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Review on the Effect of Seed Rate and Improved Varieties on Grain Yield of Bread Wheat (*Tritium Aestivum L.*) in Ethiopia

Solomon Shibeshi[1*]

[1]Sidama Region Agricultural Research Institute, Hawassa Agricultural Research Center, Hawassa, Ethiopia

Abstract: Wheat is one of the strategic crops in Ethiopia, because of its role for food security, import Substitution and supply of raw material for agro-processing industry. Wheat Produced by 4.6 million smallholder farmers on 1.8 million hectares of land with an estimated annual production of 5.0 million tons at an average productivity of 2.9 t/ha which has been consistently increasing for the last 25 years, but much lower than the world average 3.3 t/ha. The lowest yield is attributed to many factors, such as the wheat variety, seed rate, seed source, unavailability of quality seed, use of poor quality seeds and inappropriate seed size are some of the factors. Seed rate are the most important management factor affected the agronomic characteristics of wheat. Seeding rate can impact on wheat tillering, grain yield and protein quality. Hence, achieving higher agronomic performance and better end-use quality requires optimizing and periodically reviewing management practices such as seeding rates. However, in varieties that produce fewer tillers, higher seeding rates compensated for reduced tiller. In a dense wheat population, grain yield decreased due to competition between plants that induced self-regulation. So optimum seed rate is recommended depending on the growth habit of the varieties and soil fertility level for increasing wheat production and productivity.

Keywords: Bread Wheat, Seed Rate, Yield, Variety.

Review Paper

***Corresponding Author:**
Solomon Shibeshi
Sidama Region Agricultural Research Institute, Hawassa Agricultural Research Center, Hawassa, Ethiopia

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INTRODUCTION

Wheat is the major food grain crop of the world and is the staple food of millions people around the globe. Wheat is widely adaptable to wide range of climatic conditions. About 70% of the world wheat is cultivated under rainfed conditions Portmann *et al*., (2010). Ethiopia is the largest wheat producer in sub-Saharan Africa with a record harvest of 4.6 million metric tons registered in 2017 (CSA 2019). However, during that same year, the country imported 1.5 million tons of wheat, corresponding to a value of around US$600 million (CSA 2019).

Wheat is one of the most important small cereal crops in Ethiopia widely cultivated in wide range of altitudes. Most wheat producing area in Ethiopia lie between 6º and 16º N latitude and 35º and 42º E longitudes of an altitude range from 1500 to 3000 meters above sea level. The most suitable agro-ecological zones, however, fall between 1900 to 2700 meters above sea level (Bekele *et al*., 2000).

Crop adaptation to climate change requires accelerated crop variety introduction accompanied by improvement and recommendations to help farmers match the best variety with their field contexts Etten *et al*., (2019). The ideal varieties 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 Tamene *et al.*, (2018). Crop yield per area (amount of crop harvested per amount of land cultivated) is the most commonly used impact indicator for agricultural productivity activities. Crop yields are inevitably affected by many factors; these are weather, input price, changes in farming practices, amounts of fertilizer used, quality of seed and seed rate, varieties, and use of irrigation. Badebo *et al*., (2009) summarized several factors in low yields for durum wheat in Ethiopia.

Many farmers in developing countries prefer to use a higher seed rate than recommended, because they perceive it as a good strategy to control weeds and reduce the risks of crop production. Planting higher seed rate than the recommended rate is not encouraged because of its negative impact on seed quality, particularly on seed size and weight. Instead of using higher rates, farmers must pay close attention to all recommended seed production practices.

High seed rate increases the competition among crops for common resource particularly water, nutrients and sunlight which resulting in low quality and low yield. If low seed rate is used yield will be less due to lesser number of plants per unit area (Hameed *et al*., 2002). The use of inappropriate seed rates by small holder farmers leads to low yield as compared to research field.

This is due to higher seed rate which leads to higher competition, shorter spike length and lower number of grains per spike (Ejaz *et al.,* 2002). Besides, seed rate determine the crop vigor and ultimately yield (Korres and Froud, 2002). Reducing seed rate may result in more tillers and spike per plant and more spikelet per spike but in many cases reduced grain yield per hectare (Ozturk *et al.,* 2006). On the other hand, research results indicated that use of proper seed rate encourages nutrient availability, proper sun light penetration for photosynthesis, good soil environment for uptake of soil nutrients and water use efficiency; and all necessary for crop vigor and consequently increase the production and productivity of the crop (Alemayehu, 2015).

A number of bread wheat varieties differing in height, maturity and tillering capacity have been developed in Ethiopia. However, the recommended seed rate for all the varieties being used across the country is 150 kg ha^{-1} (Jemal *et al*., 2015). Different organizations recommend different seeding rates. Moreover, there is a trend by farmers uses higher seed rates greater than150 kg ha^{-1} in the area. Hence, it is important to determine optimum seeding rates for released bread wheat varieties for the maximum yield of the crop.

The presence of significance difference among seeding rates and varieties in most parameters suggested that the importance of using appropriate seed rate and improved varieties to increase yield of bread wheat. The objective of this study was to review the effects of seed rates and varieties on yield of bread wheat in Ethiopia.

2. LITERATURE REVIEW

2.1 Constraints of Wheat Production in Ethiopia

Wheat yields in Ethiopia need to increase considerably to reduce import dependency and keep up with the expected increase in population and dietary changes. Despite the yield progress observed in recent years, wheat yield gaps remain large.

In spite of its tremendous importance, wheat production in Ethiopia faced immense production constraints that are affecting both its yield potential and industrial quality (Amare *et al*., 2015). In Ethiopia wheat is predominantly grown by small scale farmers at a subsistence level. In this regard, inappropriate crop management practices such as low seed rate, improper row spacing, delay in sowing and traditional sowing methods are found to be the key elements contributed to low productivity of wheat crop (Iqbal *et al*. 2010).

Crop yield per area (amount of crop harvested per amount of land cultivated) is the most commonly used impact indicator for agricultural productivity activities. Crop yields are inevitably affected by many factors; these are weather, input price, changes in farming practices, amounts of fertilizer used, quality of seed, varieties, and use of irrigation. The relatively low yield of wheat in Ethiopia may be partially attributed to the low level of adoption of improved varieties and improved management techniques (Kotu *et al*., 2000).

Badebo *et al*., (2009) summarized several factors in low yields for durum wheat in Ethiopia. About 85 % of durum wheat cultivars are local varieties which have developed largely by natural processes to adapt to specific areas, rather than formal varieties that have been selectively bred. In addition to yield constraints, the protein quality (and therefore output price) is also affected by low soil fertilizer, excessive rainfall, and cool temperatures.

2.2 Effect of Seed Rate on Yield of Bread Wheat

Seeding rate can impact on wheat tillering, grain yield and protein quality (Staggenborg *et al*., 2003). Hence, achieving higher agronomic performance and better end-use quality requires optimizing and periodically reviewing management practices such as seeding rates (Bryan, 2001). It was reported that, in a dense wheat population, grain yield was decreased due to competition between plants that induced self-regulation (Jennifer *et al.,* 2006). However, in varieties that produce fewer tillers, higher seeding rates compensated for reduced tiller and promoted more main stem spikes (Staggenborg *et al.,* 2003). Wheat quality was not reduced at higher seeding rates as protein content, kernel weight and test weight were unaffected (Jennifer *et al.,* 2006: Bryan, 2001).

Haile *et al.* (2013) reported that the lower seed rate resulted in lower grain yield while higher yield was due to higher seed rate. Ali *et al.,* (2010) explained that lower seeding rates significantly increased the number of grains and vice versa. Rahim *et al*., (2012) who reported that higher seed rates produced significantly decreased number of grains (kernels) spike.

High seed rate requirement, which is not suitable for agronomic management and cause inter plant competition for optimum plant nutrients, sunlight, moisture and aeration (Hayatullah *et al*. 2000; Hamid, 2002; Awake *et al*., 2017). Increase in seed rate above optimum level also enhances production cost without any increase in grain yield (Rafique *et al*., 2010).

2.3 Effects of Varieties on Bread Wheat Yield

Enormous number of improved varieties of wheat was released from research institution by breeders in the country (MOANR, 2016). However, the actual yield of these wheat varieties in farmers' field is generally remains below global average yield of wheat

crop due to environmental and anthropogenic factors affecting wheat production (Bekele *et al*., 2000).

When new wheat varieties are developed by the breeders in order to increase total production, these new varieties are tested for their yield performances in different locations. The success of a new wheat variety depends upon its yield and adaptation potential in those locations. The wheat varieties with high and stable yield are highly esteemed by both farmers and breeders (Boubaker *et al*., 1999). Varieties with different morphological and economic characteristics are now available as breeding stock (Parihar and Singh, 1995). The performance of wheat genotypes is mainly associated with the soil and climatic conditions, application of inputs and other management conditions (Piepho *et al*., 2004). The performance of a genotype in a given environment is more important for wheat cultivation and improvement (Vaughan and Judd, 2003).

Each variety has a genotype-specific ability to maintain performance over a wide range of environmental conditions (Hancock, 2004). This ability is usually referred to as the sensitivity or adaptability of a variety. Such ability is an important property, because farmers naturally want to use varieties which perform well in their own fields (Bajaj, 1990).

Majid and Mohsen (2012) who reported that significant differences were found among varieties in terms of the number of kernels spike. However, this was in contrast with Igorpirez *et al.* (2013) who reported that the wheat genotypes did not influence the number of grains per ear obtained in distinct seeding densities. Girma and Esuyawkal, (2020) reported highly significant differences among wheat varieties for days to heading, plant height, spike length, thousand kernel weights and grain yield.

SUMMARY AND CONCLUSION

Wheat is one of the most important cereal crops globally and is a stable food about one third of the world population. It has been selected as one of the target crops in the strategic goal of attaining national food self-sufficiency, income generation, poverty alleviation and achieving socio-economic growth of the county. Wheat is a major crop contributing importantly to the nutrient supply of the global population and has the highest content of protein of all the staple cereals and contains essential minerals, vitamins, and lipids. It shows wide adaptation to diverse agro-ecological conditions and cropping technologies. Seeding rate can impact on wheat tillering, grain yield and protein quality. Hence, achieving higher agronomic performance and better end-use quality requires optimizing and periodically reviewing management practices such as seeding rates.

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