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Effect of Intra Row Spacing and Fertilizer Rate on Tef (Eragrostic tef) Crop Growth Performance and Productivity at Wollega University Research Sites, Western Ethiopia

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ABSTRACT

Low productivity of tef in Horro Guduru Wollega region is mainly attributed to lack of new technology and poor agronomic practices. Broad cast method of sowing has been pre dominantly used in the past and new agronomic practices should be placed to increase the productivity of the crop. An experiment was conducted at Shambu Agricultural Research Sites of Harato and Guduru animals' production research center during 2015 main growing season to determine the appropriate intra row spacing and fertilizer rate on growth and yield of tef. The experiment was consisted of three intra row spacing (5cm, 10cm and 15cm) and four fertilizer rate (25kg, 50kg, and 75kg and 100kg/ha) and the field was laid out as randomized complete block design with replicated three time at each location. At both locations the growth and yield parameters of quincho variety was revealed significant difference. The wider plant spacing (15cm) and the higher application of nitrogen fertilizer (75kg N/ha) on the tef crop was produced highest number of tiller (10.25) and (13.31) at Harato and Guduru sites, respectively. But higher amount of tillers didn't result more productivity. The highest grain yield of 17.9 quintal per hectares was obtained when 5cm intra row spacing and 75kg N/ha fertilizer used at Guduru and Harato research sites. Higher numbers of plants per hectares were given more yields. This study revealed that the optimum intra row spacing and fertilizer were found to be 5cm and 75kgN/ha for both locations.

Introduction

Tef is a major staple crop that shares 18.3% of the total grain production in Ethiopia (CSA, 2014). Ethiopia is not only the origin of tef, but also it is the center of diversity and introduced in to other tropical countries (Amanda, 2002). It is grown by over 6 million farmers house hold with greatest production value than any other in Ethiopia and 2-3 Ethiopian people per house hold consume tef daily (Kebede, 1989).

In Ethiopia the grain was mainly produced for human consumption by preparing Injera, porridge and some native alcoholic drinks (kebede, 1989).

Generally it provides for over two –thirds of the human nutrition in the country (lacey and Llewelly, 2005; Stallkenecht *et al.*, 1993). The seed is low in glycemic index; it is suitable for consumption by type II diabetic. Also the seed are gluten free, high in fiber, calcium and in iron content (ATA, 2012). The straw is mainly used for animal's feed and construction purpose. The crops are adaptive to wide ranges of environmental conditions from 1000- 2000masl, at the altitude extends to above 2000m the white tef didn't survive well. The optimum rain fall requirements for propare growth are ranges 950mm- 1500mm. The average annual temperature requirements are 25-30°c, mainly the crops are grown on sandy loam soil but also well adapt at black soil (CSA, 2014; Tareke, 2013). In Ethiopia teff is the single dominate crops, occupying an area of 2,565,155 hectares and the productions is 29, 929,235quintal (MoARD, 2008). The crops relatively insect and disease resistance Ebba, 1975.

Intra row spacing was practiced mainly for larger seed size crops like maize, broad bean, field pea, common bean and others. The yield of the crops was increased as the plant get ample amount of spacing. Fertilizer is an important nutrient element that is mainly preferred by plant in optimum amount for proper growth and development of crop plant. The soil that didn't hold adequate amount of nutrient element the productivity of crop per hectares area very low. In the study area farmers didn't use new technology because of information gap, blanket fertilizer application, traditional sowing methods practices, a biotic factors and un periodic rain fall pattern at harvesting time.

Their fore the study of this research work was help to full fill the existing gap at the study sites with the following objectives; to evaluate the effect of intra row spacing and fertilizer rate on growth and yield performance of tef at the study sites and to identify the appropriate intra row spacing of tef crops.

2. Material and method

The tef experiment was conducted at two locations of Wollega University Shambu Campus (Harato and Guduru animal's production research centers, western Ethiopia, during 2014/ 15GC growing season. The Harato study site located at an altitude of 2200masl. The mean annual rain fall of the Harato site are 2000mm and the average annual temperatures receiving ranges 18-22°c, while the Guduru

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animal's production research center is found at altitude of 2200masl, and the mean annual temperature and rain fall is 20-22°c and 1800-2000mm.

The seed of quincho variety was obtained from Debirziet agricultural research centers.

The experiment was lied out as randomized complete block design as factorial arrangement and replicated three times. The improved quincho variety was sown in 3m length, and 1m width, 0.2m inter row spacing and 0.05m, 0.1m and 0.15m intra row spacing with 5 rows at 25kgN/ha, 50kgN/ha, 75kgN/ha and 100kgN/ha fertilizer.

The crop was sown at appropriate time and all manage mental practices was done at right time. Before planting the soil sample was took randomly at the depth of 0-30cm from 20 locations for two sites at the experimental fields. The collected soil samples were composited in to one sample and air dry, ground and sieved using 2mm sieves and soil physical and chemical characteristic were tested at Nekemt soil laboratory.

The land was tilled five times until the soil ready for seed bed preparation in April 2014. The improved quincho variety was sown at July first 2015 at Harato and Guduru animal's production research sites. Nitrogen fertilizers was applied to the soil at 25-100kg/ha, while phosphorus fertilizers was added to the plot at the recommended rate. Phonological and yield component data were collected on days to 90% maturity,number of tillers, plant height, panicle length, thousand grain weight ,dry biomass, grain yield and harvest index. The data collected for the component crops were subjected to analysis of variance using SAS soft ware.

The difference between treatment means was compared using Least Significance Difference test at 5% level of significance when ANVOA shows the presence of significant different.

3. Results And Dicussion

Physicochemical Properties of the soil: The results of laboratory analysis on some physicochemical properties of the soil used for the experiment were presented in table 1. The soil has moderately acidic (PH=5.04 and 5.11) reaction, but optimum for tef production as tef grows optimally in a well – drained moist loam soil with a PH of 5.8 to 6.5 the average organic matter of >5.20 as high, 2.6-5.2 as medium, 0.8-2.6 as low and <0.8% as very low as acidic.

Table1. Major soil characteristics of the experimental sites before planting.

Soil parameters	value	
	Harato	Guduru
Soil pH (H2O 1:2.5)	5.04	5.11
EC method 1:2:5 (ms/cm)	0.143	0.12
Soil moisture content %	5.219	3.135
Organic matter content	3.3	2.8
Total nitrogen	5.7	4.8
Available phosphorus	0.3	0.2
CEC (meq/100g soil)	12.6	4.1
Particle size		
Sand	46.93	41.25
Clay	24	34
Silt	50	54
Textural class	26	12

Similarly the average total N of the two experimental field were 0.2% and 0.3% which is medium classified soils having total N greater than 1% as very high, 0.5-1% as high, 0.2-0.5% as medium, 0.1-0.2% as low and less than 0.1% as very low in total nitrogen content (Cottenie, 1980).

On the other hand available p (19.2 ppm) of the soil falls under high according to Olsen et al. (1954) rating and caution exchanging capacity (CEC) 46.9 and 41.25meq/l00g soils) under high range (Olsen, 1954).

3.2.Tef crop phenology

The analysis of variance showed that except biological yield of days to emergence and harvest index the main effect of intra row spacing and fertilizer rates were significant ($P<0.05$) effect on days to 50% flowering, days to 90% maturity, tiller number, plant height, dry biomass and grain yield of tef crops at both study sites.

The interaction effect of spacing and fertilizer rate and control didn't shown significant effect on days to 50% emergence of tef crops at the study sites. In line with the result of (Tefera and Belay, 2006) reported that higher amount of fertilizer rate was non significant difference on the phonological stage of cereals. Days to 50% flowering was significantly ($p<0.05$) influenced by the main effect tef crops at both location, but interaction effect was show significant difference at harato site. Similarly Jadhave *et al*., (1992) also reported that closer spacing enhance days to flowering and maturity of sesame crop.

Table 2. Interaction effect of intra row spacing and fertilizer rate on quincho variety of tef at harato site.

		Intra row spacing	
Fertilizer rate	5cm	10cm	15cm
25 kgN/ha	60^{c}	60.66^{c}	62.66^{b}
35kgN/ha	61.66^{b}	62.66^{b}	63.33^{b}
45kgN/ha	62.33^{b}	64.33^{a}	64^{a}
55kgN/ha	65^{a}	65^{a}	65^{a}
LSD (0.05)=2.2			
Cv%=4			

The mean followed by the same letters are non significant P=0.05%

The main effect of intra row spacing and fertilizer rate and interaction were significant ($p<0.05$) effect on number of tiller produced per plant at both locations (Table 3). The highest number of tiller per plant (15.3) was counted at 15cm and 100kg N/ha application on quncho variety of tef at harato site. Wider spacing and high amount of nitrogen fertilizer application on the tef crop was produced large number of tiller per hill. Because the competition among the plant for natural resource was very less. This result agreement with Berehe *et al*., (2013), showed that nitrogen fertilizer enhances the number of tiller and vegetative growth of cereals crop.

Table 3. Interaction effect of intra row spacing, fertilizer rate and location on number of tillers per hills of tef crop at both sites.

		Intra row spacing				
Fertilizer	5cm		10cm		15cm	
25kgN/ha	7.6^{f}	1.3^{c}	$_{9}d$	13^{b}	10.3^{c}	12.6^{b}
50kgN/ha	8^{e}	12.6^{b}	10^{d}	13.6^{b}	11.3^{c}	13.6^{b}
75kgN/ha	$_{9}d$	13.6^{b}	11^{c}	13.3^{b}	12.3^{b}	14.6^{a}
100kgN/ha	9.6^{d}	15^{a}	11^{c}	14.3^{ab}	13.3^{b}	15.3^{a}
LSD (0.05)=1.3						
Cv%=4.5	Ha	GU	Ha	Gu	Ha	Gu

Means followed by the same letters are non significant at 0.05 probability

The main effect of fertilizer rate and intra row spacing and interaction were shown significant difference on grain yield of tef at guduru site.

The highest grain yield 17.8kg/ha was measured at 75kg N/ha and 5cm intra row spacing, optimum amount of nutrient elements help for vegetative growth and reproductive activity of plant. The lowest grain yield 10.8kg/ha was measured at 15cm intra row spacing and 50kgN/ha fertilizer rate.

Low and high amount of nitrogen elements decrease tef production and also negative effect on other nutrient elements that are help there for water, and nutrients uptake from the soil.

Also it burns the internal structure of plant when it's existing in huge amount. This study in line with Tefera and Belay, 2006; Wade, 1990. High and low amount of nitrogen fertilizer was significant difference on grain yield of tef.

Table 4. Interaction effect of intra row spacing, nitrogen fertilizer rate on grain yield (kg) of tef at guduru site.

	Intra row spacing		
fertilizer rate	5cm	10cm	15cm
25 kgN/ha	1,633.3[b]	1,533.3[c]	1,133.3[e]
50kgN/ha	1,555.5[b]	1,566.6[b]	1,088.8[e]
75kgN/ha	1,788.8[a]	1,622.2[b]	1,117.7[e]
100kgN/ha	1,733.3[a]	1,522.2[c]	1,144.4[e]
Lsd(0.05)=100.3			
Cv%=9.59	Gu	Gu	Gu
Location			

Mean followed by the same letters are non significant at 0.05% probability

Conclusion

Tef crop is originated and domesticated in Ethiopia, the crops are dominantly cultivated by Ethiopian farmers for human consumption, however the production of tef relatively low in grain yield because of poor new technology adaptation like row spacing and unrecompensed fertilizer rate usage, poor site selection and manage mental practices. Among poor agronomical practices un recommended intra-row spacing and fertilizer rate are the most yield limiting factors in cereals crops.

Small grain sizes seed are usually sown through broad casting method, but there is an option to sown tef seeds in row sowing method by drilling the seed in furrows at 20cm inter row spacing and then seedling was thinned at the recommended intra row spacing of the plant.

Intra row spacing and fertilizer rate can increase yield significantly as compared with common practices of broadcast method of sowing. It boosts tiller number, produces strong culms and improves quality of grain yield. The optimum plant spacing within rows between plants for sowing tef is found to be 5cm. the yield of intra row spacing tef can be improved by providing appropriate nitrogen and Phosphorus fertilizer. The recommended fertilizer dose previously made for traditional broadcasting method should be revised since different growth habit, nutrient, water and light utilization is expected in tef spacing.

Intra row spacing system of sowing was labor intensive. However the highest grain yield (17.88quntal/ha) was recorded at Harato and Guduru study sites at intra row spacing of 5cm and 75kgN/ha fertilizer level respectively. While the lowest grain yield (10.8quintal/ha) was measured at 15cm intra row spacing and 50kgN/ha of fertilizer level at Guduru site.

Generally row method of sowing is not practices at farmer's level widely, but this method of sowing unless using machinery it is difficult to practices on large area but the amount of yield obtained is very higher, the plants produce more number of productive tillers because of less completion for nutrients.

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