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Research Article

# Registration of Newly Released Hull Less Food Barley (*HondiumVulgare L.*) Variety, 'Sena', for High Potential Barley Growing Areas in Ethiopia

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## Abstract

Twenty hull less barley genotypes from the local crossing program and germplasms introduced from ICARDA were evaluated in a multi-location variety trial to identify stable genotypes with high grain yield, desirable agronomic characters and good level of disease resistance. Results of combined analysis showed that genotype (G5 and G19) with pedigree name *TOCTE/M112/6/VMORALESCBSS04M00436T-11M-0Y-0M-3M-0AP and PENCO/CHEVRON-BAR/3/LEGACYU//PENCO/CHEVRON=BAR CBSS04Y00048S-23Y2M-0Y-0M-0Y-0AP--0TR-0TR* exhibited the highest mean grain yield with good agronomic performance and good level of disease resistance across the testing environments, while genotype. Accordingly, the two varieties were promoted to variety verification trial in 2022, and genotype G5 released in 2023; this genotype was named Sena. The variety showed good physical grain quality, coupled with high grain yield of 5.2 t/ha. Sena variety is suitable to the high potential barley growing areas. This variety is characterized by early maturity, white seed color, has good physical grain quality, resistance to leaf rust and scald, moderate resistance to net blotch, moderate tolerance to barley shoot fly, lodging tolerance and good biomass yield. The variety's demonstration and seed multiplication is underway. Therefore, cultivation of the new variety in the higher altitude areas of major barley growing environments of the country is highly recommended. Six-rowed semi hulled barley Sena was developed by Sinana Agricultural Research Center (SARC), Southeastern Oromia region, Ethiopia. If the variety is sufficiently demonstrated, scaled up and adopted by farmers, it can play significant role in increasing hull less barley production and productivity thereby increasing the income of farmers and can also be source of raw material for local market engaged in the *kolo* production.

## Keywords

Sena, Variety Registration, Hull Less

## 1. Introduction

Barley (*Hordeumvulgare* L.) is one of the oldest and first domesticated cereal crops and is believed to have originated in the Fertile Crescent region of the near east around 8000 BC [11]. Barley is and has been an important cereal crop for thousands of years. The global average of grain production of barley is estimated to be approximately 3.50 tons ha−1 in 2019 [9]. Furthermore, the average harvested area is estimated at approximately 504 000 hectares. As a whole grain, kernels

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of barley provide minerals, fiber, vitamins, moderate protein, phosphorus, and calcium content, and a small amount of B vitamins [8]. The world major producers are Europe, South Africa, Near East, Russia, China, India, Canada, USA, Australia and Ethiopia [4]. Ethiopia is the second largest producer in Africa sharing about 25% of the barley production in the content, next to Morocco and ranked 21st in the world [5].

Barley is a cool season, most dependable and early maturing cereal crop with comparatively high yielding potential in various agro-ecologies (ranging from 1800 to 4000m altitude) as well as marginal areas wherever other cereal crops aren't grown [2, 3, 15]. The crop is fully grown in all regions, but over 85% of total production comes from Oromia and a few a parts of Gojjam, Gondor, Tigray and Wollo [1]. Its grain is the major source of carbohydrate, proteins and lipids [13]. Barley is understood as "king of grain" in Ethiopia accounting about 5% of per capita calorie consumption as a main ingredient in staple food and drinks. It's additionally used as substitute for different cereals within the country [6]. Besides its importance as staple food and animal feeds, it's additionally a cash crop, used for production of malt and roasted grain locally known as 'Kolo" which is made up of special barley "Semi-hulled" or *'SenefKolo'* variety [12].

The development of varieties which can be adapted to a wide range of environments is the crucial goal of plant breeders in a crop improvement program [14]. Multi-environment yield trials are crucial to identify adaptable high yielding cultivars and discover sites that best represent the target environment [7]. Poor response of genotypes to different environmental condition is the result of genotype and genotype by environment interaction; resulted in yield variations among genotypes across environments [10]. Thus, multienvironment trials (MET) are required to identify genotypes that have the specific and the general adaptability in tested environments. Barley production constrained by various biotic and abiotic factors. To alleviate these constraints confronting barley production, barley breeding program at Sinana has been working on development of barley varieties with high yield potential and resistance to major barley diseases. The ideal cultivar for high grain yield or for any other desirable traits needs to express genetic potential with low value of variance in different environmental factors of growing. Therefore, generating more new improved production technologies on barley must be continues to contribute in food self-sufficiency and sustainable agriculture and could be source of income generation for the local farmers. The objective of the present study was to develop high yielding and disease resistant food barley varieties suitable for optimum environments.

## 2. Materials and Methodologies

Twenty hull less barley lines International Center for Agricultural Research in the Dry Areas (ICARDA) origin were tested under national variety trial for two consecutive years at three environments namely; Sinana, Dinsho and Bekoji in 2020-2021. The field experiment was laid out in randomized complete block design with three replications. Lastly, two lines as candidate *TOCTE/M112/6/VMORALESCBSS04M00436T-11M-0Y-0M-3M-0APand PENCO/CHEVRON-BAR/3/LEGACYU//PENCO/CHEVRON=BAR CBSS04Y00048S-23Y2M-0Y-0M-0Y-0AP--0TR-0TR* were selected and verified at multi locations along with two checks; *Jelkebne*and*Senefkolo*due to significantly better mean grain yield, good quality and tolerant to major barley diseases. Both candidates were verified during 2022 main cropping season at four environments (Sinana, Dinsho, Bekoji and Bore) using none replicated 10m x 10m plot design. All study environments are characterized by bi-modal rainfall pattern. Seeding and fertilizer rates 125kg/ha and 100/50 kg/ha (UREA/NPS/UREA) were applied respectively. Whereas; UREA (N) was applied in split application form where 1/3rd was applied at planting time and the remaining 2/3rd was applied at tillering stage as per agronomic recommendation. Planting was done by hand drilling; weed was controlled by using hand weeding. The variety was evaluated by National Variety Release committee and officially released for wider production in the high potential barley growing areas of Ethiopia.

## 3. Morphological and Agronomical Characters

Sena is six-rowed hull less barley variety, erect growth habit with average days to heading and maturity date of 77 and 147 days, respectively (Table 2). The variety has medium plant height (104 cm). On the other hand, seed color is white and has average thousand-kernel weight of 38.9g. It is also characterized by better resistance/tolerance to main biological insect pest (shoot fly) than the standard variety *(Jelkebne)* and local variety *Senefkolo*showed rapid compensatory growth after damage by the insect.

***Table 1.*** *Combined Mean of agronomic performance and disease reactions of 2020 in National Variety Trial in2020 and 2021.*

| Genotype | DH | DM | PH | GY | TKW | HLW | ST | SC | NB | Lodg |
|---|---|---|---|---|---|---|---|---|---|---|
| CABUYAMJA//PENTUNIA 1/5/PENCO/CHEVRON-BAR/3/ ATACO/BERMEJO//HIGO/4/PENTUNIA 1 CBSS04B00030S-11M-0Y-0M-3Y-0M-0AP-0TR-0TR | 79.9 | 148.7 | 94.4 | 2610.3 | 32.7 | 62.6 | 72.0 | 2.4 | 32.6 | 0.6 |
| CP0LO9109PENTUNIA2 M9908600108/2J0010 | 77.2 | 146.4 | 104.3 | 3063.8 | 28.8 | 62.2 | 70.9 | 1.4 | 32.4 | 0.3 |
| ZDIJIJ/3/ZBA/PENTUNIA 1//CABUYA CBSS04B00127S-0M-0OR-0M-0OR-3M-0AP | 80.9 | 148.4 | 103.9 | 2859.4 | 34.1 | 61.6 | 70.8 | 1.1 | 30.9 | 0.8 |
| TOTCE/PENTUNIA 2//PENTUNIA 1CBSS01Y00830T-E0Y-1M-1M-1Y-0M-0AP-0TR-0TR | 82.5 | 149.8 | 102.9 | 3247.6 | 31.8 | 62.7 | 70.1 | 1.1 | 27.9 | 1.3 |
| TOC-TE/M112/6/VMORALESCBSS04M00436T-11M-0Y-0M-3M-0AP | 76.8 | 146.9 | 103.8 | 3749.1 | 28.9 | 64.0 | 72.0 | 1.4 | 32.9 | 0.3 |
| Arupo'S'12/3/P1002325/Maf102///Cossack/4/Viriga'S'/5/Mundah icb03-0173-23AP-0AP-0TR-0TR | 78.9 | 145.3 | 101.3 | 2482.6 | 37.6 | 71.7 | 75.9 | 2.6 | 33.3 | 1.3 |
| CABUYAMJA//PENTUNIA 1/5/PENCO/CHEVRON-BAR/3/ ATA-CO/BERMEJO//HIGO/4/PENTUNIA 1 CBSS04B00030S-10M-0Y-0M-3Y-0M-0AP-0TR-0TR | 85.6 | 151.1 | 98.3 | 2743.2 | 30.0 | 61.9 | 70.3 | 1.8 | 34.4 | 0.3 |
| ICNB93-369//Atshualpa/Iraqi Black ICB06-1243-37AP-0AP-0TR-0TR | 78.4 | 147.8 | 103.4 | 2957.8 | 30.9 | 64.3 | 72.3 | 3.2 | 32.3 | 1.2 |
| ESCO-BA/3MOLA/SHYRI//ARPP0*2.JET/4/ALELI/5/GUYAM99142001 08/2G0013 | 76.2 | 147.5 | 102.4 | 2620.9 | 37.0 | 67.7 | 73.1 | 2.7 | 33.4 | 1.3 |
| Rhn-03/3/Mar25-84/Att//Mari/Aths*3-02/4/Ssn/Badia//Arar/S/ gloria'S' Copal'S'ICB05-054-9AP-0TR | 77.3 | 144.8 | 109.3 | 2852.6 | 33.2 | 60.5 | 72.3 | 2.3 | 33.7 | 5.4 |
| Viringa'S'//WI2291/WI2269/5/Atahualpa/4/300Union/Sv73608//perugia/3/w28g15-1-N/Weihenstenphan 173/Namoi icb06-1177-18AP-0AP-0AP-0AP--0TR-0TR | 75.6 | 145.8 | 104.4 | 2365.2 | 40.6 | 64.7 | 70.3 | 2.9 | 32.9 | 1.8 |
| LIB-YA/ICNBF8-614/4/Ssn/BADIA//ARAR/3/GLORIA'S'COPN'S' ICB06-1286-4AP-0AP-0AP-0AP-0TR-0TR | 74.2 | 146.1 | 96.1 | 2939.2 | 38.3 | 61.7 | 69.4 | 2.7 | 33.3 | 0.6 |
| NACTAHJA A33//FFNC1CBSS05Y00293S-25Y-13M-0Y-0M-11AP--TR-0TR | 80.1 | 146.1 | 104.6 | 2829.3 | 31.0 | 63.5 | 69.4 | 2.8 | 34.7 | 1.0 |
| Aths/Lignee686//Orge905/Cr289-53-2/3/pentunia2/6/M64-77/Ben//Jo/York/3/M5/Galt//As46/4/Hj34-80/Astrix/5/M6/Robur-35-6-3 | 78.5 | 148.3 | 106.0 | 2764.8 | 32.2 | 61.5 | 71.3 | 2.3 | 36.8 | 2.6 |
| Rt013/Nainaa/4/Lignee527/Chn-01//Gustoe/3/Atahuanlpa ICB97-1254-0AP-2AP--0AP--3TR-6AP--0AP-0TR-0TR | 78.8 | 145.7 | 112.6 | 2749.8 | 34.4 | 61.1 | 72.3 | 2.4 | 33.4 | 6.1 |
| DD-21/Wavenery ICB02-0576-0AP-6TR-5AP-0AP-0TR-0TR | 68.8 | 141.1 | 97.8 | 1819.7 | 36.5 | 77.3 | 73.6 | 3.5 | 33.5 | 2.4 |
| LAMOLI-NA95/4/ALELI/ESCOBA/3/ARUPO/K8755//MORA CBS01M00161S-17M-4Y-1M-2Y-0M-0AP--0TR-0TR | 78.4 | 145.1 | 110.0 | 2670.3 | 33.8 | 60.4 | 74.3 | 2.1 | 33.1 | 6.7 |
| NACTAHJA A33//FFNC1CBSS05Y00293S-25Y-0M-0Y-OM-3AP--TR-0TR | 71.7 | 145.2 | 89.0 | 2754.5 | 33.9 | 63.0 | 70.2 | 3.3 | 31.5 | 1.6 |

| Genotype | DH | DM | PH | GY | TKW | HLW | ST | SC | NB | Lodg |
|---|---|---|---|---|---|---|---|---|---|---|
| PEN-CO/CHEVRON-BAR/3/LEGACYU//PENCO/CHEVRON=BAR CBSS04Y00048S-23Y2M-0Y-0M-0Y-0AP--0TR-0TR | 82.7 | 151.2 | 110.8 | 3475.7 | 34.8 | 67.2 | 73.4 | 3.3 | 32.5 | 0.4 |
| Local check | 89.2 | 152.7 | 119.7 | 2548.8 | 45.2 | 62.3 | 73.4 | 2.5 | 35.1 | 2.1 |
| Mean | 78.6 | 147.2 | 103.8 | 2803.9 | 34.3 | 64.0 | 71.9 | 2.4 | 33.1 | 1.9 |
| LSD | *0.66* | | *2.28* | *112.52* | *0.46* | | *0.89* | | | |
| CV | *3.30* | | *8.58* | *15.60* | *5.32* | | *4.87* | | | |

*DH-Days to heading, DM- Days to maturity, PH (cm)- Plant height, GY (kg/ha)- Yield per hectare, TKWThousand seed weight, HLW- hecto litter weight, NB (00-99)- Net blotch, ST= Stand Count, Lodg=Lodging

## 4. Yield Performance

*Sena* was tested together with 19 barley genotypes including check in national variety trial at 6 environments in major barley producing areas of highlands during 2020- 2021 consecutive years. It was evaluated along with *Senefkolo* as local variety at altitudinal range of 2400-2600 meter above sea level at Sinana, Dinsho andBekojilocations in each year. During evaluation seasons, the overall location grain yield mean of this variety was better than all genotype means. Beside, Sena showed 47% yield advantage over the local check *Senefkolo*. On research field *Sena* gave yield ranging from 2.7 t/ha$^{-1}$ to 5.17 t/ha$^{-1}$, whereas 3.3 t ha$^{-1}$to 5 t ha$^{-1}$ on farmers' field.

## 5. Disease Reaction

The major barley disease according to their importance in the growing area is net Bloch, rust (SR and LR) and scald. Accordingly, Sena net Bloch scored 33 (%) for Scald 1.4 (%) for stem rust and leaf rust trms which makes it tolerant to barley diseases (Table 1). The variety response is moderately resistance to net Bloch, rust (SR and LR) and scald. Generally, Sena variety is tolerant to major barley disease and other abiotic factors.

## 6. Adaptation and Agronomic Recommendations

Newly released hull less barley variety, Sena is recommended for highpotential barley growing areas. It performs very well at altitude ranging from 2400-2600m.a.s.l. and receiving annual rainfall of 800 -1700mm areas. The seed and fertilizer rates recommended for Sena variety is 125kg/ha and 50/100 kg/ha (UREA/NPS) respectively. Fertilizer (UREA) application is in split form where; 1/3rd applied at planting and the remaining 2/3rd applied at tillering stage. Based onset of rainfall planting time ranged from mid-August to early September. Favorable growing temperature ranges from 10 ℃ – 21 ℃ through crop growing stages which, is optimum temperature for barley production areas. Variety maintenance The variety is maintained under the responsibility of breeder and foundation of the seed by Sinana Agricultural Research center/Oromia Agricultural Research Institute.

## 7. Conclusion and Recommendation

Sena is high yielding and stable variety across locations with desirable agronomic and morphological traits as compared to rest of the genotypes used in the study. Accordingly, it has been officially released for high potential barley growing areas of Ethiopia in 2023. This variety is currently under seed multiplication for further production in potential barley growing areas. Small holder farmers, private investors and seed enterprises can benefit more from producing Sena variety following its full production package.

***Table 2.*** *Agronomic and morphological characteristics of Sena.*

| No | Agronomical and Morphological Characteristics | |
|---|---|---|
| 1 | Adaptation area | For high potential barley growing areas in Ethiopia |
| 2 | Altitude (m.a.s.l.) | 2400-2600 |
| 3 | Rainfall (mm) | 800 -1700mm |
| 4 | Seed Rate (Kg/ha) | 125 |
| 5 | Planting date | End of July to Early August |
| 6 | Days to Flower | 77 |
| 7 | Days to Maturity | 147 |
| 8 | Plant Height (cm) | 104 |
| 9 | 1000 Seed Weight (gm) | 38.9 |
| 10 | Test weight (kg/hl) | 64 |

| No | Agronomical and Morphological Characteristics | |
|---|---|---|
| 11 | Seed Color Light brown | Amber |
| 12 | Growth habit | Erect |
| 13 | Crop pest reaction | Tolerant to major pests |
| 14 | Disease reaction | Moderately resistance to major barley diseases |
| 15 | Yield (t $ha^{-1}$) | 15.1. Research field: 2.7 to 5.2 t/$ha^{-1}$; 15.2. Farmers field: 3.3 to 5 t $ha^{-1}$ |
| 16 | Spike density | Very dense |
| 17 | Flag leaf and stem color | Glucocity |
| 18 | Awns attitude | Medium |
| 19 | Glumes color | White |
| 20 | Hulled type | Hull less |
| 21 | Seed size | Large |
| 22 | Seed shape | Moderately elongated |
| 23 | Year of release. | 2023 |
| 24 | Breeder/Maintainer | SARC/IQQO |

## Abbreviations

| | |
|---|---|
| CSA | Central Statics Agency |
| LR | Leaf Rust |
| M.a.s.l | Meters Above Sea Level |
| MET | Multi Environment Trial |
| NPS | Nitrogen Phosphors Sulfur |
| SR | Stem Rust |
| Trms | Tress Moderately Susceptible |

## Conflicts of Interest

The authors declare no conflicts of interest.

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