Registration of '*Babile-4*' and *'Babile-5'* Groundnut Varieties

Abdi Mohammed[1], Seltene Abady[1*], Tullu Tadessa[1], Amare Kebede[1], Zeyede Akale[1], Daniel Endale[2], and Yeshiwas Sendikie[3]

[1]School of Plant Sciences, Haramaya University, P. O. Box 138, Dire Dawa, Ethiopia
[2]Werer Agricultural Research Center, Ethiopian Institute of Agricultural Research, Werer, Ethiopia
[3]Pawe Agricultural Research Center, Ethiopian Institute of Agricultural Research, Pawe, Ethiopia

Abstract

Background: In Ethiopia, groundnut **(***Arachis hypogaea*) is widely grown for food, cash income and animal feed. *Aspergillus* species infections and aflatoxin contamination in groundnut along the production chains have become the major problems in the country. Over thirty groundnut varieties have been released in Ethiopia. However, none of them were bred or evaluated for resistance against *Aspergillus flavus* and aflatoxin contamination.

Objectives: The objectives of this study were to identify groundnut genotypes with resistance to *Aspergillus flavus* and aflatoxin contamination, and to identify high yielding genotypes with desirable agronomic traits.

Materials and Methods: Two independent experiments (experiment-I and experiment-II) were conducted at Pawe, Babile and Werer during the 2015 and 2016 main cropping seasons. Sixteen and 19 groundnut genotypes, including standard checks in experiment-I and experiment-II, respectively, were laid out as a randomized complete block design with three replications.

Results: Genotypes with accessions code ICGV 95469 and ICG 67 x BIGSEED were released with local names '*Babile-4'* and '*Babile-5'*, respectively to be cultivated in Ethiopia. *Babile-4* and *Babil-5* had significantly higher average seed yields of 1.86 t ha^{-1} and 2.12 t ha^{-1} and yield advantages of 41% and 16% over the standard checks, Were-961 and BaHa-Jidu in that order. Besides, *Babile 4* and *Babile 5* were stable in seed yield across the test environments. Furthermore, *Babile-4* was found to be resistant to *Aspergillus flavus* while *Babile-5* has good seed features (large seed size, preferable seed color and ease of blanching) for confectionery purposes. Thus, the National Variety Release Committee evaluated these two varieties through commonly used procedures and approved them for release in 2019.

Conclusion: Two groundnut varieties, *Babile-4 and Babile-5, have been* approved for release and recommended for production in Babile, Pawe, Werer and other agro-ecologically similar areas in Ethiopia.

Keywords: Aflatoxin; *Aspergillus flavus*; *Arachis hypogaea;* Confectionery

1. Introduction

Groundnut (*Arachis hypogaea* L) is tetraploid (2n = 4x = 40, AABB) and it is one of the major oilseed and food crops in the world. It ranks fifth among oilseed crops after oil palm, soybean, rapeseed, and sunflower in terms of volume of production and is widely grown in more than 100 countries of tropical, subtropical, and warm temperate regions, for its multi-purposes (FAOSTAT, 2020). Globally, it covers an area of 28.52 million ha which accounted for a total production of 49. 95 million tons with an average yield of 1.75 t ha^{-1} (FAOSTAT, 2020). In Ethiopia, groundnut has been widely cultivated in mid and lowland areas of the country and become the second most important lowland oilseed crop next to sesame. The national mean dry pod yield is 1.8 t ha^{-1}, and the total area under groundnut production is 113, 515 ha (CSA, 2021).

Currently, the demand for groundnut production has been increasing in the country mainly due to increasing number of companies producing seed oils. However, the productivity of the crop is constrained by several biotic, abiotic and socio-economic factors. *Aspergillus* species infections and aflatoxin contamination are the major challenges in groundnut production and along the value chain of the crop in the country (Abdi Mohammed et al. 2016). Furthermore, several studies indicated that drought stress during flowering and pod filling stages (Seltene Abady *et al*., 2019), pre-and post-harvest mold infection (Abdi Mohammed and Alemayehu Chala, 2014), and limitation of advanced production technologies and fragmented market linkages (Fredu Nega *et al*., 2015) among actors are the major groundnut production constraints in Ethiopia. Furthermore, the lack of high-yielding and stable groundnut varieties is one of the most

*Corresponding Author: selteabady@yahoo.com

ISSN 1993-8195 (Online), ISSN 1992-0407(Print)

important groundnut production constraints in the country(Seltene Abady *et al.*, 2019).

Aflatoxin is the secondary metabolites of *Aspergillus* species, mainly produced by section *Flavi*. Naturally, there are four common types of aflatoxins (AFB_1, AFB_2, AFG_1, and AFG_2), among which aflatoxin B_1 is the most toxic one known in nature (IARC, 1993). The aflatoxin-producing fungi, *A. flavus* and *A. parasiticus* (Navya *et al.,* 2013), invade groundnut seeds and pods in the field or pre-harvest up to storage and processing stages. Several studies reported infections of groundnut by *Aspergillus* species and subsequent aflatoxin contaminations at pre- and post-harvest stages, leading to constraints in producing the crop in the country (Abdi Mohammed and Alemayehu Chala, 2014; Abdi Mohammed *et al.,* 2016).

Breeding groundnut for resistance to seed infection and/or aflatoxin contamination and developing varieties that are resistant to contamination by the toxin is one of the economically feasible options in managing both pre- and post-harvest aflatoxin contamination t. Resistance breeding against groundnut aflatoxin contamination can be achieved by imparting resistance to pre-harvest seed infection, in vitro seed colonization (IVSC) by *A. flavus* and aflatoxin production (Nigam *et al.*, 2009). Screening of resistant groundnut genotypes are getting a prior attention as aflatoxin management options, where variety development and biological control using non-toxigenic *Aspergillus* strains are found as optimistic approaches (Waliyar *et al.,* 2008). Moreover, various management approaches such as organic manure and biocontrol agents, managing environmental factors, are employed against *Aspergillus* infections and aflatoxin contamination to groundnuts in various countries (Khan *et al.*, 2021). So far, many groundnut varieties have been released for cultivation in Ethiopia (Ministry of Agriculture 2020). However, none of these commercial cultivars have been bred for resistance to *A. flavus* and aflatoxin contamination. Thus, the development of groundnut varieties resistant to *A. flavus* infections is indispensable. To this end, pertinent groundnut genotypes were introduced from Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and examined for resistance to *A. flavus* infection, seed yield, and desirable confectionery traits.

2. Origin and Pedigree

Babile-4 (ICGV 95469) and *Babile-5* (ICG 67 x BIGSEED) were introduced from the International ICRISAT, India.

3. Variety Evaluation

Two independent experiments were conducted at Pawe, Werer and Babile in 2015 and 2016 main cropping seasons. The first set of the experiment was conducted to identify groundnut genotypes with high yielding and resistance to *Aspergillus flavus* and associated contaminations, and the second experiment was executed to identify high yielding genotypes combined with desirable seed traits for confectionery uses. Two released varieties, namely, *Werer-961* and *BaHa-Jidu*, were used as the standard checks in experiment-I and experiment-II, respectively. The experiments were laid out in RCBD design with three replications. Seeds of each genotype were sown in four rows of a 4 m row length, and 60 and 10 cm spacing between rows and plants, respectively. *Babile-4* and *Babil-5* had significantly higher average seed yields of 1.86 and 2.12 t ha^{-1}, respectively, than average seed yields of the standard checks Werer-961 (1.32 t ha^{-1} in the first set experiment) and BaHa-Jidu (1.82 t ha^{-1}) in the second set experiment) (Table 2). The seed yield advantages of the two new varieties are reasonably higher to enhance the productivity of groundnut in the country.

4. Variety Approval and Release

Yield trials were conducted using 15 and 18 groundnut genotypes along with standard checks (*Werer and BaHa-Jidu*) in experiment-I and experiment-II, respectively. The genotypes were evaluated at Babile, Pawe and Werer for two growing seasons (2015 and 2016). After the yield trials, *ICGV 95469* and *ICG 67 x BIGSEED* were identified and proposed as candidate varieties for experiments I and II, respectively. Accordingly, verification trials were carried out at three on-stations and 6 on-farms and evaluated by the National Variety Release Committee of the country. Finally, the committee approved the candidate varieties for release in 2019.

5. Agronomic and Morphological Characteristics

Brief agronomic and morphological characteristics of the released groundnut varieties are presented in Table 1. *Babile-4* is a Spanish bunch type and has a dark green leaf with partially runner type. It is medium maturing and has a medium seed size and flat seed shape. *Babile-5* is a Virginia bunch type and has a light green leaf and relatively has erect growth habit. It is late maturing and has a large seed size and elongated seed shape, high

shelling percentage and heavy hundred seed weight. Both varieties have red tan seed color.

6. Reaction to Major Diseases

Developing resistant groundnut varieties to early and late leaf spots is among the major objectives of the national groundnut breeding program. In the current study, both early and late leaf spots were considered and the disease incidence was scored on a scale of 1 to 9 before leaf senescence in all test environments. According to Faujdar and Oswalt (1992), the description of the scale is; 1: immune, 9: Susceptible; hence, 1–3 = resistant, 4–6 = medium and 7–9 = susceptible. Thereby, both *Babile-4* and *Babile-5*, were scored 3, which is resistance against leaf spot disease, in comparison with the standard checks.

Table 1. The main agronomic and morphological characteristics of those two released groundnut varieties.

Characteristics	*Babile-4*	*Babile-5*
Adaptation areas	Assosa, Babile, Fedis, Gursum, Pawe, and Werer	Same
Altitude	Low-land to mid-altitude	Same
Planting date	Early May to June, depends on the planting period of the location	Same
Soil types	Sandy clay	Same
Seeding rate (kg ha^{-1})	60–80	100
Spacing (cm) between plants	10	Same
Between rows	60	Same
Fertilizer requirement	No	Same
Growth habit	Spanish bunch type	Virginia type
Seed coat color	Tan red	Same
Flower color	Yellow	Same
Days to 50% Flowering	38.66	43
Days to 95% Maturity	127.33	152.67
Shelling Percentage	65.55	70.88
Hundred seed weight	40.33	63.4
Seed size	Medium	Large
Oil content (%)	47.7	46.65
Incidences of *A. flavus* reaction (*In-vitro*)	0	not tested
Aflatoxin contamination	Not detected	Not tested
Reaction to leaf spots (1–9)	3-resistant	Same
Seed yield (ton/ha): Research field	1.86	2.1
Year of release	2019	Same
Breeder/maintainer	Haramaya University	Same

7. Seed Yield

The seed yield performance of Babile-4 and Babile-5 was found to be superior over the checks across all the test environments, confirming to the stability of yield performance. (Table 2). Babile-4 and Babile-5 had seed yield advantage of 41 and 16% over the checks Were-961 and BaHa-Jidu in that order.

Table 2. Mean seed yield of groundnut varieties at six enviroments.

Trials	Location	Pawe		Babile		Werer		Mean (t ha^{-1})	Yield advantage over check
	Year	2015	2016	2015	2016	2015	2016		
Experiment-I	Babile-4	1.64	1.58	1.08	1.23	3.26	2.38	1.86	41
	Werer-961 (check)	1.85	1.17	0.58	0.88	1.97	1.48	1.32	
Experiment-II	Babile-5	1.26	1.72	1.4	2.05	3.58	2.69	2.12	16
	BaHa-Jidu (check)	0.94	1.58	1.05	1.73	3.37	2.24	1.82	

8. Conclusion

The study has revealed that *Babile-4* and *Babile-5* groundnut varieties are superior to the check varieties (Werer-961 and BaHa-Jidu) in terms of yield, disease resistance, and desirable seed characteristics. The two candidate varieties have also comparatively stable yields. In addition, *Babile-4* is resistant to contamination *by A. flavus* and associated aflatoxin. Both varieties are resistant to leaf spot disease. Besides, *Babile-5* has desirable seed quality attributes for confectionery uses such as large and uniform seed size, ease of blanching, a red tan seed color mainly for the domestic market. Therefore, the newly released varieties are recommended for cultivation Babile, Pawe, Werer and other areas with similar agro-ecologies in the country for increasing productivity of the crop and farmers' income.

9. Acknowledgments

The authors thank the Ethiopian Institute of Agricultural Research (EIAR) for funding the research. The authors also thank the Office of the Vice-President for Research Affairs of Haramaya University, Pawe and Werer Agricultural centers for providing technical supports during the study.

10. References

Abdi Mohammed and Alemayehu Chala. 2014. Incidence of Aspergillus contamination of groundnut (*Arachis hypogaea* L.) in Eastern Ethiopia. *African Journal of Microbiology Research*, 8: 759–765.

Abdi Mohammed, Alemayehu Chala, Mashilla Dejene, Chemeda Fininsa, David, A.H., Victor, S.S. and Renee, S.A. 2016. Aspergillus and aflatoxin in groundnut (*Arachis hypogaea* L.) and groundnut cake in Eastern Ethiopia, *Food Additives & Contaminants: Part B*, httpps://doi: 10.1080/19393210.2016.1216468.

CSA (Central Statistical Agency). 2021. Agricultural Sample Survey 2020/21: Report on area and production of major crops (private peasant holdings, main season), Vol.1. Statistical Bulletin No. 590. CSA, Addis Ababa, Ethiopia. Pp. 13.

Faujdar, S. and Oswalt, D.L. 1992. Major Diseases of Groundnut. Skill Development Series no. 6. Human Resource Development Program ICRISAT International Crops Research Institute for the Semi-Arid Tropics Patancheru, Andra Pradesh 502 324, India. Pp. 51.

Food and Agriculture Organization of the United Nations Database (FAOSTAT). 2020. Food and Agriculture Organization of the United Nations Database of agricultural production. FAO Statistical Databases. Available at *http*: www.fao.org/faostat/. Accessed on 14 December 2021.

Fredu Nega, Mausch, K., Rao, K.P.C. and Gizachew Legesse. 2015. Scoping Study on Current Situation and Future Market Outlook of Groundnut in Ethiopia. Socioeconomics Discussion Paper Series 38.

IARC (International Agency for Research on Cancer). 1993. Monograph on the evaluation of carcinogenic risks to humans. Volume 82. Lyon: IARC Press. 56: 489–521.

Khan, R., Ghazali, F.M., Mahyudin, N.A., Samsudin, N.I.P. 2021. Biocontrol of Aflatoxins Using Non-Aflatoxigenic *Aspergillus flavus*: *Journal of Fungi,* 7: 381. https://doi.org/10.3390/ jof7050381.

Ministry of Agriculture. 2020. "Crop Variety Register Issue No. 23. Plant Variety Release". Protection and Seed Quality Control Directorate. MoANRs, Addis Ababa, Ethiopia. Pp. 410.

Navya, H.M., Hariprasad, P., Naveen, J., Chandranayaka, S. and Niranjana, S.R. 2013. Natural occurrence of aflatoxin, aflatoxigenic and non-aflatoxigenic *Aspergillus flavus* in groundnut seeds across India. *African Journal of Biotechnology*, 12: 2587–2597. https://doi: 10.5897/AJB2013.12310.

Nigam, S.N., Waliyar, F., Aruna, R., Reddy, S.V., Lava Kumar, P. and Craufurd, P.Q. 2009. Breeding peanut for resistance to aflatoxin contamination at ICRISAT. *Peanut Science*, 36: 42–49.

Seltene Abady, Shimelis Hussein and Janila, P. 2019. Farmers' perceived constraints to groundnut production, their variety choice and preferred traits in eastern Ethiopia: Implications for drought-tolerance breeding. *Journal of Crop Improvement,* 33: 1–17. https://doi.org/10.1080/ 154275 28.2019. 1625836.

Waliyar, F., Kumar, P.L., Ntare, B.R., Diarra, B. and Kodio, O. 2008. Pre- and post-harvest management of aflatoxin contamination in peanuts. In J. F. Leslie et al. (Eds.), Mycotoxins: Detection methods, management, public health and agricultural trade. Wallingford: CABI. Pp. 209–218.