



Demonstration and scaling of integrated management of parasitic weeds on faba bean in Northern Ethiopia and Morocco



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RATIONAL

Cool-season food legumes (faba bean, field pea, chickpea and lentil) are important crops for food, income generation, animal feed and improving soil fertility through nitrogen fixation in Ethiopia and Morocco. The productivity and acreage of these crops are decreasing due to diseases, insect pests and parasitic weeds. Parasitic weeds (*Orobanche* and *Phelipanche* spp.) play more damaging roles than other biophysical constraints in North Africa and Ethiopia (Ennami *et al.*, 2020; Negewo *et al.*, 2023). No single control measure is effective in minimizing the damaging of parasitic weeds in food legumes. Therefore, demonstration and scaling of integrating control options can play roles in minimizing yield gaps caused by parasitic weeds.

APPROACHES

Demonstration and scaling of integrated parasitic weed management (IPWM) on faba bean was implemented in farmers' fields in Morocco and Ethiopia.

Morocco: Six farmers were involved in the demonstration of integrated parasitic weed management in Chaouia region. Each farmer hosted IPWM demonstration on one ha of land using faba bean cv. Alfia, 1-2 sprays of sub-lethal glyphosate (160 cc/ha) at flowering stages of the crop (Figure 1). Non-sprayed plots were used as checks. Due to severe drought, data was collected from two farmers. Data on *Orobanche* number, biomass and seed yields were recorded.

Ethiopia: Based on the outputs of the 2021/22 cropping season, demonstration of partially resistant faba bean cv. *Hashengie*, two sprays of sub-lethal glyphosate at flowering stage and 1-2 hand weeding were scaled in three districts of South Wollo (Dessie Zuria, Kutaber and Tehuledere districts) and one district in South Gondar (Tach-Giant district) zones in Amhara region.

Partial budget analysis: The cost benefit assessment of 2021/22 demonstration of IPWM was analyzed by considering the variable costs in the innovations using the following formula (CIMMYT, 1988).

$$MRR = \frac{DNI}{DIC}$$

Where, *MRR* is marginal rate of return; *DNI*, difference in net income compared with control and *DIC*, difference in input cost compared with control.

Alternative crops: In addition to IPWM practices, validation of economical legume and oil seed crops that are not attacked by *O. crenata* were evaluated. On-farm evaluations were done using common bean, fenugreek and linseed. Faba bean was included as a control crop in the rotation. The on-farm trial was done in two villages in South Wollo district.



Figure 1. Location of validation sites, training on machine planting and spraying, 2022/23 cropping season, Chaouia region, Morocco.

OUTPUTS AND OUTCOMES

In Morocco, the 2022/23 cropping season was marred with severe drought that affect all rainfed crops including faba bean and only results from two farmers are reported. Moreover, we also experienced security challenges in the intervention sites in Ethiopia. As a result, was a challenge field days and regular field visits were affected in the Amhara region. In both countries, *O. crenata* was the major parasitic weed species affecting food legumes.

Morocco

Sub-lethal Glyphosate sprays at flowering stages were found effective in reducing the number of parasitic weeds population and infected plants as compared to the unsprayed farms (Figure 2). Although faba bean productivity was low due to drought, better biomass and seed yield was recorded from the innovations (Figure 3). These innovations will be scaled in 2023/24 cropping season.

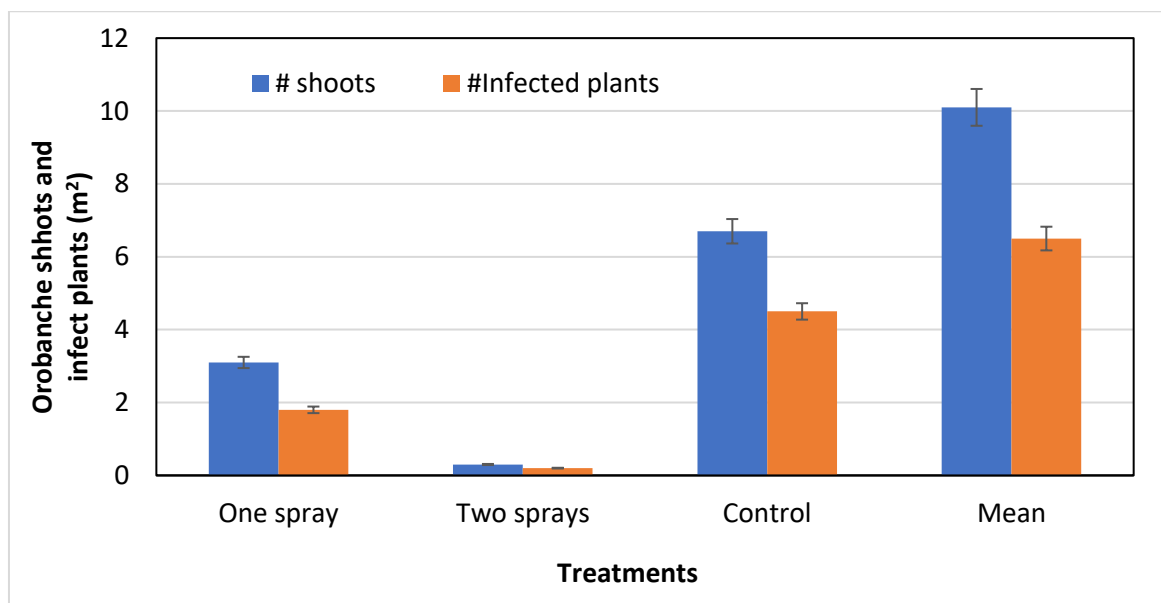


Figure 2. Effects of sub-lethal sprays of glyphosate on parasitic weed shoots and infected plants, 2022/23 cropping season, Morocco.

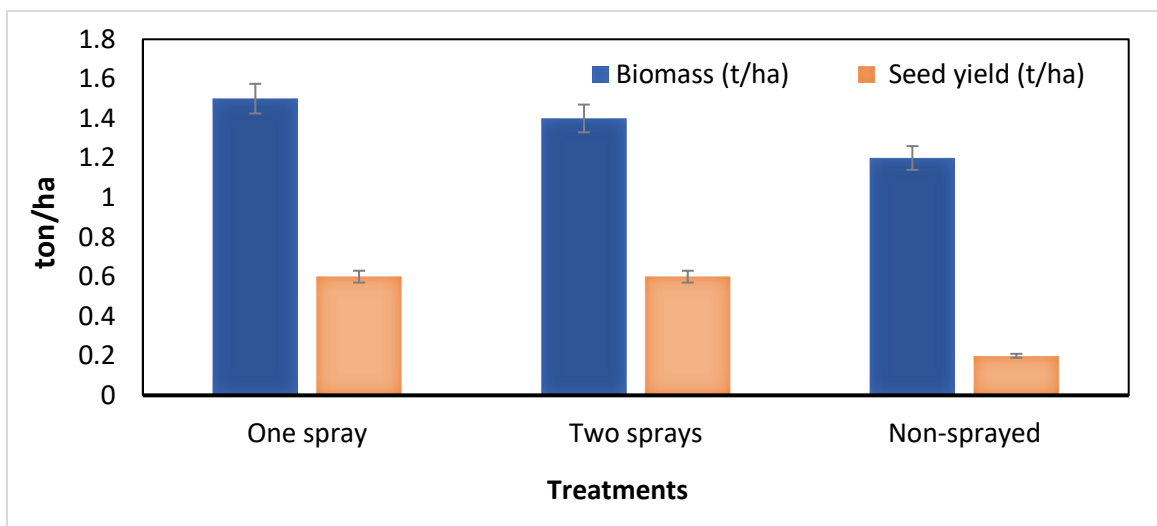


Figure 3. Effects of glyphosate sprays on biomass and grain yield of faba bean, 2022/23 cropping season, Morocco.

Field day - Farmer and stakeholder day was organized on March 14, 2023, where 24 faba bean farmers and three Agricultural advisories from ONCA (National Office of Agricultural Advisory) participated (Figure 4). The field day was focused on using glyphosate soluble concentrate formulation; herbicide drift and selecting suitable nozzles for spaying. Moreover, farmers were advised not to use hard water since glyphosate's efficacy by high concentration of calcium ions (Ca⁺⁺), ferrous ions (Fe⁺⁺), and magnesium ions (Mg⁺⁺). Farmers were advised to incorporate neutralizing agents such as ammonium sulfate.



Figure 4. Field day participations by farmers and other stakeholders, 2022/23 cropping season, Morocco.

Ethiopia

Based on 2021/22 cropping season demonstration of IPWM outputs, scaling of the innovation was implemented by sixty-five farmers (58 male and seven female farmers) in four districts of Amhara region. Farmers used 1.9 ton of seeds of partially resistant variety (cv. *Hashengie*) to cover 14 ha of land (Table 1). The seeds produced by farmers will be exchanged with other farmers for 2023/24 cropping season.

Table 1. Scaling of integrated management innovations to manage parasitic weeds on faba bean, Amhara region, Ethiopia, 2021/22 cropping season.

Zones	Districts	Number of farmers		
		Male	Female	Total
South Wollo	Kutaber	6	1	7
	Tehuledri	19	3	22
	Dessie Zuria	10	0	10
South Gondar	Tach-Gaint	23	3	26
Total	4	58	7	65

Demonstration of IPWM - The innovation in managing parasitic weeds on faba bean was demonstrated in new villages in the target zones in Amhara region. The average productivity of faba bean can reach 2.9 t/ha as compared to the local practices with less than 1t/ha (Figure 5).

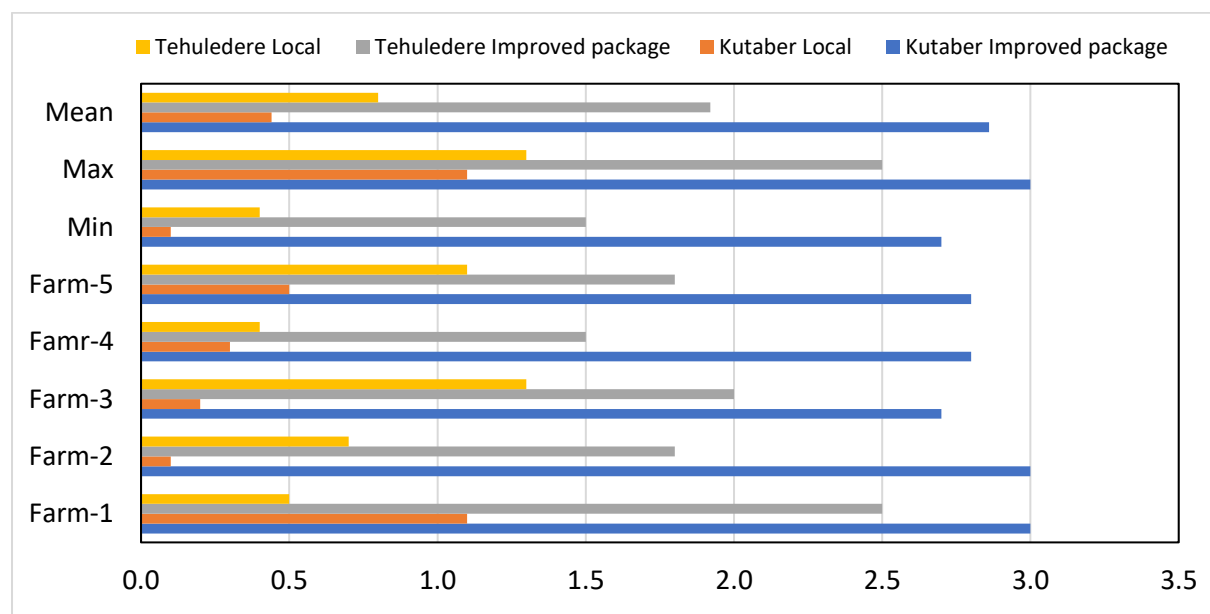


Figure 5. Productivity (t/ha) of faba bean under improved parasitic weed management practices in two districts, South Wollo Zone, Ethiopia.

Partial budget analysis of IPWM options - The management options benefits were calculated for on-farm demonstration plots in south Gondar and south Wollo zones two zones. In South Wollo, the analysis indicated that the maximum net benefit (149,300.00 ETB ha⁻¹) was obtained from cv. *Hashengie* treated with Glyphosate followed by cv. *Hashengie* treated with glyphosate (140,750.00 ETB ha⁻¹). The lowest net benefit (75,780ETB ha⁻¹) was recorded from unsprayed susceptible local variety (Table 2).

In south Gondar, integrating partially resistant cv. *Hashengie* to parasitic weeds with glyphosate sprays gave high grain yield and net benefit compared with other treatments (Table 2). In locations where faba bean gall disease is a problem, adding fungicide seed treatment also gave better net benefit since the variety is susceptible to the disease.

Table 2. Partial budget analysis of IPWM options, in 2021/22 season, South Wollo and South Gondar¹, Ethiopia.

Innovation components	AGY/ha	PP/kg (ETB)	GB/ha	VC	MC (ETB/ha)	NB (ETB/ha)	MNB (B/ha)	MRR (%)
South Wollo								
Farmer practices	1082.6	70	75780.1	0	0	75780.1	0	0
cv. Hashengie + Glyphosate sprays	2025.7	70	141800	1050	1050	140750	64969.9	61.9
cv. Hashengie + Fungicide seed treatments	1684.3	70	117900	900	900	117000	41069.8	39.1
cv. Hashengie+ Glyphosate sprays + fungicide seed treatment	2155.7	70	150900	1600	1600	149300	73519.9	45.9
South Gondar								
Farmer practices	900.0	51	45900	0	0	45900	0	0
cv. Hashengie + Glyphosate sprays	2875.8	51	146667	750	750	145917	100017	133.4
cv. Hashengie + Fungicide seed treatments	1376.7	51	70210	690	690	69520	23620.2	34.2
cv. Hashengie+ Glyphosate sprays + fungicide seed treatment	2672.5	51	136298	1440	1440	134858	88957.5	61.8

¹AGY: adjusted faba bean yield/ha; PP/kg: price per kilogram of the faba bean in Ethiopian birr; GB: gross benefit; VC: variable cost; NB: net benefit; MC: marginal cost; MNB: marginal net benefit; MRR: marginal rate of return

Faba bean early generation seed multiplications - Access to early generation seeds partially resistant faba bean variety is one of the components of IPWM innovations. Three hundred kg of cv. *Hashengie* was multiplied by Sirink Research Centre that will be used by informal seeds growers in next season.

Alternative crops - The alternative crops were not infected with *O. crenata* and the parasitic weed was not served on faba bean (Table 3 and Figure 6). This innovation can be used in reducing weed seed banks.

Table 3. Mean number of parasitic weed shoot per m² on different crops, South Wollo Zone, Ethiopia, during 2021/2022 season.

Crops	Site in Kutaber district	Site in Dessie Zuria district
Linseed	0	0
Fenugreek	0	0
Common bean	0	0
Faba bean	19	6.5



Figure 6. Performance of alternative crops at farmer field, Desie Zuria district, Ethiopia, during 2021/2022 season.

CONCLUSION

- **Impact of Parasitic Weeds:** Significant damage caused by parasitic weeds, notably *Orobanche crenata*, to faba bean and other cool-season legumes in both countries.
- **Effectiveness of IPWM:** The implemented IPWM strategies, including using partially resistant varieties, sub-lethal glyphosate sprays, and hand weeding, proved effective in reducing parasitic weed infestation and increasing faba bean yields.
- **Economic Benefits:** The partial budget analyses demonstrate the financial advantages of adopting IPWM compared to traditional practices. Farmers using these innovations achieved higher net income and marginal rate of return.
- **Alternative Crops:** The evaluation of alternative crops not susceptible to parasitic weeds provides additional options for managing weed seed banks and promoting crop diversification.
- **Farmer Participation:** The active involvement of farmers in demonstrations and field days showcases the importance of engaging the target audience in research and extension activities.

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