ISSN No:-2456-2165

Pearson Correlation Analysis of Yield and Quality Parameters under Varied Nitrogen Application Time and Recently Released Malt Barley Varieties at Arsi Zone, Ethiopia

Zenebe Mulatu Fetene[1]:
Kulumsa Agricultural Research Center, Ethiopian Institute of Agricultural Research, P. O. Box 489, Asella, Ethiopia

Fasil Shimelis Gebreyohannis[2]:
Kulumsa Agricultural Research Center, Ethiopian Institute of Agricultural Research, P. O. Box 489, Asella, Ethiopia

Abstract:- Many research works done on behalf of malt barley fertilizer rate and time of application. But, there is no enough information on the association of its grain yield and quality parameters of malt barley. Therefore, a field experiment was conducted during main cropping season of 2018/2019 at West Arsi zone of Ethiopia with the objective of Pearson correlation analysis of grain yield and malt quality parameters under varied varieties and nitrogen application time at Arsi Zone of Ethiopia. Factorial combination of two malt barley (Ibon 174 and Traveller) varieties and three times of nitrogen application 100% recommended rate of N fertilizer ha^{-1} at planting (150 kg ha^{-1}), 1/3 at planting and 2/3 at tillering, and 2/3 at planting and 1/3 at tillering) laid out in randomized complete block design with three replications. The result reveals that grain yield was positively correlated with hectoliter weight, thouthend kernel weight, sieve test, protein content and germination energy, while extract content and germination capacity was negatively associated.

Keywords:- *Grain Quality, Grain Yield, N Application Time, Varieties.*

I. INTRODUCTION

Many countries grow barley as a commercial crop. Globally European Union, Russia, Canada, USA and Argentina are the top five largest world barley producers where, European Union produces the greatest quantities with an estimated of 20.5 million tons followed by Russian federations about 8 million tons, whereas Canada, USA and Argentina barley production was estimated 7.3, 3.1 and 2.8 million tons respectively (USDA, 2017). Ethiopia is the second largest producer of barley in Africa next to Morocco. It accounts 5.6 percent of the total cereal production in the country (FAO, 2014, Shahidur *et al*., 2015). It is the fifth important cereal crop next to teff, maize, sorghum and wheat in the country's domestic production with total area coverage of 959,273.36 hectares and total annual production of about 2.03 million tons in main season, the mean barley productivity was 2.1 tons ha^{-1} (CSA, 2017). Ethiopia is also recognized as a center of diversity, as its barley germplasm has global significance since landraces include disease resistance traits (Bonman *et al*., 2005).

Barley (Hordeum Volgare L.) is a highly adoptable cereal grain that is produced in climate region from sub-arctic to sub-tropical. Historically, barley is an important food source in many parts of the world. At present only 2% of barley is used for human food worldwide (Baik and Ulrich, 2008). The main use of malt barley is for malting purpose mostly for brewing industry. The increased competition within the brewing industry needs maximizing the raw materials. Barley is the basic raw material for brewing. Its chemical and composition is highly affected the beer quality and the economic efficiency of the brewing process.

In Ethiopia, Barley production started long years ago and is largely grown as a food crop in the central and northern parts of Ethiopia, with Oromia, Amhara, Tigray, and Southern Nations, Nationalities, and People's Region (SNPPR) as the main areas of production. The market potential for malt barley in Ethiopia is directly related to market demand for beer, which has shown significant growth in terms of consumption. From 2003 to 2011, beer production in Ethiopia increased from 1 million hectoliters to roughly 4 million hectoliters (Abu Tefera, 2014). Despite the immense potential for producing malt barley in Ethiopia, only about 2% of total barley produced goes into malt factory for the six local breweries in the country (Tefera, 2012). Only one-third can be supplied from locally produced barley. The remaining two-thirds are imported primarily from Belgium and France (ORDA (2008b).

Nitrogen is the key element required for crop growth and development. This is because nitrogen is the building block of proteins, where it involves in cell division and growth. This signifies that nitrogen is required in optimum amount in crop production. Nevertheless, improper and excess use of nitrogen could be lost easily from the soil through leaching, volatilization and other natural process that has environmental implication. Thus, N fertilizer management must be optimized to prevent N deficiency in the critical crop growth period, to avoid yield and quality losses and avoids excessive application of N fertilizer (Tedone *et al*., 2018).

Quality requirements for malt barley are fairly strict, and directly related to processing efficiency and product quality in the malting and brewing industries. Excessively higher protein content is undesirable, because of the strong inverse correlation between protein and carbohydrate content; thus high protein content leads to a low malt extract level (Fox *et al.,* 2003). Grain N content is thus a determining factor of malt quality; high grain N content not only means lower carbohydrate content and lower malt extract level. Infarct full nitrogen application at planting expose the nutrient losses due to leaching and volatilization as the crop have not developed efficient roots that can uptake all the applied nitrogen fertilizer. Nevertheless, split application of nitrogen fertilizer at different growth stage of malt barley reduces loss of nitrogen and increase supply of N to the crop throughout its growth stage that increases the yield. Hence, it is important to overcome association among malt barley varieties with different nitrogen fertilizer application time. This study is, therefore, carried out to evaluate the Pearson correlation analysis of grain yield and malt quality parameters under varied nitrogen application time and varieties at Arsi Zone, Ethiopia.

II. MATERIALS AND METHODS

2.1. Description of the Study Area

This experiment was conducted during the main cropping season of 2018/19 at Bekoji wereda, Arsi Zone. It is located 7°36′51″ N, 39° 14'15″ E and at an altitude of 2576 m.a.s.l. The dominant soil type of Bekoji is Nitisol (IUSS Working Group 2014). The average annual rainfall and annual mean minimum and maximum temperatures were 951.4mm, and - 5.1ºC and 27.9ºC, respectively). Major crops grown in the area are wheat, barley, faba bean, and field pea.

2.2. Treatments and Experimental Design

The treatment consisted of a factorial combination of two improved malt barley varieties (Traveller and Ibon 174), three seed rates (75, 100 and 125 kg ha^{-1}), and three times of nitrogen application: 100% recommended rate of N fertilizer ha-^{1} at planting (150 kgha-1), 1/3 at planting and 2/3 at tillering, 2/3 at planting and 1/3 at tillering) was laid out in randomized complete block design (RCBD) with three replications. The land was ploughed using oxen and plots was level manually NPS was apply at sowing time, while nitrogen fertilizer in the form of urea was added to the soil depending on treatments. Malt barely varieties was sown as per the seed rate treatment and planted in rows by using a manual row marker. Proper hoeing and weeding of the experimental fields were carried out uniformly as per research recommendations.

2.3. Data Collection

2.3.1 Quality Parameters

Sieve Test (SST): Sieve test was carried out using 2.2, 2.5, 2.8 mm size sieves and proportion of the seed trapped by each sieve was weighed and converted to percentage. Finally, the sums of all the three sieve sizes were used for sieve test.

Extract Content (EC): It content was carried out at Holeta Agricultural Research Center food science and nutrition research laboratory taking grain sample of 300g from each treatments using near infrared (NIR) spectroscopy as described in AACC (2000).

Grain protein content (GPC): Grain protein content were determined using near infrared (NIR) spectroscopy (NIR Grain analyser model 1241) as described in AACC (2000) at KARC food science and nutrition research laboratory by taking grain sample of 300g from each treatments.

Germinating energy (GE in %): Germination energy was determined from 100 seeds germinated in a petridish after 72 hours as per Bam *et al.* (2006). The germinated kernels were counted and the result was expressed as percentage of the total.

Germination capacity (GC): Two hundred seeds was soaked in a flask with 0.3M H2O2 (hydrogen peroxide) and counted after 48 hours and converted to percentage to determine germination capacity.

Hectoliter weight (kg/hl): The hectoliter weight (HLW) was determined by measuring 1000 ml kernel and weighing with the sensitive balance and then changed to kg/1 litter in order to measure the density of the grains powdering or milling capacity.

2.3.2 Yield and yield components

Grain yield (kg ha^{-1}): The grain yield was measured by taking the weight of the grains threshed from the 10 center rows net plot area of each plot and converted to kilograms per hectare after adjusting the grain moisture content to 12.5%.

2.3.3. Statistical Data Analysis

The data was subjected to analysis of Pearson correlation analysis for both locations following the standard procedure. Pearson correlation coefficient was used to estimate the strength and direction of the relation between yield and quality parameters of malt barley. Pearson correlation a measure the strength and direction of the linear relationship between two variables, describing the direction and degree to which one variable is linearly related to another.

III. RESULT AND DISCUSSION

Analysis of the Pearson correlation coefficient indicated in table 1 showed that there was significant association between grain yield and malt barley quality parameters. Grain yield was positively correlated with all parameters except with malt extract Content and germination capacity (table 1.) Grain yield has strong correlation with hectoliter weight(r= 0.4658; $P \leq 0.05$) followed by thousand kernel weight(r= 0.3028; $P \leq 0.05$), sieve test(r= 0.2937; $P \leq 0.05$), germination energy (r=0.1858; $P \leq 0.05$), protein content (r=0.1103; $P \leq 0.05$) and extract content (r= 0.0640; $P \leq 0.05$) respectively. The result of the relation showed that, grain yield is the function of grain per spike that leads higher thousand kernel weight and hectolitre weight .The result of this study in line with; Ermias (2013) who found that grain yield was highly correlated ($P \leq 0.01$) with number of seed pod^{-1} , leaf area and number of branches of common bean.

Germination energy was negatively correlated with grain protein content(r= -0.3178; $P \leq 0.05$), malt extract content (r= -0.3721; $P \leq 0.05$) and sieve test(r= -0.4591; $P \leq 0.05$) whereas hectolitre weight, thousand kernel weight and germination capacity were positively correlated with its value (r= 0.4114; $P \leq 0.05$, r= 0.2209; $P \leq 0.05$, and r= 0.4656; $P \leq 0.05$) respectively. A negative correlation of germination energy with grain protein implies that high protein content delayed germination energy, since it leads low carbohydrate content and reduced enzymes activity that breakdowns barley kernels during germination. In agreement with this excessively higher protein content is undesirable, because of the strong inverse correlation between protein and carbohydrate content; thus high protein content leads to a low malt extract level (Fox et al., 2003)

Correlation analysis reveal that germination capacity was positive correlation with thousand kernel weight (r=0.2350; $P \leq 0.05$ and r= 0.5196; $P \leq 0.05$) while, highly negative correlation with protein content(r= -0.5383; $P \leq 0.05$), malt extract content(r= -0.6540; $P \leq 0.01$) and sieve test(r= -0.5478; $P \leq 0.05$) respectively. On the other hand malt extract content has negatively correlated with germination energy (-0.3721; $P \leq 0.05$), germination capacity (r=- 0.6540; $P \leq 0.01$),) hectolitre weight (r=-.02818; $P \leq 0.05$) and thousand kernel weight (r=- 0.2867; $P \leq 0.05$) while, high positive correlation with sieve test (r=0.6297; $P \leq 0.01$) followed by grain yield (r=0.0640; $P \leq 0.01$). A negative correlation of malt grain protein content with malt extract content implies that malt barley with high protein content leads slow down water uptake during steeping, finally it affecting final malt quality.

Table 1. Pearson correlation analysis of malt quality parameters under varied seeding rate, varieties and nitrogen application time at Arsi Zone, Ethiopia

	1	2	3	4	5	6	7	8
	TKW	HLW	PR	EXC	ST	GC	GE	Gy
TKW	1.0000							
HLW	0.4101*	1.0000						
PR	0.6108**	0.4030*	1.0000					
EXC	-0.2867	-0.2818	-0.3097	1.0000				
ST	-0.4164*	-0.4877*	-0.4964*	0.6297**	1.0000			
GC	0.2350	0.5193**	-0.5387**	-0.6540**	-0.5478**	1.0000		
GE	0.2209	0.4114*	- 0.3178	-0.3721	-0.4591*	0.4656*	1.0000	
Gy	0.3028	0.4658*	0.110	-0.0640	0.2937	- 0.0628	0.1858	1.0000

TKW= thousand kernel weight, HLW= hectolitre weight, PRC= protein content, EXC= extract content, ST= sieve test, GE= germination energy, GC= germination capacity, Gy= grain yield, NS= not significant, *= significant at 5% and **= significant at 1%

IV. SUMMARY AND CONCLUSION

This research experiment was card out at Arsi zone, Oromia Region, Ethiopia to find out the correlation of grain yield and malt quality parameters under varied varieties and nitrogen application time. The result of these experiment indicates that, except germination capacity and extract content all malt quality parameters were positively correlated with grain yield and the highest positive correlation of grain yield with hectoliter weight followed by thousand kernel weight was observed.

REFERENCES

[1]. Abu Tefera and Teddy Tefera. 2014. Ethiopia: Grain and Feed Annual Report. Gain Report No: ET 1401.

[2]. Baik BK, Ullrich SE. 2008. Barley for food: characteristics, improvement, and renewed interest-Critical review. Journal of Cereal Science 30:1– 10.

[3]. Bonman JM, Bockelman HE, and Jackson LF, Steffenson BJ: Disease and Insect Resistance in Cultivated Barley Accessions from the USDA National Small Grains Collection. Crop Science. 2005, 45: 1271-1280. 10.2135/crop science 2004.0546.

[4]. CSA (Central statistical agency) agricultural sample survey. 2017. Report on area and production of major crops (private peasant holdings, Meher season). Volume I, Statistical bulletin. Addis Ababa, Ethiopia, Pp10-12.

[5]. Fox G.P., Panozzo J.F., Li C.D., Lance R.C.M., Inkerman P.A. & Henry R.J. 2003. Molecular basis of barley quality. Australian Journal of Agricultural Research, 54: 1081–1101.

[6]. ORDA (Organization for Rehabilitation and Development in Amhara) 2008b. Ethiopia: Malt barley variety.

[7]. SAS. 2004. Software Syntax, Version 9.1, SAS Institute, Cary, NC, USA.

[8]. Shahidur Rashid, Gashaw Abate, Solomon Lemma, James Warner, Leulsegged Kasa. & Nicholas Minot. 2015. Barley value chain in Ethiopia: Research for Ethiopia‟s Agriculture Policy (REAP): Support for the Agricultural Transformation Agency (ATA).

[9]. Tefera A. 2012. Ethiopia Grand and feed annual report. USDA Foreign Agricultural Service.

[10]. United States Agency for International Development (USAID) (2012).

[11]. USDA (United States Department of Agriculture). 2017. Ethiopia Grain and Feed Annual Report. Global Agricultural Information Network (grain) Report ET-1503. Foreign Agricultural Service, USDA, Washington, DC. Retrieved MAY 17, 2018, from http://www.fas.usda.gov/data/ethiopia grain-and feedannual.