Enhancing Navy Bean Production Through Development of Arcelin Based Bruchid Resistant Varieties in Ethiopia

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Introduction

Navy beans are among the export commodities for Ethiopia contributing over 100 million USD per annum in export earnings. However, their productivity is relatively low owing to both field and post-harvest biotic and abiotic stresses. Among the post-harvest problems, bruchids (*Zabrotes subfasciatus*) are the major problem for the navy bean farmers, bulkers and exporters. In the warmer areas like the Central Rift Valley of Ethiopia, this species is known to cause post harvest grain losses estimated up to 38% with equivalent weight loss 3.2% (Negasi, 1994). Grain losses of up to 60% after only 3-6 months in storage have also been reported (Getu et al., 2003). Although different cultural and chemical options have been recommended for the control of bruchids, most of these practices are not oftenly used by farmers because of chemical supply shortages, cost and concerns related to environmental hazards and food safety. Therefore, development of environmentally safe, sustainable and feasible control measures like host plant resistance is probably the best option to manage bruchids in common bean, particularly amongst smallholder farmers. Antibiosis expressed as adverse effects of seed protein arcelin in extending the time of adult emergence, growth and lifecycle of these insects (Velten *et al.*, 2008) in wild bean accessions has been exploited in developing bruchid resistant common bean germplasm. Even though promising results were achieved from past breeding efforts in terms of developing genotypes with arcelin based resistance (Cardona, 2004; Beneke, 2010), such efforts have not yet resulted in a release of commercial variety for wider production. Thus, the objective of the study was to develop high yielding, disease and bruchid resistance navy bean varieties from arcelin containing recombinant inbred lines.

Methods

Multi-environment trials were conducted on 15 arcelin-containing inbred lines (RAZ lines) sourced from CIAT and a commercial check variety, (Awash 1), at eight locations from 1700- 1900masl altitude testing locations for three cropping seasons in the period 2011-2013. The trial was set up as a 4x4 triple lattice design and the recommended field cultural practices applied. Phenological, morphological, productivity and disease resistance related data was recorded. Furthermore, the lines were subjected to artificial infestation of the insects to confirm the resistance. Mass rearing of the insects was done using a susceptible variety at an average room temperature of 27°C & relative humidity of 70%. Twenty grams of seed were placed in transparent plastic jars (6 cm x 7 cm) with an opening at one end for free air circulation. The experiment was laid out in a CRD with three replications. Each jar was infested with 5 female & 5 male newly emerged bruchids and the jars left for 10 days to allow oviposition. Thereafter the jars were opened and the number of emerged adult bruchids was counted every second day starting from the first emergence and continued until the last emergence.

Results

- The multi- location trials revealed that the overall mean yield performance of three RAZ lines (RAZ-42, RAZ-11 and RAZ-119) were greeter than 2t/ha and exceeded the standard check Awash 1 by 12%. These lines also exhibited combined resistance to major diseases (Common bacterial blight, halo blight, angular leaf spot and anthracnose) across tested sites.
- The artificial infestation of these lines, showed highly sig. differences ($P < 0.01$) among the genotypes for all characters measured for bruchid resistance.
- RAZ lines demonstrated resistance by having 0-2 index of susceptibility (IS= (log (progeny per infesting female / days to adult emergence)*100) and seed weight loss from 0-5.8%. Where as Awash 1 exhibited SI of 9 and seed weight loss of 46%.

Table 1. Mean yield and disease score (for eight locations)of arcelin containing bean lines for three years

		Mean yield					Disease score	
Trt No	Variety	20111	2012	2013	G. Mean	HB	CBB	Ant
1	RAZ 36	2064	1934	1545	1847	3.5	3.4	2.8
2	RAZ 34	1848	1838	1682	1789	3	3.1	2
3	RAZ 44	1896	1912	1540	1783	3.8	3.4	2.2
4	RAZ 42	2199	2137	1804	2047	3.8	3.2	2.1
5	RAZ 11 - 1	2064	1936	1480	1827	3.4	3.8	2.2
6	RAZ 11	1931	2044	1721	1899	3.6	3.9	2.4
7	RAZ 120	1914	1854	1775	1848	3.9	3.9	2.6
8	RAZ 114	1490	1062	1319	1290	3.9	4	3.1
9	RAZ 2	1868	1578	1186	1544	4.6	4.5	2.7
10	RAZ 119	1940	1916	1825	1894	4	3.9	2.5
11	RAZ 19	1661	1577	1516	1585	4.1	3.9	2.6
12	RAZ 138	1608	1518	1318	1481	3.5	3.7	2.7
13	RAZ 40	1760	1802	1601	1721	3.5	3.5	2.5
14	RAZ 111	1475	1585	1272	1444	3.7	3.5	2.4
15	Nevy Line 47	2043	1924	1455	1807	3.5	3.8	4.4
16	Awash-1	2080	1954	1226	1753	3.4	3.8	4

Conclusions

Generally, arcelin containing inbred lines (RAZ-11, RAZ-36, RAZ-2, RAZ-44, RAZ-120, and RAZ-40 showed consistently complete resistance for bruchids. However, based on grain yield, RAZ 42 and RAZ 11 were higher yielders and resistant to the major bean diseases. These two varieties have been proposed for variety verification trials and eventual release. However, before releasing these varieties, nutrition related tests like anti-nutritional factors (phytate, polyphenols, Saponins, Hemoglobin etc.) and processing effect (blanching, heat treatment, soaking) on arcelin content will be studied. Results from these tests will used by the Ethiopian Public Health Institute (EPHI) to assess conformity and advise the variety release process. The release of these varieties will enhance the production of navy beans, reduce postharvest loss & improve the benefits of growers as well as traders from bean production and marketing.

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