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**Short communication**

# PRELIMINARY EVALUATION OF *PHYTOMYZA OROBANCHIA* (DIPTERA: AGROMYZIDAE) AS A CONTROLLER OF *OROBANCHE* SPP. IN ETHIOPIA

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**ABSTRACT:** In this study the effectiveness of *Phytomyza orobanchia* in the control of *Orobanche* spp. (broomrapes), a serious root parasite of tomato (*Lycopersicon esculentum* Mill.) and other members of the family Solanaceae in Ethiopia has been investigated. Out of the three locations surveyed, the fly *P. orobanchia* was found to occur only in Malima farm. The fly has shown effective destruction of *O. ramosa* and *O. cernua* seed capsules by 81.4% and 71.7%, respectively under natural conditions at Malima (Ethiopia).

**Key words/phrases: Biological control, Ethiopia, Orobanche spp., *Phytomyza orobanchia***

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## INTRODUCTION

*Orobanche* spp. (Orobanchaceae) are noxious root parasites which seriously constrain the production of many crops, particularly in the Leguminosae and Solanaceae families in Ethiopia (Parker and Riches, 1993).

Three species of *Orobanche* are known to be widespread in Ethiopia, of which the most common is *O. minor* Sm. This species mainly parasitizes wild ornamental plants of the family Asteraceae as well as other economically important crops such as sunflower (*Helianthus annuus* L.) and nuog (*Guizotia abyssinica* Cass.) (Stroud, 1989). The second species which is also very widespread on a range of different families such as Solanaceae and Cruciferae is *O. ramosa* L. It is found to cause a serious problem on tomato (*Lycopersicon esculentum* Mill.), tobacco (*Nicotiana tabacum* L.) and rapeseed (*Brassica napus* L.) in Ziway and Upper Awash Valley (Mohammed Gelma, 1991). The third species which is much more restricted in distribution is *O. cernua* Loefl. However, this species is a serious problem on tomato, egg plants (*Solanum melongena* L.) and tobacco in Upper Awash Valley, especially at Nura Era Horticulture Development Enterprise and around Nazreth (Parker, 1992).

Over 1000 ha of irrigated tomato were infested by *O. ramosa* and *O. cernua* at the Nura Era Horticulture Development Enterprise (Ahmed Sherif and Mohammed Gelma, 1992). Losses from heavy infestation of *O. ramosa* were estimated at 50–60% in tomato (Kassa Admasu[1], 1994, personal communication). Due to the *Orobanche* problem on tomato in Ethiopia, the Ziway Horticulture Enterprise has totally shifted from tomato to flower production (Ahmed Sherif and Mohammed Gelma, 1992). *Orobanche crenata* Forsk. is a localized recent problem on faba bean (*Vicia faba* L.) at Kedijo Geter and Kutaber near Dessie town (North Ethiopia). It has caused complete failure of faba bean at both localities (Assefa Admassu and Endale Berche, 1994).

Various control methods have been tested for broomrape control, but none has proved entirely satisfactory (Saghir, 1979; Pieterse, 1979; Saghir *et al.*, 1980;

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Jacobsohn, 1986; Korpff and Schippers, 1986; Linke and Saxena, 1991). The production of a large number of seeds (30,000-200,000 per plant) (Schroeder, 1994), which remain viable in the soil for more than ten years, and the intimate physiological interaction with their host plants limits the application of conventional weed control measures for *Orobanche* control.

Several records show that biological control of *Orobanche* has been successfully achieved in the field. The fly *Phytomyza orobanchia* Kalt., has been used successfully for *Orobanche* control in the former USSR and Eastern Europe (Lekic, 1970, 1974; Kurbanov, 1970; Bronshtien, 1971; Kapralov, 1974; Horvath, 1983; Klyueva and Pamukchi, 1983; Horvath and Wittmann, 1988). This fly occurs widely in Ethiopia, but it was too often killed by routine use of insecticides (Rezene Fessehaie and Parker, 1992). The larvae of this fly feed mainly on the young seed capsules and are able to destroy between 11 % and 90 % of the *Orobanche* seeds (Sauerborn, 1991).

The main objective of this study was to evaluate the natural effectiveness of *Phytomyza orobanchia* in the control of *Orobanche* spp. under field conditions.

## MATERIALS AND METHODS

Identification of *Phytomyza orobanchia* Kalt. was carried out following Spencer (1973). For confirmation, the fly specimens were sent to Dr. K.A. Spencer[2] and to the Faculty of Biology, University of Bielefeld, Germany.

In order to estimate the percent of damage caused by *P. orobanchia* to *O. ramosa* and *O. cernua*, three heavily infested locations by broomrapes were randomly selected. For this study a total of 180 broomrape plants (90 plants from each species) were taken from tomato fields of Nura Era state farm, Mertigegu state farm and Malima private farm, which are located in Ethiopia (Fig. 1).

[2] K.A. Spencer, Exwell Farm, Bray Shop, Callington PL17 8QJ, Cornwall, England.

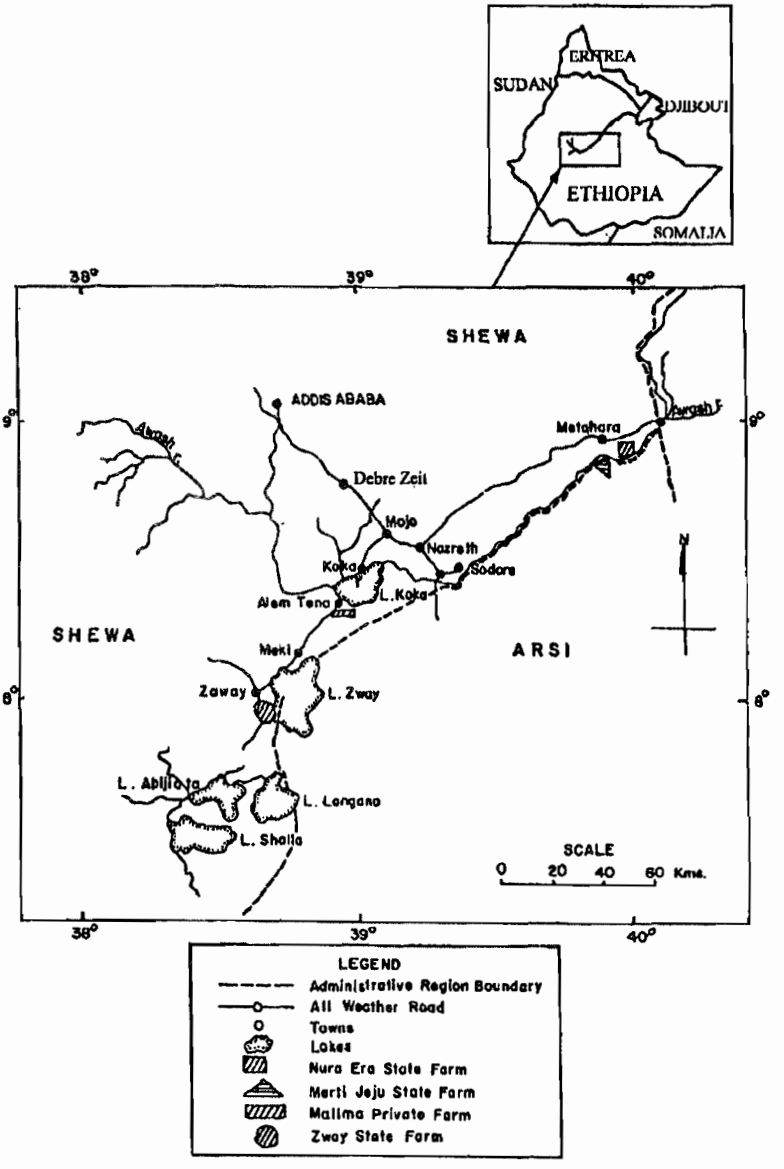


**Fig. 1. Map of East and South Shewa Province showing the area of the study.** (Modified from the Ethiopian Mapping Authority, 1995).

Thirty broomrape plants at full flowering to early ripening stage were collected randomly per field, with at least one meter between samples by walking diagonally across the fields and along the peripheries (Abbasher, 1994). In the laboratory, the percentage of damaged and undamaged *Orobanche* plants caused by *P. orobanchia* was determined by cutting the *Orobanche* shoots. In addition, fifteen seed capsules were randomly detached from each damaged plant, five from the top, five from the middle and five from the bottom of the shoot, to determine the percentage of infested capsules per plant. It has been reported by (Tawfik and Awadallah, 1976) that, external symptoms of infestation like shrinkage and rottening of the seed capsules (fruits) can be seen as a result of complete destruction of all seeds and excretion and accumulation of faeces of the larvae. Following these symptoms, infestation of seed capsules was determined.

The extent of damage on *O. ramosa* and *O. cernua* plants caused by *P. orobanchia* at Malima, was evaluated using a scale (Table 1).

**Table 1. Evaluation of the extent of damage caused by *P. orobanchia* on *Orobanche* plants.**

| Damaged capsules (%) | Class of damage |
|---|---|
| 1–33 | slight |
| 34–67 | moderate |
| 68–100 | severe |

Density of *P. orobanchia* population on *O. ramosa* was determined by counting larval and pupal stages following the dissection of the capsules and stems.

## RESULTS

In this study, of the three locations investigated for presence of *P. orobanchia*, the fly was found only in Malima farm with 73.3% and 66.7% infestation of *O. ramosa* and *O. cernua* respectively (Table 2).

**Table 2. Infestation of *O. ramosa* and *O. cernua* with *P. orobanchia* at Malima, Ethiopia (December, 1994).**

| *Orobanche* sp. | Investigated plants | Damaged plants | % of infestation |
|---|---|---|---|
| *O. ramosa* | 30 | 22 | 73.3 |
| *O. cernua* | 30 | 20 | 66.7 |

In order to estimate the level of infestation on individual plants, 300 seed capsules of each *Orobanche* species were investigated. Of these 81.4% and 79.7% of *O. ramosa* and *O. cernua*, respectively were damaged (Table 3). Figure 2 shows the extent of damage caused by *P. orobanchia* on *O. ramosa* and *O. cernua* plants. The result indicated that, 85% of each *O. ramosa* and *O. cernua* plants were severely damaged. However, symptoms of damage like wet rottening and shrinkage of the seed capsules, accumulation of the larval faeces, and exit-holes made in the fruits by emerged adults of *P. orobanchia* were observed in the infested seed capsules.

**Table 3. Percent of damage of *Orobanche* seed capsules caused by *Phytomyza orobanchia*, and it's larval and pupal stages found per *Orbanche* plant, at Malima (Ethiopia), (December 1994).**

| Species[A] | B | Infested capsules | | C | Larvae and pupae per plant | | |
|---|---|---|---|---|---|---|---|
| | | No. | % | | No. | per capsules (%) | per stems (%) |
| *O. ramosa* | 15 | 10.6 | 81.4 | 39.6 | 8 | 34.5 | 65.5 |
| *O. cernua* | 15 | 10.1 | 79.7 | – | – | – | – |

[A], Twenty plants from each *Orobanche* species were investigated; B, Average number of seed capsules examined per plant; C, Infested capsules found with larvae and pupae (%); –, Not estimated.

About 8 larvae and pupae on average were recorded per *O. ramosa* plant, among which 34.5% were found in the capsules and 65.5% found in the stems (Table 3).

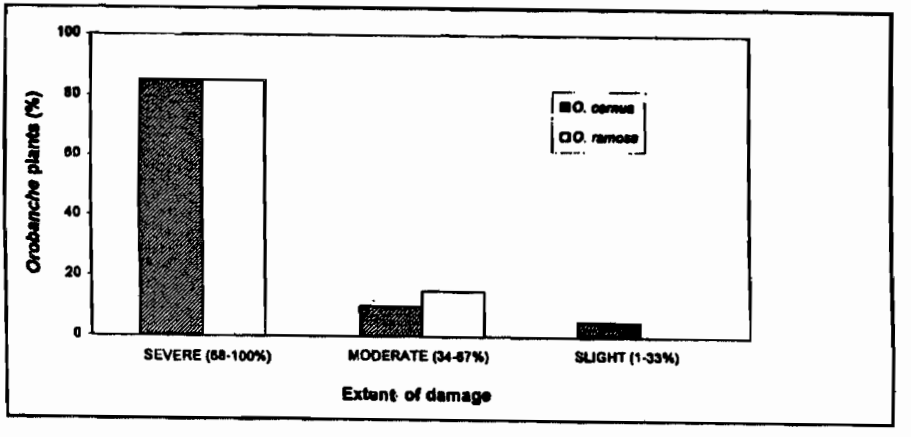


**Fig. 2. Extent of damage on *O. cernua* and *O. ramosa* plants caused by *P. orobanchia* at Malima (Ethiopia).**

## DISCUSSION

*Phytomyza orobanchia* larvae are monophagous and live exclusively on *Orobanche*. It has been shown that this insect provided excellent control of *Orobanche* spp. in the former USSR (Klyueva and Pamukchi, 1983), Turkey (Giray and Nemli, 1983), Syria (Linke *et al.*, 1990; Linke, 1992) and in India (Manjunath and Nagurkatti, 1977).

The study indicate that the occurrence of *P. orobanchia* in Ethiopia seems to be limited (Table 2). The absence of *P. orobanchia* in the fields of Nura Era and Mertigegu state farms might be associated with the application of insecticides at a high rate in these farms. A wide range of insecticides were used in the state farms, which included Thiodan, Sumicidin, Mitac, Cymbush

and Deltanet (Ibraheim Assabi[3], 1994, personal communication). This agrees with the observations of Mihajlovic (1986), Parker and Riches (1993) and Schroeder (1994) who reported that the use of insecticides against crop pests can largely eliminate *Phytomyza orobanchia*. In addition, Sauerborn (1991) reported that 74.5% of *Orobanche* was damaged by *P. orobanchia* in crops not treated with insecticides, while only 33.75% were damaged in treated crops.

In this study, *P. orobanchia* was found in *O. ramosa* and *O. cernua* in Malima farm. Our findings agrees with the observation of Lekic (1974) and Puzzilli (1983), that *P. orobanchia* lives mainly on *O. ramosa* and *O. cumana* (*O. cernua*) plants. Recently, Klein (1995) have confirmed its occurrence and effectiveness in controlling *O. crenata* in Morocco, with 96 % reduction of seed production per seed capsule.

*P. orobanchia* reduced *O. ramosa* infestation by destroying 81.4% of the seed capsules (Table 3). Similar results have been reported in USSR by Girling *et al.*, (1979). AL-Khesraji and Abdel-Wahid (1988) have observed that, larvae of this insect led to 21% reduction of *O. aegyptiaca* seeds in tomato fields in Iraq. On the other hand, the fly effectively destroyed *O. cernua* capsules (Table 3). The insect has been found to be efficient in reducing seed capsules of *O. cumana* (*O. cernua*) by 96% in Yugoslavia (Mihajlovic, 1986). In Hungary and former USSR reduction in seed production per capsule of *O. cumana* on sunflower of 60–85% caused by *P. orobanchia*, has been reported by Horvath (1987) and Kapralov (1974).

In this study, 65.5% of the larvae and pupae were found in stems of *O. ramosa* (Table 3). This might indicate that most of the pupae had started to diapause to overwinter. Diapause duration of *P. orobanchia* in the lower part of the stem, (seldom in the dried seed capsules), is a significant phenomenon in the maintenance of this species population (Mihajlovic, 1986; Klyueva and Pamukchi, 1982). It has been reported by (Sauerborn, 1991) that 2–22% of the pupae of the first generation, 33–86% of the second generation and almost 100% of the third generation stay up to four years in diapause.

[3]Ibraheim Assabi, Head Research Section, Nura Era Horticulture Development Enterprise, Ethiopia.

It can be concluded from the present work that *P. orobanchia* could be a promising biological control agent of *Orobanche* spp. in Ethiopia, especially if artificial mass rearing and field release techniques could be adopted. More detailed studies are needed.

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