale (Kroschel, 2001).

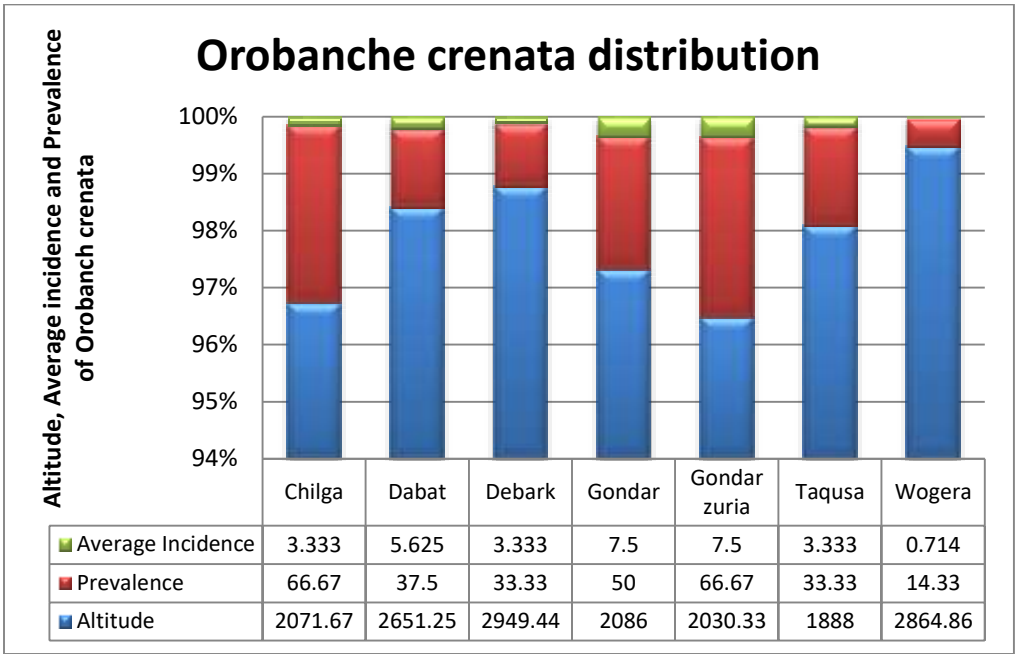
Table 1: Severity scale used in assessment of *Orobanche* spp. distribution in North Gondar

Rating scale	Infestation	Definition
0	Not infested	No *Orobanche* emerged
1	Very low	Very few *Orobanche* shoots in the whole field
2	Low	Few *Orobanche* shoots in the whole field
3	Moderate	Majority of the host plants infected with 2 shoots
4	High	Host plants infected with more than 2 shoots
5	Very high	All host plants infected with more than 5 shoots fields seemed to be an *Orobanche* field
6	Host plant completely destroyed	Host plants dead, no yield

RESULT AND DISCUSSION

The field survey covered major pulse producing districts in North Gondar administrative zone with an altitude ranging from 1838 to 3151 meter above sea level. In all surveyed areas, low to medium *Orobanche* spp. was recorded. The *Orobanche* spp. found in surveyed areas of North Gondar was *Orobanche crenata* and its prevalence varied with altitude across districts.

Crops with poor crop condition were severely infested with *Orobanche crenata*. The highest prevalence of *Orobanche crenata* was recorded around Chilga and Gondar zuria districts with an average altitude of 2071 and 2030 meter above sea level followed by Gondar town with an average altitude of 2086 meter above sea level (Fig 1). In agreement with this study, Gonzáles-Andújar et al. (2001) indicated that *Orobanche crenata* does not always show a uniform geographical distribution in the invaded areas.



	Chilga	Dabat	Debark	Gondar	Gondar zuria	Taqusa	Wogera
Average Incidence	3.333	5.625	3.333	7.5	7.5	3.333	0.714
Prevalence	66.67	37.5	33.33	50	66.67	33.33	14.33
Altitude	2071.67	2651.25	2949.44	2086	2030.33	1888	2864.86

Fig 1: Prevalence and Incidence of *Orobanche crenata* at different altitude

Incidence of *Orobanche crenata* varies across surveyed districts. Out of the seven districts, four of them had low level of *Orobanche crenata* infestation. However, Medium level of infestation was recorded only on three fields covered with Field pea, Faba bean and Linseed crops at Gondar, Gondar zuriya and Dabat districts, respectively. The highest severity of *Orobanche crenata*, which was 3 out of 6, was recorded only on two fields covered with Field pea and Linseed at Gondar and Dabat districts.

Incidence and prevalence of *Orobanche crenata* varied with crop types (Fig 2). Fields covered with Linseed had highest incidence and prevalence of *Orobanche crenata*, 10.71% and 85.71%, respectively. In contrary, the least incidence of *Orobanche crenata* with wider distribution was recorded on fields covered with Faba bean (Fig 2). In addition to its association with Linseed, Faba bean and Field pea; *Orobanche crenata* were found by forming association with *Xanthium strumarium* weed in bare land and sorghum fields. In line with this, *Orobanche crenata* occurred across districts regardless of the crop production system, crop condition and crop type.

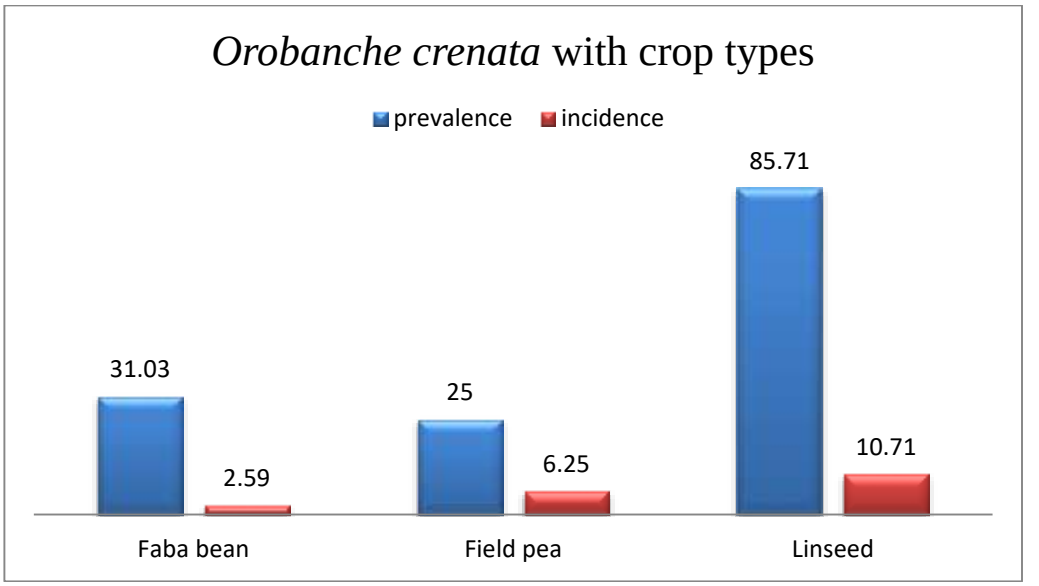


Fig 2: Prevalence and average incidence of *Orobanche crenata* with crop types

The variability in incidence and prevalence across surveyed districts either it might came from absence of *Orobanche crenata* seed in large amount in the soil or due to fluctuation in temperature. Temperature is one important abiotic factor that controls broomrape development. Soil temperature fluctuations during a warm wet period are required for the activation of germination hormones (Song et al., 2005).

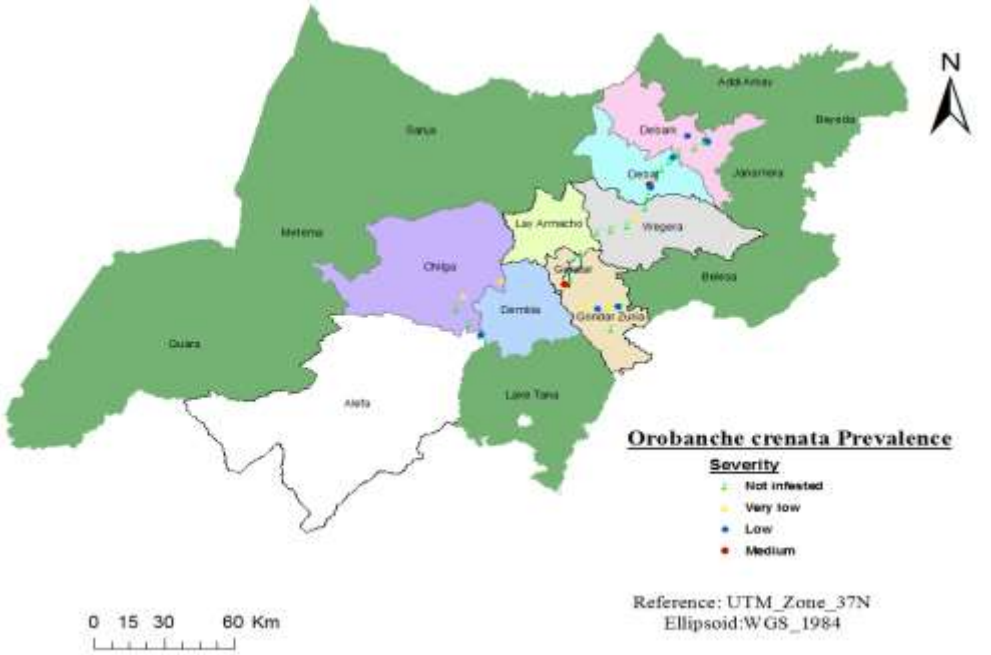


Fig 3: Map of districts assessed during the survey

Orobanche crenata was only recorded with a prevalence of 44.44% on fields having light soil. Soil texture can also influence the vegetation structure (Dodd et al., 2002). Likewise, Soil texture could have impact on the parasitic weed virulence. The increased coarse sand content was positively associated with *Orobanche* attack intensity under greenhouse conditions (Miladinović et al., 2012) and *Orobanche* spp. generally occurs on sandy soils where nitrogen availability is poor (Dhanapal et al., 1996). We observed that some farmers didn't have a clue about the parasitic weed. Likewise, during the survey we observed that without drastic measures to stop the spread of *Orobanche crenata*, it will reach to the level in which production pulse crop will be difficult and the whole area is at high risk of full scale infestation. Therefore, awareness creation to prevent the weed problem gradual increment in the area and establishment of quarantine system should be done to prevent the dissemination of the parasitic weed seed from one are to the other. Finally, development of integrated management options should be the focus in the future not only to minimize the yield loss due to the parasitic weed but also to manage its wild host.

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