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Integrated weed (Orobanche crenata) management on faba bean

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ABSTRACT

Ethiopia pulse crops are widely grown and Faba bean (Vicia faba L., 2n=12) is an old world grain legume of the family Leguminasae. This crop is one of the major pulses grown in the highlands of Ethiopia ranging from 1800-3000 m.a.s.l receiving an annual rainfall of 700-1100 mm, and the country is now considered as one of the secondary centers of genetic diversity. In eastern Amhara region high lands, faba bean is cultivated widely and thought to be an area for the largest collection of faba bean landraces. The production of faba bean is declined from year to year due to various production constraints such as diseases, soil acidity and weeds, particularly root parasitic weeds Broomrape (Orobanche species). These parasitic weeds cause very high levels of crop damage in terms of both yield and quality. Yield losses due to Orobanche weed ranges from 5 to 100% depending on the level of infestation and environmental conditions. Orobanche species are root parasitic flowering plants lack of leaves and totally dependent on their hosts for their life cycle. The parasitic is on a wide range of food legumes such as faba bean, field pea, lentil, vetch, Solanaceae crops, oil crops and root crops. The severe invasion of legume crops, especially faba bean and field pea are by Orobanche crenata. The physical attachment and the damage of the weed are under ground. The weed disperses by wind, flood, birds, animals, crop seeds, humans and farm machinery. It is propagated by seeds which can remain dormant and survive and able to viable in the soil for more than 20 years. Due to the complete devastation of faba bean by Orobanche crenata, farmers forced to replace pulse crops by cereals and

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spice in south Wollo (Kutaber, Dessie zuria, Tenta and Mekidela woredas); therefore, farmers lost the benefits obtain from pulse crops. The experiment was conducted using completely randomized block design in three replications with the objective of selecting the best integrated Orobanche weed control management at Kutaber woreda 010 kebele (Flago-ber) using Orobanche weed tolerant faba bean(Ashenge), local variety, 0.3 l ha-1 glyphosate chemical and hand weeding for two years (2014-15) on two farmers' fields on a plot size of 4 m * 5 m (4 m width by 5 m length). The analysis of variance revealed highly significant different between treatments. Ashenge variety gave the maximum and minimum grain yields 3200 and 2868.8 kg ha-1, respectively, using two times sprayed of 0.3 liters ha-1 Glyphosate chemical in 250-300 liters ha-1 water, the local variety obtained maximum and minimum yields 568.8 and 150 kg ha-1 with two and without sprayed, respectively. Hand weeding of Orobanche weed before seed setting was applied and has an additional advantage that could reduce Orobanche weed seed bank. Using this integrated management plus awareness and supporting of farmers by DA's and researchers, Ashengie faba bean can be cultivated on Orobanche weed infestation area and can give 28-32 qt ha-1.

Key words: Attachment, Glyphosate, Haustrium, Holoparasitic , Strigolactones

Background and justification

In Ethiopia pulse crops (faba bean, field pea, lentil, grass pea, chickpea, haricot bean, cowpea and mung bean) are widely grown. Faba bean (*Vicia faba* L., 2n=12) is an old world grain legume of the family *Leguminasae*. It is believed that it was introduced to Ethiopia soon after its domestication around 5000 B.C. The crop is one of the major pulses grown in the highlands of Ethiopia ranging from 1800-3000 m.a.s.l receiving an annual rainfall of 700-1100 mm, and the country is now considered as one of the secondary centers of genetic diversity. Faba bean is a good source of protein, starch, cellulose, minerals and the most efficient fixers of the atmospheric nitrogen and can enhance soil nitrogen fertility through biological N2-fixation and is ranked first nationally from pulse crops (Pulse crops production is 19,531,935.01 quintals, from this faba bean shares is 6,977,983.87 quintals and productivity is 15.2 quintals / ha), CSA, 2010 / 2011. In eastern Amhara region high lands, faba bean is cultivated commonly and thought to be an area for the largest collection of faba bean landraces.

The production of faba bean is declined from year to year due to various production constraints such as diseases (faba bean Gall, Ascochyta blight and Chocolate spot), soil acidity and weeds particularly root parasitic weeds Broomrape (*Orobanche species*). These parasitic weeds cause very high levels of crop damage in terms of both yield and quality. Yield losses due to *Orobanche* weed ranges from 5 to 100% depending on the level of infestation and environmental conditions. Because of the serious problems of *Orobanche*, farmers shift their field to barley, wheat and spice crops; therefore, farmers lost the benefits obtain from pulse crops. The infected environments in Amhara region are; south Wollo (Kutaber, Dessie zuria, Tenta and Mekidela weredas) and north Wollo (Meket and Wadila weredas), south Gonder and in Tigray region south Tigray.

The Biology of Broomrape (*Orobanche* species)

Orobanche species are root parasitic flowering plants lack of leaves and totally dependent on their hosts for their life cycle. When the rainy season begins, the seeds imbibe water and move into a conditioning phase which lasts for several months until they get a chemical signal from the faba bean. If the seed never receives the chemical signal, it dries out and it will return

to its dormant state.

The first step in the interaction is seed germination activated by germination signal **(**Strigolactone) of host-plant. After germination, *Orobanche* seedlings produce a specialized organ (haustorium). A haustrium serve as a bridge between the parasitic weed and its host and grow through the vascular system of the host plants. It take away water, mineral nutrients and carbohydrates from the host causing drought stress, wilting, stunted growth, leaf chlorosis and finally yield reduction and the yield losses range from 5 to 100% depending on the level of infestation and environmental conditions (Besufekad *et al.,* 1999).

The physical attachment and the damage of the weeds are under ground**.** Once attached to the host root, the outer part of the connection zone develops into a tubercle, which gives a spike (Parker and Riches 1993). Frequently require dry conditions and can attack all food legumes, oilseeds and solanacous crops then grow among the tissues of host plants, absorb mineral nutrients directly from the host crop and destroy them.

Broomrape*s (Orobanche species)* are holoparasitic flowering plants native to the Mediterranean region (North Africa, the Middle East, and southern Europe) and western Asia where large areas ranging from 5-100% infestation have been recorded (Besufekad *et al.,* 1999). Their range extends to similar climates in Asia, Africa, Australia, and North-South/America where they also cause significant crop damage. The parasitic is on a wide range of food legumes such as faba bean (*Vicia faba* L.), field pea *(Pisum sativum* L.), lentil (*Lens culinaris)*, vetch *(Vicia* species), Solanaceae crops (eggplant*, tomato, tobacco,* and potato), oil crops sunflower (*Helianthus annuus), Noug (Guizotia abyssinia), linseed (Linum usitatisimum) and root crops carrot (Daucus carota* L.).The severe invasion of legume crops, especially faba bean and field pea is by *Orobanche crenata* (Besufekad *et al.,* 1999).

The host plants produce obligate signal compounds or strigolactones and have the following main functions:

• first, as endogenous hormones to control plant development,

• Second as components of root exudates to promote symbiotic interactions between plants and soil microbes,

• Third stimulate germination of parasitic weed seeds found closely to the root zones of host plant.

This third function plays a vital role for *Orobanche* species' seed germinating, but it is a weakness for the host plants themselves.

Symptoms of the weed

The physical attachment of the parasite occurs below ground. Affected plants show water stress, leaf yellowing, stunted growth and often do not flower or drop its flower without pod setting. Once attached to the host root, the outer part of the connection zone develops to a tubercle, and then produces seeds under favorable conditions within a week.

Mechanism of distribution of the weed

The weed disperses by wind, flood, birds, animals, crop seeds, humans and farm machinery. It is propagated by seeds which can remain dormant in soil for several years. They can survive and able to remain viable in the soil for more than 20 years (Linke *et al.,* 1989).

Control measures for these noxious parasitic weeds, *Orobanche spss* including; Late sowing, hand pulling, glyphosate spraying, catch and trap crops have all been shown to reduce levels of infestation, however, no totally effective methods have yet been introduced. Sirinka Agricultural Research Center was conducted trials in 2004-05 and 2011cropping seasons at south Wollo Kutaber woreda to control *Orobanche crenata*, but no positive results.

Orobanche crenata is found in the faba bean, field pea, lentil and vetch crops mostly in mid altitude (2620 masl) on light soils and up to the high altitude (3111 masl) on clay soils, but *Orobanche ramosa* is mostly found in high altitude (around 2977 masl) on acidic soils on linseed and Camelina crops. *Orobanche minor* is found attaching to some weedy plants like alfalfa (*wajima*) on mid altitudes (around 1850 masl) on pastoral lands and *Orobanche cernua* is on field pea and lentil.

Table 1: Mean agronomic data of integrated management practices for the control of *Orobanche crenata* 2014 (farm-1)

Tr	FD	MD	Orob. No./ha	Oro. Dw (ton/ha)	GY (kg/ha)
v1 F0	53	153	925 (60.4)	3.6	1006.2 (1.6)
v1 F1	52	153	625 (32.2)	2.3	2056.2 (1.8)
v1 F2	54	158	525 (30.7)	2.1	2868.8 (1.7)
v2 F0	52	153	5,825 (485.8)	2.3	300.5 (1.2)
v2 F1	50	148	6,225 (556.5)	3.2	475.0 (1.5)
v2 F2	52	153	7,125 (428.1)	1.8	568.8 (1.7)
LSD (5%)	ns	ns	**	ns	**
CV (%)	4.6	4.1	45.9 (20.8)	0.4	42.4 (1.7)

Where: v1F0 = Ashenge variety without spray, v1F1 = Ashenge variety with one spray of 0.3 l/ha, v1F2 = Ashenge variety with two spray of 0.3 l/ha, v1F0 = Local variety without spray, v1F1 = Local variety with one spray of 0.3 l/ha, v1F2 = Local variety with two spray of 0.3 l/ha, Orob. No./ha = Orobanche number per hectar, Orob.dw (ton/ha) = Orobanche dry weight, GY = grain yield and numbers in braces are square root transformed

Table 2: Mean agronomic data of integrated management practices for the control of *Orobanche crenata* 2014 (farm-2)

Tr	FD	MD	Orob. No./ha	Oro. Dw (ton/ha)	GY (kg/ha)
v1 F0	53	139	602 (544.2)	4.4	1125 (2.5)
v1 F1	53	139	646 (568)	4.6	2225 (3)
v1 F2	55	145	204 (280.7)	0.8	3200 (2.5)
v2 F0	53	137	1543 (414.9)	2.0	250 (2)
v2 F1	51	131	1007 (681.7)	2.4	450 (2.5)
v2 F2	53	138	908 (461.6)	2.3	550 (3)
LSD (5%)	ns	ns	**	ns	**
CV (%)	4.8	6.7	65.3 (42.5)	0.3	87.5 (29)

Table 3: Mean agronomic data of integrated management practices for the control of *Orobanche crenata* 2015 (Farm-1)

Tr	FD	MD	Orob. No/ha	Orob. Dw (ton/ha)	GY (kg/ha)
v1 F0	47.5	150	182, (8.6)	1.4	1250 (35.2)
v1 F1	50	150	152 (7.6)	1.3	1500.0 (38.2)
v1 F2	47.5	153	125 (5.6)	1.2	2900.0 (40.6)
v2 F0	47.5	120	227,500 (518.8)	1.6	152.0 (27.0)
v2 F1	45	120	177,500 (326.1)	2.2	250.0 (27.0)
v2 F2	47.5	120	115,000 (293.1)	1.3	450.0 (38.2)
LSD (5%)	ns	ns	**	Ns	**
CV (%)	6.7	1.3	77.8 (24.2)	22.9	51.6 (26.6)

Table 4: Mean agronomic data of integrated management practices for the control of *Orobanche crenata* 2015 (Farm-2)

Tr	FD	MD	Orob. no/ha	Orob. Dw (ton/ha)	GY (kg/ha)
v1 F0	50	150	120,000	1.7	1250
v1 F1	50	150	11,500	1.1	1580
v1 F2	50	150	10,750	1.8	2960
v2 F0	45	120	22,250	3.2	150
v2 F1	45	120	18,400	2.2	325
v2 F2	45	120	16,500	2.2	153
LSD (5%)	-	-	*	ns	**
CV (%)	-	-	25.6	0.2	26.1

Due to the complete devastation of faba bean by *Orobanche crenata*, farmers are forced to replace pulse crops by cereals and oil crops production in south Wollo (Kutaber, Dessie zuria, Tenta and Mekidela woredas). The replacement of faba bean by other crops will create a problem as far as sustainable faba bean production for food security, disease and insect breaks for cereal crops and foreign currency earning is also concerned; therefore, this experiment was conducted with objective of identifying the best integrated manage options for the control of *Orobanche crenata.*

Materials and methods

The experiment was conducted using completely randomized block design in three replications with the objective of selecting the best integrated *Orobanche* weed control management for the *Orobanche* infected environments at Kutaber woreda 010 kebele (Flago-ber) using *Orobanche* weed tolerant faba bean (*Ashenge*), local variety, 0.3 l ha-1 Glyphosate chemical and hand weeding for two years (2014-15) on two farmers' fields on a plot size of 4 m width by 5m length.

Results

Orobanche weed tolerant faba bean was released by Alemata Agricultural Research Center with a local name, *Ashenge*. Sirinka Agricultural Research Center was conducted a research for two years (2014/15) using integrated methods with this variety, Glyphosate chemical and hand weeding. On *Ashenge*, *Orobanche* shoots were emerged lately but on local variety emerged as the faba bean starting flower and most of the faba bean died immediately before pod setting. The analysis of variance revealed highly significant different between treatments. The maximum and minimum grain yields of *Ashenge* variety gave 3200 and 2868.8 kg ha-1 (Tables 2 and 1) respectively, using two times sprayed of 0.3 liters ha-1 Glyphosate chemical in 250-300 liters ha-1 water (at the faba bean start flowering and one week after the first sprayed), the local variety gave maximum and minimum yields 568.8 and 150 kg ha-1 (Tables 1 and 4) with two and without sprayed, respectively. Continues hand weeding of *Orobanche* before seed setting was applied and has an additional advantage; hence, reduce *Orobanche* weed seed bank. Using this integrated management plus awareness and supporting of farmers by DA's and researchers, *Ashengie* faba bean can be cultivated on *Orobanche* weed infestation area and give better yield (28-32 qt ha-1) with two times sprayed and continues hand weeding. The price of Glyphosate is 130 - 140 birr per liter, 1 liter can spray 3.3 ha and 1 quintal faba bean price is 3000.00 birr.

Conclusion and recommendation

Using this integrated management plus awareness and supporting of farmers by DA's and researchers, *Ashengie* faba bean can be cultivated on *Orobanche* weed infestation area and it can give 28-32 qt ha-1. Continues hand weeding is a very important practice on *Ashenge* variety hence, the weed is emerged a little bit far away from the faba bean and the damage is started after the faba bean has been pod setting. Continues hand weeding has an additional advantage that, *Orobanche* seed bank can reduce.

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