



Effect of Planting Techniques on Tef (*Eragrostis tef*) Yield and Yield Components

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Abstract: Without a crop management cooperation, only genetically modified cultivars may not be able to overcome the crop's expected yield gap in any research. Tef grain yield is low as a result of inadequate management practices. The current study was conducted on the research field of the Holeta Agricultural Research Center during the main cropping seasons of 2021 and 2022 to evaluate the three planting/sowing methods (Broad casting, Row sowing, and transplanting) of improved Quncho tef variety by randomized complete block design with three replications for two consecutive years. This study revealed that there is no statistically significant difference between row planting and broadcasting at 5 and 25 kg/ha at row spacing of 15 and 20cm at 5kg, both row sowing and broadcasting gave highest grain yield than transplanting. Tef transplanting gave the lowest grain yield as well as straw in addition to high cost of labor. Row planting at a 15 cm spacing and 5 kg per ha seed and broadcast sowing at 5kg per ha were the most economically effective tef planting method according to this finding. However, it is advisable to undertake further research across soil type, years and locations to draw sound recommendation on a wider scale.

Keywords: Broadcasting, Planting, Row, Tef, Transplanting

1. Introduction

Tef is a tetraploid plant that belongs to the Poaceae family and is one of the 350 species in the *Eragrostis* genus [1]. It is also known as *Eragrostis tef* (Zucc. (Trotter) $2n = 4x = 40$). According to Vavilov, Ethiopia is the tef crop's origin and diversity center [2]. Prior to the introduction of emmer wheat and barley, tef may have been grown in Ethiopia [3]. Tef is only grown as a cereal food grain in Ethiopia, where it is grown annually on more than 3 million hectares of land, producing an estimated 5.7 million tons, with a national average of 1.914 t/ha [4].

Tef is a crop with many agronomic and ecological uses. It may be grown in a variety of soil types and climates, from below sea level to 3200 m above it. Tef is the most widely used crop in Ethiopia as a source of food and animal feed. Additionally, it is resistant to pests, especially storage pests, drought, and water logging. As a result of its delayed release of carbohydrates and ability to be gluten-free, tef has recently gained popularity on a global scale as a food source for those with diabetes and celiac disease. As a result, it is seen as a possible substitute for foods like pasta, bread, beer, cookies,

and pancakes that contain the gluten-containing grains wheat, barley, and rye [5].

According to the research of Alaunyte and his colleagues, Tef has a high iron concentration that makes it suitable for anemia caused by pregnancy [6]. According to BoSTID (Board on Science and Technology for International Development) reported, places where tef is consumed do not experience anemia, suggesting that the iron concentration is particularly important in Ethiopia [7]. Although tef has a higher economic value and covers a larger area, its productivity is substantially lower than its projected potential yield level of 6 tons/ha [8]. Ethiopian urban populations consume 61 kg of tef per person, compared to 20 kg in rural areas. Tef is an economically better good, and its costs are typically double those of the cheapest cereal, maize, according to [9]. Tef's income elasticity is 1.1 for urban regions and 1.2 for rural areas.

Even though the crop's yield and production have increased significantly over the past seven decades, Tafes and his colleagues claim that without crop management collaboration, only genetically improved varieties may not be able to fill the crop's potential yield gap [10]. Low landrace yields under

widespread cultivation, sensitivity to lodging, biotic and abiotic stresses are the main causes of the low national or regional tef productivity [11, 12].

According to Mihretie and his colleagues, improved crop management techniques are required to raise tef productivity and lower production costs [13]. Compared to broadcasting, row planting of tef requires 30% additional labor [9]. In Southern Ethiopia, row-sown tef has been reported to produce a higher grain yield [14]. In contrast, Jemberu and Gebretsadik's research in North Gondar found that compared to row sowing, the broadcasting technique of sowing provided the maximum grain yield of tef [15]. Another study conducted at Debre Zeit found no significant difference in grain yield between tef broadcasting and row planting [16].

According to Meseret and her colleagues, adequate research must be done to identify the optimal tef sowing/planting technique for both small- and large-scale farmers in terms of increasing production and cost-effectiveness [17]. Therefore, it is essential to evaluate various tef management and sowing techniques in order to provide the most productive planting technique to farmers, investors, and other stakeholders.

2. Materials and Methods

2.1. Description of the Study Area

The experiment was carried out at the Holeta Agricultural Research Center of the Ethiopian Institute of Agricultural Research (EIAR) with rainfall during the 2021 and 2022 main cropping seasons. Holeta Agricultural Research Center (HARC) is suited in the central part of Ethiopia, 39 km to the west of Addis Ababa. It lies at latitude 09°03'N and longitude 38°30'E. It has an altitude of 2400 m. a. s. l and it receives a monomodal average annual rainfall of 1100 mm per annum. The long-term mean minimum and maximum temperature is

6.1 and 22.2°C, respectively. The soil type of the study area is classified as Nitisol with a pH of 5 to 5.5.

2.2. Experimental Materials, Design and Field Management

One released variety called Quncho was used in the study. The experiment was laid out in triplicated randomized complete block design of plots with 3 m length by 3m width (9 m²) area. The spaces between plots and replications were 1 and 1.5 m, respectively. The DAP and urea fertilizers were applied at the rate of 131 kg ha⁻¹ DAP and 36 kg ha⁻¹ urea by the universal recommended rate of tef (60% P₂O₅ and 40% N) for light red soil type. All the DAP was applied at planting and urea was applied in two splits, half at the time of planting and the remaining half at tillering stage. The experimental materials were sown on the first week of July of each year. All other pre- and post-planting management practices were done by the research recommendations for tef production in the area.

2.3. Data Collection

Seven quantitative traits data were obtained based on plot bases. These traits were days to heading, days to maturity, plant height, panicle length, lodging index, biomass yield, grain yield, and number of fertile tillers per plant. Except for several fertile tillers, the rest traits were recorded on a plot basis.

2.4. Data Analysis

Analysis of variance was done using the help of SAS Computer Statistical Package version 9.3 [18]. Variance effects were considered as significant and highly significant at $P < 0.05$ and $P < 0.01$, respectively.

3. Result and Discussion

Table 1. Effect of Planting Methods on Tef Yield and Yield Components.

Planting Methods	Traits							
	DH	DM	PH	PL	LOG	SBM	GY	TIL
BC@5KG/ha	74.00BC	141.17B	118.60A	44.97A	89.00AB	98.70B	24.93A	6.67A
BC@25KG/ha	71.00C	138.67B	109.40B	42.18B	94.67A	107.03AB	23.00A	4.00B
RP@5KG/ha with 20cm	75.50BC	133.67B	117.90A	45.38A	79.33C	110.35A	25.53A	6.00A
RP@5KG/ha with 15cm	75.17BC	140.00B	121.03A	45.30A	84.33BC	108.52AB	25.58A	6.00A
TP 20x10 cm b/n plant	77.50AB	160.50A	87.17C	37.38C	63.67D	31.48C	8.67B	5.67A
TP 20x15 cm b/n plant	82.33A	157.33A	85.47CD	36.67C	63.00D	27.22C	7.42B	5.67A
TP 20x20 cm b/n plant	82.50A	157.50A	82.77D	37.25C	66.33D	23.33C	8.17B	6.67A
CV	6.25	5.37	3.32	4.12	8.58	12.73	20.79	10.62
LSD	5.70	9.37	4.07	2.02	7.86	10.94	4.35	1.10

Where DH- Days to Heading, DM- Days to Maturity, PL- Panicle Length, LOG- Lodging index, SBM- Shoot biomass, GY- Grain Yield and TIL- Number of Fertile Tillers.

BC-Broadcast; RP- Row Planting and TP-Transplanting methods

*Means with the same letter are not significantly different.

3.1. Days to Heading and Maturity

Days to heading show highly significant differences for all

the traits evaluated; this indicates that planting methods can affect the heading time of the plant. From this result transplanting 20x20cm spacing between plants took the highest heading dates (82.5 days) while broadcasting at 25 kg

per hectare the least heading dates (71 days); whereas row planted heading dates were between these two. As a whole as the seed rate increase; On the other hand, spacing between plants decreases the heading dates will be increased, which means it will be head in a short period due to competencies for nutrients. This result contradicts with [16].

Days to maturity also showed highly significant differences among the treatments. The high mean value was recorded for transplanted methods rather than broadcast and row planted methods as stated in Table 1. This revealed that as space between plant increase the days to mature increase which means it takes long days to mature physiologically.

Growth Parameters (Plant Height and Panicle Length) Plant heights, as well as panicle length, have shown highly significant differences among the treatments, but there is no significant difference within treatments except broadcasting at a 25kg/ha seed rate. Especially there is a highly significant difference between row planting and transplanting, in the case of transplanting as space increases the plant height decrease. This result showed a greater plant height in row planting compared with that of broadcasting and transplanting there is efficient resource utilization around the root zones including moisture, light, and other nutrients. These findings are consistent with those reported by Mihretie and his Colleagues [13].

3.2. Lodging Index

The lodging index also showed a highly significant difference among all the treatments but there is no significant difference within each treatment. For example, broadcasted treatments showed highly lodged while row planted showed medium, and transplanted ones showed a relatively low lodging percentage.

3.3. Shoot Biomass and Grain Yield Traits

There is no statical significant difference between the broadcast and row planting methods for shoot biomass and grain yield while transplanting methods showed a highly significant difference over row planting and broadcasting methods. This showed that as the space between the plant increases the shoot biomass and grain yield decrease because the plant population decreased, but the best yield was obtained at the optimum population level. Row planting techniques were said to produce a greater grain production [14]. According to Gezagn and Tamiru finding a 10 kg/ha seed rate with 20 cm and broadcasted with a 25 kg/ha seed rate delivering significantly greater grain production, and the largest net benefit was achieved at a 10 kg/ha seed rate [19]. This result is in line with Lakew and Berhanu's assertion that broadcasting with a greater seed rate provided a lower net benefit than using a seed rate of 15 kg per ha and a row spacing of 20 cm [20].

In contrast, Jemberu and Gebretsadik's research in North Gondar found that compared to row sowing, the broadcasting mode of sowing produced the maximum grain yield of tef [15]. Another study conducted at Debre Zeit

found no discernible difference in grain output between tef broadcasting and row sowing [21].

3.4. Number of Fertile Tillers

There is no significant difference among the treatments except broad casting methods at the seed rate of 25kg/ha low number of fertile tillers comparing the rest of the planting methods. This indicates that as the number of plants increases the space for getting tiller will decrease.

4. Conclusion

From the three planting methods, transplanting needs higher man-days than row planting whereas row planting needs more man-days than broadcast planting. The recommended seed rate for tef varies from 3 to 25 kg/ha depending on the sowing method. This study revealed that there is no statistically significant difference between row planting and broadcasting at 5 and 25 kg/ha at row spacing of 15 and 20cm at 5kg, both row sowing and broadcasting gave highest grain yield than transplanting. Tef transplanting gave the lowest grain yield as well as straw in addition to high cost of labor. Row planting at a 15 cm spacing and 5 kg per ha seed and broadcast sowing at 5kg per ha were the most economically effective tef planting method according to this finding.

Generally, 5-15 kg/ha is suggested for row sowing and up to 25 kg/ha is suggested for broadcasting. Economically row planting was fairer and more acceptable than broadcasting. In general, agronomic recommendations are location specific because the response of plants to specific treatment is significantly influenced by the environment. Hence, universal or blanket recommendations cannot be given for agronomic studies. Since optimum cultural practices differ from region to region, detailed studies need to be made on diverse crop management practices at representative agro ecological locations.

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