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"Evaluation and Registration of White Seeded Sesame Variety (*Sesamum indicum L.*): Setit-3 (Hurc-4) in Western Tigray, Ethiopia" Describes the Performance of a New Sesame Variety in Western Tigray in Ethiopia

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ABSTRACT

Setit-3 (HuRC-4) is an adaptable, stable, high yielding (0.89 ton^{ha-1}), high oil content (54.4%) with desirable traits as well as blight resistant variety. This variety was also selected by farmers during field evaluations for capsule number, number of branches, growth characteristics, number of seeds/capsule, logging characteristics, seed color, earliness, and diseases resistance. More over Setit-3 variety had about 18.25% and 34.25% yield advantage over the standard and local checks, respectively. Setit-3 (HuRC-4) was therefore registered and released as a variety for sesame growing areas of western zone of Tigray and similar agro-ecologies of Ethiopia.

Keywords: *Setit-3, variety registration, Sesamum indicum.*

INTRODUCTION

Sesame (***Sesamum indicum L***.), a member of the ***Pedaliaceae*** family, is an erect annual herb commonly known as sesamum, benniseed, or simsim. It is one of the oldest and most traditional oilseed crops, valued for its high-quality seed oil. According to recent archeological findings, sesame cultivation was derived from wild populations native to South Asia, and its cultivation was established in South Asia from the time of the Harappan civilization and spread west to Mesopotamia before 2000 B.C. [1].

Sesame is a broad-leafed summer crop like cotton, sunflower, soybeans, black-eyed peas, or mungbean. Sesame is an annual self-pollinating plant with an erect, pubescent, branching stem. It is either single stemmed or branched with indeterminate and determinate growth habits and reaching up to 2 m in height. According to Kobayashi et al (1990), 36 species have been identified under the genus *Sesamum* with three cytogenetic groups 2n = 26, 2n = 32 and 2n = 64 and the widely cultivated *Sesamum indicum* is within the first group. The fruit of sesame is a capsule, often called pod. Some varieties have a single capsule per leaf axil while others have triple capsules. Flowering starts 35-45 days after planting and stops 75-85 days later. The seed is produced in the capsules and each capsule contains about 70 seeds [2].

Sesame seed is often branded as 'Humera', 'Gonder' and 'Welega' types, well known in the world market by their white color, sweet taste and aroma. The Humera and Gondar sesame seeds are suitable for bakery and confectionary purposes and the high oil content of the Welega sesame seed gives a major advantage for edible oil production [3]. The major quality requirements of sesame seed exports are thousand seed weight (TSW), oil content and seed color. Thousand seed weight should be greater than 3g, oil content of 40-50% and pearly-white seed color. White to golden color seeds are mainly used in raw-form because of their aesthetic value and are mostly priced higher than mixed seeds while yellow to dark brown seeds are generally crushed into oil [4].

Though the volume of sesame produced by different countries is variable from year to year, Myanmar with productivity of 0.56 tonha-1was the leading one in 2012 main cropping season followed by India (0.34 tonha-1), China (1.31 tonha-1), Sudan (0.26 tonha-1) and Tanzania (0.67 tonha-1) [5] (FAO STAT, 2013). The average sesame productivity in Ethiopia in

2014/2015 main cropping season was about 0.7 tonha-1[6] and was above the world average productivity of 0.51 tonha-1 [7].

Ethiopian sesame is among the highest quality in the world, as seeds are produced at near-organic levels. Humera and Gonder types from the respective areas in particular are renowned for high quality and nutty aroma. Sesame production is therefore an important agribusiness sector in Ethiopia and is one of the six priority crops of the Agricultural Growth Programme [8]. Sesame is also 2nd oil crop in terms of area coverage (420,495 ha) and total production (288770 ton of sesame seed yield from the total area coverage) next to noug =*Guizotia abyssinica Cass*) [6]. The major sesame regions in Ethiopia are Tigray (western and north western 36%), Oromia (East Welega 17%), Benishangulgumuz (Belles valley 15%) and Amhara (Metema 31%) are the most sesame producing regions in the country [9].

Western Tigray is among the major sesame producers in the country where most of the production is directed to national and international markets [10] though the average yield of sesame in western zone of Tigray is very low (<500kg^{ha-1}). The reasons for low productivity include improper agronomic practices and unavailability of varieties resistant to biotic and abiotic stresses. So high yielding, adaptable, pest tolerant varieties with good plant characteristics and high demand for export are needed for the area. Humera Agricultural Research Center (HuARC) is therefore conducting different research activities in collaboration with regional, national and international research centers and universities to solve sesame production constraints. So far four white-seeded sesame varieties demanded by the export market (Setit-1, Humera-1, Setit-2 and Setit-3) and suitable for western zone of Tigray and similar agro-ecology of Ethiopia were developed and released for beneficiaries (investors and small scale farmers) [10].

Material And Methods

The experiment was conducted at six locations in northern Ethiopia; Humera, Dansha, Sheraro, Maykadra, Wargiba (Alamata) and Gendawuha (Metema) and at two farmers' fields in each location (Table 1) in the variety evaluation during 2014-2015 in the main season. The experiment was laid out in randomized complete block design (RCBD) with three replications in all testing sites. Each genotype was randomly assigned and sown in a plot area of 2m x 5m with 1m between plots and 1.5 m between blocks keeping inter and intra row spacing of 40 cm and 10 cm, respectively.

Three promising candidate genotypes ('HuRC-4', 'HuRC-3' and 'Landracegumero' (candidate) were compared with 'Setit-2' (standard check) and 'Hirhir' (local check) during the 2016 growing season. Each plot had a total area of 100 m^2 (10 m x10 m), with inter and intra row spacing of 40cm and 10 cm, respectively, and 23 harvestable rows during variety verification. The experimental plots were ploughed two times (first time before sowing and second during sowing) to maintain fine seedbed suitable for sesame establishment. Each experimental plot received the same rate of (100^{kg-1}) Diammonium phosphate (DAP) and 50kg^{ha-1} urea (split application of urea 25kg^{ha-1} during planting and 25kg^{ha-1} after thinning at vegetative stage). All field management practices were done equally and properly as per the recommendations to the study areas. Phenological data viz. days to emergence, flowering, maturity, plant height (PH), number of branches (NBPP), number of capsules per plant(NCPP), length of capsule bearing zone(LCBZ), Days to maturity (DM)**TSW=,** Thousand seed weight**, SY=**Seed yield/ha recorded along with oil content. Five sample plants were taken and recorded for each data. But yield, thousand seed weight, oil content, pest tolerance, logging resistance data recorded plot wise. Seed color data was recorded according to color identification chart and sesame descriptor.

Statistical estimations and computations were performed using different statistical software. Homogeneity of residual variances was tested prior to a combined analysis over locations in each year as well as over locations and years using Bartlett's test [14]. Analysis of variance for each environment, combined analysis of variance over environments, AMMI analysis and correlation between different stability parameters were computed using [15]**.** Coefficient of regression (bi) and deviation from regression (S^2di) stability parameters were also analyzed using **Agrobase (2000)** software.

As the error variance were homogenous for seed yield and oil content continued to combined analysis of variance from the mean data of all environments to detect the presence of GEI and to partition the variation due to genotype, environment and GEI. The environments (locations and years) in the study were assumed as random effects and the genotype effects were treated as fixed. Moreover, mean comparison using Duncan's Multiple Range Test (DMRT) was performed to explain the significant differences among means of genotypes, years and locations (environments). Unbalanced design ANOVA model were used for combined analysis of variance because of different locations and years in the study. GenStat 16th edition [15] (2009) statistical software was used for most of the statistical analyses.

Table1. *Description of the study areas from (HuARC, 2016[16])*

Descriptor	Humera	Dansha	Banat	Maykadra	Sheraro	Gendawuha
Altitude (m)	606	773	593	707	1006	760
Latitude	1419388	1355139	1378043	1387835	142400	12^{o}
Longitude	3676001	3696491	3639773	3662495	375600	36^{o}
Temperature (^{0}C)	18.8-37.6	28	28	28	13.3-40.5	19.5-35.7
Soil type	Chromic Vertisol	Vertisol	Chromic Vertisol	Chromic Vertisol	Vertisol	Vertisol
RF (mm)	576.4	888.4	NA	NA	1000	850-1100

Map of Test Sites

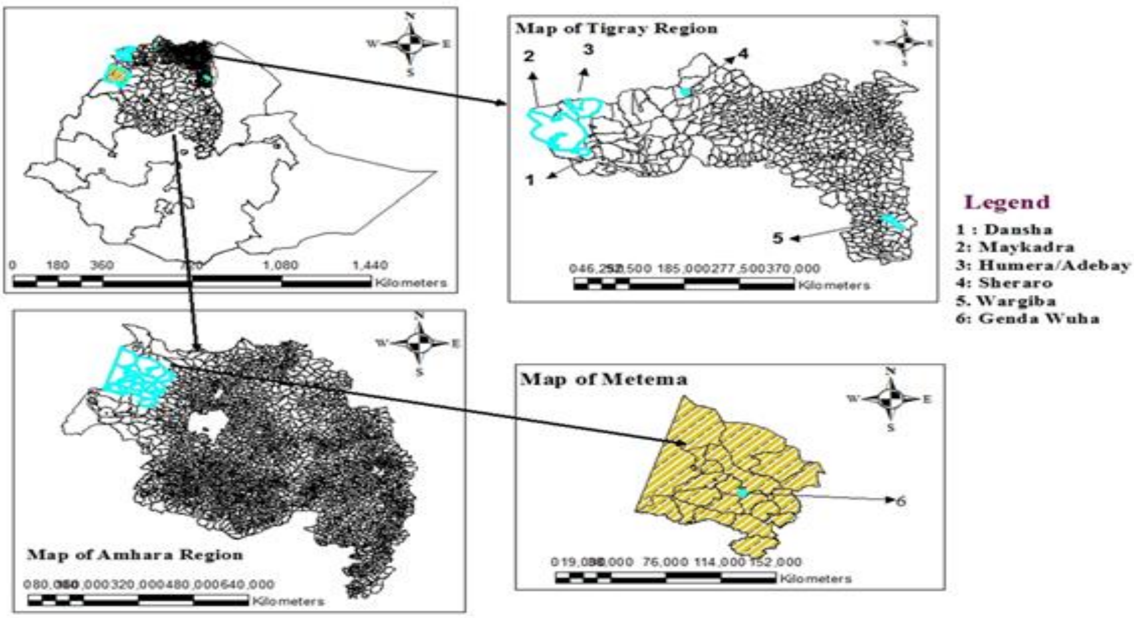

Figure1. *Map of the test sites from HuARC, 2016 [17])*

Result and Discussion

White-Seeded Sesame Varieties Performance Evaluation

The adaptation trial of 17 sesame genotypes was conducted at Humera, Dansha, Sheraro, Wargiba, Maykadra, and Gendawuha from 2014-2015 main cropping seasons and were evaluated for yield, yield components, oil content as well as their pest and disease reaction. There was significant difference among the varieties across years and locations for mean yield (Table 2), with mean yield of the tested varieties across years and locations ranged from 0.44 ton^{ha-1}to 0.867 ton^{ha-1}.

Three best adapted genotypes with the highest mean yield, oil content and other agronomic characteristics ('HuRC-4'), 'Landracegumero' and 'HuRC-3' were identified as candidate varieties and were evaluated during 2016 main season by comparing them with standard and local checks (Setit-2 and Hirhir) at six locations and two farmers field in each test station; Humera, Dansha, Sheraro, Banat, Rawyan and Adebay. Each plots had a total area of 100 m^2 (10 m x 10 m) with inter and intra row spacing of 40 and 10cm, respectively.

Each experimental plot received the same rate of Diammonium phosphate (DAP) and urea fertilizer. Pesticides and all field management practices were applied according to the recommendations. The national technical variety evaluating committee were invited and found that Setit-3 ('HuRC-4') had good field performance and was high yielder, early maturing and blight tolerant as compared with the standard and local checks. The national variety release committee, considering field performance report from the technical committee, farmer's preference and their 10 environment combined report, selected Setit-3 (HuRC-4) to be released as variety in 2017 cropping season.

Table2. *Analysis of variance result of the white-seeded sesame varieties at six locations*

Sources of variation	d.f.	s.s.	m.s.	v.r.	F pr.
Replication	2	245131	122565	15.57	<.001
Location	5	4210695	842139	107.01	<.001
Genotype	5	839921	167984	21.35	<.001
Year	1	1491662	1491662	189.54	<.001
Location x Genotype	20	815788	40789	5.18	<.001
Location x Year	3	8849898	2949966	374.85	<.001
Genotype x Year	5	386684	77337	9.83	<.001
Location x Genotype x year	12	461660	38472	4.89	<.001
Residual	102	802712	7870		
Total	155	18104151	116801		

Agronomic and Morphological Characters

Setit-3 (HuRC-4) variety has a pearly white seed color, ovoid seed shape, medium seed size, good thousand seed weight (2.9 g), erect growth characteristics, extra early maturity and had a height of 99cm. Agronomic and morphological characteristics of the varieties was summarized and presented in Appendix table 1 and Table 3, respectively.

Table3.Yield and yield components of white-seeded sesame varieties across years and location

Table3. *Yield and yield components of white-seeded sesame varieties across years and locations*

Varieties	DM	NCPP	NBBP	LCBZ	TSW	SY	% Oil content
HuRC-3	89.80	27.73	3.12	52.89	2.70	792.50	50.35
HuRC-4	76.90	37.25	3.21	54.50	3.11	867.40	54.40
Landracegumero	85.73	31.43	3.63	51.40	2.85	753.80	50.10
Hirhir	80.10	32.03	3.44	52.44	2.92	645.50	49.95
Setit-2	80.83	30.50	3.21	49.97	2.94	745.10	50.30
Grand mean	82.67	31.79	3.32	52.24	2.90	760.85	50.14
LSD (5%)	**	**	*	*	*	**	**
CV%	3.20	10.50	20.50	10.00	14.10	15.10	28.00

*** =Highly significant,* =Significant*

Setit-3 (HuRC-4) was one of the collected 100 landraces from northern Ethiopia and has passed different sesame breeding stages from 2014 to 2016 main cropping seasons. This variety was also evaluated against checks for mean yield and oil content across locations and years. The mean yield of this variety was 0.11 ton^{ha-1}at research station and 0.89 ton^{ha-1}at farmer's field during verification trial. Similarly recently released varieties Obsa and Dicho gave yields ranging from 0.106 to 0.868.8 ton^{ha-1} at farm level [18].Moreover Setit-3 (HuRC-4) had about 18.25% and 34.25% yield advantage over the standard and local checks, respectively. The average productivity of sesame in many farmers and investors in the Humera area is less than 0.5 ton^{ha-1}and the low productivity was due to poor agronomic practices, no use of improved varieties and other biotic and abiotic constraints. This variety, besides to good yield, is very early and is therefore recommended for moisture stress areas in western zone of Tigray and similar agro-ecology of Ethiopia.

Diseases Reaction

Sesame webworm and seed bug are the major insect pests of sesame while blight, fusarium wilt and phyllody are major diseases, yet this variety has recorded the lowest blight, phyllody and fusarium wilt score as compared with the standard. Diseases were assessed on randomly selected ten plants from each entry under natural epiphytotic conditions. Bacterial blight disease was assessed at 75 days after sowing using 0 to 5 rating scale [19]. The disease reaction was categorized as highly resistant (HR), resistant(R), moderately resistant (MR), moderately susceptible (MS), susceptible (S) and highly susceptible (HS) as per the disease severity range of 0%, 1 to10%, 11 to 25%, 26 to 50%, 51 to 70% and 71 to 100%, respectively.

Fusarium wilt diseases data was recorded based on Six points rating scale (1-5) 1-20%=1, 20.01-40=2, 40.01-60=3, 60.01-80=4, 80.01-100=5. [13] The comments of those scale values [1=Resistant(R), 2= Moderate Resistant (MR), 3=Moderate Susceptible (MS), 4=Susceptible (S) and 5=highly susceptible (HS)]. Phyllody diseases; (0-6) rating scale, where 0 = no infection (highly resistant); 1 = 0.1-10% plants infected (resistant); 2 = 10.1- 20 % plants infected (moderately resistant); 3 = 20.1-30 % plants infected (tolerant); 4 = 30.1-40 %plants infected (moderately susceptible); 5 = 40.1-50 % plants infected (susceptible) and 6 = more than 50 % plants infected (highly susceptible[20]**).**

Yield Stability Across Years and Locations

The stability analyses were conducted for 17 collected sesame land races genotypes for two years and across six locations [21]. According to coefficient of regression analyses trials and estimated value, Setit-3 variety is the most stable with its mean seed yield and oil content than others. Setit-3 is considered adaptable and good mean yield performance at an altitude of 650 (Humera) to 1500 meters (Wargiba and Metema). This finding is therefore in agreement with that of [22] with[23] who reported that the best agro-ecology for sesame adaptation and wider genetic diversity is an altitude below 1500 meters.

Conclusion and Recommendation

Setit-3 (HuRC-4) is a high yielding sesame variety and well adapted to western Tigray. It has high oil content besides being blight tolerant. Setit-3 is liked and selected by the farmers for its seed color, earliness, and uniformity. Moreover Setit-3 variety has demonstrated to have significant advantages over the standard and local checks respectively. Setit-3 is released and registered as variety for commercial production in western zone of Tigray as well as similar agro-ecologies of Ethiopia.

Conflict of Interests

The work was from my thesis. The author(s) declare(s) that there is no conflict of interest regarding the publication of this paper.

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