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Review On Genetic Variability of Ethiopian Barley *(Hordeum Vulgare L.)* Genotypes for Acid Soil Stress Tolerance

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1. INTRODUCTION

Barley belongs to the genus *Hordeum* and tribe Triticeae of the grass family Gramineae (Von Bothmer, 1992). There are around 32 species within the *Hordeum* genus all have basic chromosome number of x=7. Cultivated barley, *Hordeum vulgare L. ssp.vulgare* and its wild progenitor H. *vulgare L. ssp. Spontaneum* (C.Koch.) are diploid species with chromosome number of 2n=2x=14 (Komatsuda *et al.*, 1999). Barley (*Hordeum vulgare L.*) was first domesticated from its wild relative *Hordeum spontaneum* around 7,000 B C in the 'Fertile Crescent', which encompasses geographic areas within Israel/Jordan with the Himalayas as a diversification region of domesticated barley (Zohary and Hopf, 1993; Badr *et al*., 2000). Ethiopia was first considered to be a centre of origin for cultivated barley although later it became regarded as a secondary centre of diversity because of the absence of the wild relative (Vavilov, 1951).

Barley is the fourth most important cereal crop grown in the world after wheat, maize and rice. Globally, European Union, Russian Federation, Ukraine, Australia and Canada are the top five largest barley producers in the world where, European Union produce the greatest quantities of barley with an estimated production of 61.53 million tons followed by Russian federations with a production of about 17.08 million tons(USAD, 2017). The factors constraining the production of barley in the different barley production systems include both biotic and abiotic stress. The most important abiotic stresses are low soil fertility, low soil pH, poor soil drainage, frost and drought and from biotic stresses diseases and insect pest like Scald, Net blotch, Spot blotch, Rusts, Shoot fly and Aphids are the most important (Bayeh and Berhane, 2011). From abiotic stress soil acidity is one of the major constraint to barley production on the acidic soils mainly Nitosols or Oxisols in Ethiopian highlands, where the rainfall intensity is high and crop cultivation has been carried out for centuries (Desta, 1987. However, Tenaye and Tesfaye (2014) conducted research on16 barley cultivars to evaluating acid soil tolerance under greenhouse conditions and their findings were Cultivars "Ibon 174/03" and "Eh 1847" showed higher shoot biomass yield compared to cultivar "Bekoji-1 under lime untreated soil condition. **There for the objective of this paper is to review on Genetic Variability of Ethiopian Barley *(Hordeum vulgare L.)* Genotypes for Acid Soil Stress Tolerance**.

2. LITERATURE REVIEW

2.1. Origin, Domestication And Taxonomy Of Barley *(Hordeum Vulgare L.)*

2.1.1. Origin And Domestication.

Barley was first domesticated about 7,000 BC from its wild relatives, H.vulgare ssp spontaneum, in the area of the Middle East Known as the Fertile Crescent, most likely from two geographic areas within Israel/Jordan, with the Himalayas as a diversification region of domesticated barley (Zohary and Hopf, 1993; Badr et al., 2000). Ethiopia was first considered a centre of origin for cultivated barley (Vavilov, 1926), although later it became regarded as a secondary centre of diversity because of the absence of the wild relative (Vavilov,1951).).

2.1.2. Brief description and taxonomy of the barley

Barley belongs to genus Hordeum in the tribe Triticeae of the grass family, Gramineae (Von Bothmer, 1992). There are 32 species within the Hordeum genus all with a basic chromosome number of x=7.Cultivated barley, Hordeum vulgare L. ssp.vulgare and its wild progenitor H. vulgare L. ssp. Spontaneum (C.Koch.) are diploid species with 2n=2x=14 chromosomes(Komatsuda et al.,1999).

2.2. Production Statues and Importance of Barley Crop

Barley is the fourth most important cereal crop in the world after wheat, maize and rice. It is among the top ten crop plants in the world with area under production of 49.70 million hectares and production of 147.93 million tons. Globally, European Union, Russian Federation, Ukraine, Australia and Canada are the top five largest world Barley producers with an estimated production of 61.53 million tons, 17.08 million tons, 8.75 million tons, 8.59 million tons and 8.23 million tons respectively (USAD, 2017). Barley is an important grain crop grown twice a year for many purpose in different seasons during the main season, Meher (August -December) and the short rainy season, Belg (March-July) and production systems from1800m to 3400 m altitude (Berhane et al.,1996; Yirga et al., 1998; Muluken, 2013

In Ethiopia, mostly food barley had been produced, with share estimate of 90 percent and remain is for malt barley (Alemu et al., 2014).The demand for both food and malt barley is increase from time to time. The reason includes foremost the government invited two world's largest breweries (i.e., Heineken and Diageo) to start the production of malt and beer and the local company Dashen Brewery expand its production capacity (from 1 million hectolitre to 4 million hectolitres). There is a spatial variation in barley production and area coverage. Most of the barley productions take place in the highlands of the Oromia and Amhara regions. From 2003-2013, these two regions accounted for about 83 percent of the total barley production (52 percent in Oromia and 31 percent in Amhara). While Tigray and SNNP region represent only 9 and 8 percent of the total barley production, respectively (REAP, 2015).

2.3. Soil Acidity Extent and Distribution in Ethiopia

Soil acidity is one form of chemical degradation of soils. The problems of acid soils is high acidity and low amount of exchangeable cations especially calcium and it is considered to be one of the most important factors that affect the soil chemical fertility. Acid soils are phototoxic because of nutritional disorders, deficiencies or unavailability of essential nutrients such as calcium, magnesium, molybdenum and phosphorus and toxicity of aluminium, manganese and hydrogen activity (Foy et al., 1978). The initial toxic effect of acid soil stunts and shortens root growth then limits growth and productivity of barley by restricting water uptake and nutrient absorption (Wang et al., 2006). Deficiencies or unavailability of essential nutrients manifested by overall stunting, small, dark green leaves, late maturity, purpling of stems, leaves and leaf veins, and yellowing and death of leaf tips (Foy,1992).

Major reasons for soils to become acidic are rainfall and leaching, acidic parent material, organic matter decay, removal of products from the farm or paddock and inappropriate use of nitrogenous fertilizers. These causes of soil acidity are more easily understood when we consider that a soil is acidic when there is an abundance of acidic cations, like hydrogen (H^+) and aluminium (Al^{+++}) present compared to the alkaline cations like calcium (Ca^{++}), magnesium (Mg^{++}), potassium (K^+) and sodium (Na^+) (Johnson, 1914).

The strongly acid (pH<5.5) soils are found in ecologies which received historically high incidence of rainfall and have warm temperatures much of the year.

The optimum soil pH for plant production is one that is slightly acidic (pH 6-6.5), at this pH soil, microorganisms are most active and plant nutrients are readily available. At extremes of high (pH >9) and low (pH<4), this delicate balance is disturbed and plant nutrients are in adequate supply and becomes deficient to plant growth. Some essential nutrients such as phosphorous, calcium, magnesium and molybdenum become unavailable if the soil pH becomes too acid. Acid conditions will result in a lowering of plant production in farming systems (Eshetu, 2011).

2.5. Genetic Diversity of Barley and Analysis of Diversity

2.5.1. Barley genetic diversity

Genetic biodiversity and its utilization are topics for a wide range of research (Bothmer et al., 2003b). Genetic diversity of any crop species is defined as genetic variation within and between populations, landraces and cultivars, arising due to recombination, mutations and introgressions (Hawkes, 1983). The use of highly diverse germplasm in breeding increases the chances for success in developing highly productive new cultivars with good quality properties over a long period of time (Bockelman et al., 2010).

Genetic diversity in barley is preserved in gene banks (ex-situ) and in nature (in-situ). A total number of more than 400 000 barley accessions are available for research and breeding at different gene banks in the world.

2.5.2. Measure of Genetic Diversity in Barley

Study of genetic diversity is the process by which variation among individuals or groups of individuals or populations is analyzed by a specific method or a combination of methods. Genetic diverse populations arising from pure lines, accessions, landraces, wild or weed races are analyzed using a number of methods. Such method can be single or in combination of two or more methods (Mohammadi and Prasanna, 2003). Multivariate Statistical techniques, which simultaneously analyze multiple measurements on each subject under investigation, are widely used in analysis of genetic diversity. Among the multivariate techniques, cluster analysis, principal component analysis (PCA), principal coordinate analysis (PCoA) and multidimensional scaling (MDS) are mostly commonly used (Mohammadi and Prasanna, 2003; Grahic et al., 2013).

3.CONCLUSION

Barley belongs to the genus Hordeum and tribe Triticeae of the grass family Gramineae. It is the fourth most important cereal crop grown in the world after wheat, maize and rice. Globally, European Union, Russian Federation, Ukraine, Australia and Canada are the top five largest barley producers in the world where, European Union produce the greatest quantities of barley with an estimated production of 61.53 million tons followed by Russian federations with a production of about 17.08 million tons. In Ethiopia, mostly food barley had been produced, with share estimate of 90 percent and remain is for malt barley. Soil acidity is one form of chemical degradation of soils. The initial toxic effect of acid soil stunts and shortens root growth then limits growth and productivity of barley by restricting water uptake and nutrient absorption. The strongly acid (pH<5.5) soils are found in ecologies which received historically high incidence of rainfall and have warm temperatures much of the year. Heritability is a quantitative measure that provides information about the correspondence between genotypic and phenotypic variance

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