

Integrated management of broomrape and seed and soil borne diseases of faba bean in northern Ethiopia

Ayimut, Kiros-Meles¹, Tsehaye Berhane, Derar G/Medhin & Tesfay Araya

¹Department of Horticulture and Crop Sciences, Mekelle University, Mekelle, Ethiopia

Corresponding author: kirosm62@gmail.com

Abstract

Broomrape (*Orobanche crenata*) and fungal diseases are among the most limiting factors to faba bean production particularly in northern Ethiopia with a serious impact on household food-security. The absence of a legume rotation crop contributes to the persistence of these pests in soil. This study was initiated to identify the best combination of treatments, from among faba bean varieties, bio-inoculants and antagonists, that suppresses diseases and *O. crenata* infection. The study looked at the synergistic effect of bioinoculants (*Rhizobium leguminosarum* and *Trichoderma harzianum*) and varieties (Hashenge, Walki, and Moti and a local susceptible cultivar) on the severity of *O. crenata* infestation and faba bean yield. Variety and bio-inoculation with *R. leguminosarum* and *T. harzianum* singly or in combination resulted in significant grain yield improvements. The combined use of *T. harzianum* and *R. leguminosarum* on the Orobanche resistant variety resulted in yield increments of about 29% over the uninoculated resistant variety. The yield increment recorded by the orobanche resistant variety treated by both inoculants over that of the remaining varieties treated with both inoculants ranged from 527% to 1012%. The findings of the study so far demonstrate that a combination of a resistant variety and application of both *R. leguminosarum* and *T. harzianum* can improve plant growth, both biomass and seed yield of faba bean.

Key words: Chocolate spot, combined resistance, faba bean, *Orobanche crenata*, *Rhizobium leguminosarum*, synergistic effect, *Trichoderma harzianum*

Résumé

Orobanche (*Orobanche crenata*) et les maladies fongiques sont parmi les facteurs les plus limitants de la production de haricot féverole particulièrement en Ethiopie du nord avec un sérieux impact sur la sécurité alimentaire des ménages. L'absence d'une culture de rotation des légumineuses contribue à la persistance de ces parasites dans le sol. Cette étude a été effectuée pour identifier la meilleure combinaison de traitements, parmi les variétés de féverole, les bio-inoculants, et les antagonistes, qui suppriment les maladies et les infections d'*O. crenata*. L'étude a examiné l'effet synergique des inocula (*Rhizobium leguminosarum* et *Trichoderma harzianum*) et des variétés (Hashenge, Walki et Moti et un cultivar local

sensible) sur la gravité jusqu'à présent une combinaison d'une variété résistante et de l'application conjointe de *R. leguminosarum* et *T. harzanium* peut améliorer la croissance des plantes, la biomasse et le rendement de graines de féverole.

Mots clés: la tache de chocolat, résistance combinée, féverole, *Orobanche crenata*, *Rhizobium leguminosarum*, effet synergique, *Trichoderma harzanium*

Background

Faba bean (*Vicia faba* L.), a major food crop widely grown in the cooler medium to high altitude areas in Ethiopia, provides the much needed protein supplement to the diet of rural households, which otherwise includes mainly cereal or root crops (Crépona *et al.*, 2010). Its haulm is also an important source of livestock feed. The importance of faba bean as a rotation crop and its role in improving soil health through atmospheric nitrogen fixation is well recognized (Sahile *et al.*, 2008). In the cooler highlands, where other pulse crop types are least cultivated, it is the major and sometimes the only legume rotation crop planted following cereals every two to three years. Despite its importance in the Ethiopian farming system, its productivity has remained far below its potential due to the low grain yielding potential and susceptibility to biotic and abiotic stresses of indigenous cultivars (Mussa *et al.*, 2008; Sahile, *et al.*, 2008). Faba bean production particularly in the northern Ethiopian highlands is facing a very serious challenge and is on the verge of being pushed out of production from the combined effect of fungal diseases such as chocolate spot and Fusarium root rots, and severe infestation of fields by the parasitic weed Broomrape (*Orobanche crenata*). These challenging circumstances necessitate research to make sure that the benefits that the rural community used to get from the crop are maintained.

Efforts are under way to develop an integrated management of fungal foliar and root diseases and the parasitic weed and *O. crenata*, problems in the Tigray region. A combination of bio-control approaches and genetic resistance against fungal foliar and root rot diseases and *O. crenata* are being investigated in this research.

Evaluation of the synergistic effect of host plant resistance, rhizobial inoculants, and/or bio-control agent (*Trichoderma* spp.) on severity of *Orobanche* infection.

This part of the study was carried out in 2016 on soils with a history of severe *O. crenata* infestation. The treatments included a bio-inoculant (*Rhizobium leguminosarum*), a bio-control agent (*Trichoderma harzianum*) and three improved varieties, Hashenge, Walki, and Moti and a local susceptible cultivar. Hashenge is resistant to *O. crenata*. In this study, both variety and bio-inoculation with *R. leguminosarum* and *T. harzanium* singly or in combination resulted in significant grain yield improvements. The combined use of *T. harzanium* and *R. leguminosarum* on the *Orobanche* resistant variety resulted in yield increments of about 29% over the uninoculated resistant variety. But the yield increment recorded by the *orobanche* resistant variety treated by both inoculants over that of the remaining varieties but similarly treated with both inoculants ranged from 527% to 1012%. In the current study the level of host plant resistance to *O. crenata* seems to have contributed more to increased faba bean grain and dry biomass production. The *O. crenata* resistant

variety had significantly higher seed and biomass yield and lower Orobanche shoots per unit area as well as orobanche dry biomass. But still the contribution of dual application of *R. leguminosarum* and *T. harzanium* to faba bean has been found to be substantially high as compared to the un-inoculated control.

Evaluation of faba bean lines for combined resistance to seed and soil borne diseases and *O. crenata* at Korem and Hashenge. A total of about 30 faba bean lines including lines obtained from ICARDA's chocolate spot, ascochyta blight, and *O. crenata* nurseries, locally improved released faba bean lines and local cultivars are being evaluated for their resistance to both fungal diseases and *O. crenata* under natural infection at at Korem and Hashenge areas in northern Ethiopia. The study is yet to come up with one or more lines that have combined resistance to both the parasitic weed, and foliar and root diseases.

Evaluation of the synergistic effect of host plant resistance, rhizobial inoculants (*R. leguminosarum*), and/or bio-control agent (*Trichoderma* spp.) on the severity of seed and soil borne diseases under natural disease development. This study is being conducted on *O. crenata* infested soils and under natural infection of both foliar and root diseases at Tahtay Maichew and Tahtai Koraro areas in northern Ethiopia. The study will focus on seed and soil borne diseases. The trial sites will be *O. crenata* non-infested soils. Four different varieties of faba bean including a local cultivar, improved varieties comprising of a commonly susceptible variety, and two varieties with a known level of resistance to either of the faba bean diseases are being evaluated for the level of disease development and yield combined or singly applied *R. leguminosarum* and *T. harzanium*.

Conclusion

For faba bean to continue being cultivated in the highlands of Tigray, northern Ethiopia, the problems of *O. crenata*, and foliar and root diseases have to be solved or minimised. An integrated approach to the management of these problems is the most viable option as addressing the problems singly has failed to bear any effective measures. The findings of the partly completed studies have shown promising results. The study has demonstrated that a combination of a resistant variety with application of *R. leguminosarum* and *T. harzanium* can improve growth, biomass and seed yield of faba bean. The importance of resistance to *O. crenata* to yield of faba bean has also been demonstrated in this study. Thus, there is a need to find how resistance to Orobanche and application of *R. leguminosarum* and *T. harzanium* can be optimally combined to maximise faba bean yield in the context of the above constraints.

Acknowledgement

This project is funded by The Regional Universities Forum for Capacity Building in Agriculture (RUFORUM) under the Competitive Grants System (No. RU 2014 GRG094). This paper is the project's project contribution to the 5th RUFORUM Biennial Conference and African Higher Education Week 2016, Century City Conference Centre, Cape Town, South Africa, 15-21 October 2016.

References

- Baraka, M.A., Shaban, W.I. and Abd EL-Moneim H. 2009. Influence of *Rhizobium* sp. combined with *Trichoderma* sp. on damping off diseases and growth parameter of some legume crops. *Agricultural Research Journal* 9 (3): 87-96.
- Crépona, K., Marget, P., Peyronnet, C., Carrouéa, B., Arese, P. and Duc, G. 2010. Nutritional value of faba bean (*Vicia faba* L.) seeds for feed and food. *Field Crop Research* 115: 329–339.
- ICARDA, 2006. Technology generations and dissemination for sustainable production of cereals and cool season legumes. International Center for Agricultural Research in the Dry Areas, Aleppo, Syria. 256pp.
- Kloepper, J.W., Tuzun, S., Liu, L. and Wei, G. 1993. Plant-growth promoting rhizobacteria as inducers of systemic resistance. In: Pest management: Biologically based technologies. Lumsden, R.D. and Waughn, J.L.). ACS Conferences Proceedings Series, American Chemistry Society Press. pp. 159-165.
- Mabrouk, Y., Zourgui, L., Sifi, B., Delavault, P., Simier, P. and Belhadj, O. 2007. Some compatible *Rhizobium leguminosarum* strains in peas decrease infections when parasitised by *Orobanche crenata*. *Weed Research* 47: 44-53.
- Mussa, J., Dereje, G. and Gemechu, K. 2008. Procedures of faba bean improvement through hybridization. 48p. Technical Manual No. 21, Ethiopian Institute of Agricultural Research.
- Saber, W.I.A., Abd El-Hai, K.M. and Ghoneem, K.M. 2009. Synergistic effect of *Trichoderma* and *Rhizobium* on both biocontrol of chocolate spot disease and induction of nodulation, physiological activities and productivity of *Vicia faba*. *Research Journal of Microbiology* 4: 286-300.
- Sahile, S., Ahmed, S., Fininsa, C., Abang, M.M. and Sakhuja, P.K. 2008. Survey of chocolate spot (*Botrytis fabae*) disease of faba bean (*Vicia faba* L.) and assessment of factors influencing disease epidemics in northern Ethiopia. *Crop Protection* 27: 1457-1463.
- Sahile, S., Sakhuja, P.K., Fininsa, C. and Ahmed, S. 2011. Potential antagonistic fungal species from Ethiopia for biological control of chocolate spot disease of faba bean. *African Crop Science Journal* 19 (3):213-225.
- Shaban, W.I. and El-Bramawy, M.A. 2011. Impact of dual inoculation with *Rhizobium* and *Trichoderma* on damping off, root rot diseases and plant growth parameters of some legumes field crop under greenhouse conditions. *International Research Journal of Agricultural Science and Soil Science* 1 (3): 98-108.