Effect of Inter Row Spacing and Seed Rate on Finger Millet (*Eleusine Coracana* L.) Production in MerbLekhe District – Ethiopia

[1]Chekole Nigus, and [1]Birhanu Melese

[1]Tigray Agricultural Research Institute, Axum Agricultural research Centre, P.O. Box 230, Axum, Ethiopia
Corresponding author**:-**chekolenigus@gmail.com
Phone +251914400919

ABSTRACT

Finger millet (*Eleusine coracana* L.) Gaertn.ssp. coracana), is an important crop grown in low input farming systems by resource poor farmers in eastern and southern Africa. One of the factors contributing to low yield of finger millet is poor crop management practices such as, seed rate, spacing and optimum fertilizer rate. The main objective of the present study was to determine the appropriate inter row spacing and seed rate. The experiment was conducted in 2014 (a main cropping season) at Merblekhe district at central zone of Tigray, Ethiopia, substation of Axum agricultural Research center. The experimental design was laid out in split plot design with three replications. The main plot was spacing whereas, subplots were the seed rate. Analysis of variance revealed significant difference ($P \leq 0.01$) due to the interaction effects of spacing and seed rateon the means of plant height, number of productive tillers and biomass yield whereas, a significant difference ($P \leq 0.05$) for grain yield. However, there is no statically significance differences at the number of fingers and length of fingers at ($P \leq 0.05$).The higher grain yield and biomass yield was recorded from the interaction effect of 30cm spacing with 15kg/ha (2214.4 kg/ha) and (12889kg/ha) respectively. Results of study revealed that the production and productivity of finger millet in Merblekhe district and similar agro ecology, the appropriate inter row and seed rate is the interaction of 30cm with 15kg/ha. This is one year data; further working on this trial is necessary recommendation of the present study.

Keywords: Finger millet; Inter row spacing; Seed rate; Interaction and split plot design

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INTRODUCTION

Finger millet (*Eleusinecoracana* L.) Gaertn. ssp. coracana), is the second most widely grown millets on the continent of Africa[1] and it is an important crop grown in low input farming systems by resource poor farmers in eastern and southern Africa. This is indigenous to the highlands of Uganda and Ethiopia, Finger millet is widely produced by small scale landholders and consumed locally[2]**.** It is well adapted to heat, drought and poor soil stress that prevail in marginal and degraded soils[3]**.** It is valued for nutrition, malt, good storability, income and other uses animal feeds (unpublished). In Ethiopia, finger millet occupies 456 171.54ha with the productivity of 22.30 qt/ha while in Tigray Regional occupies 86 613.23 ha coverage and 22.63 qt/ha of productivity[4].

Some of the factors contributing to low yield of finger millet are lack of high yielding cultivars, moisture stress, lodging effect, threshing5, diseases and low fertility and poor crop management practices such as fertilizer rate, seed rate and spacing. Strengthen the seed production and delivery systems for improved varieties also the most bottleneck of the in this crop on the small scale farmers. The appropriate row spacing and seed rate are most important management factor affecting the agronomic characteristics of wheat[6]. Suitable combination of seed rate and row spacing could increase grain yield of wheat[7]. Therefore, testing the optimum spacing and seed rate will be enhancing the finger millet production and productivity of water deficit areas of the region. Recommended seeding rates differ based on cultivar and seed size, location, soil water content and environmental conditions such as rainfall and temperature[8].

Since, determining the optimum spacing and seed rate has an importance; on the growth of the plant in access of nutrients, competition with weeds, access available water content and use of sunlight. As the inter row spacing wider there was increment on both plant height and tiller

number per plant. The inter row spacing of 45 cm or the seed rate of 10 kg /ha is advisable and could be appropriate for finger millet production[9].Thus, to increase the productivity of finger millet in areas faced with erratic rainfall, selection of early maturing genotypes and application of appropriate agronomic management is mandatory. This implies that, identification of appropriate inter row spacing and seed rate was the not time allowable conditions for this area. Therefore, the main objective of the present study was to determine the appropriate inter row spacing and seed rate of finger millet production.

MATERIALS AND METHODS

Study Site:

The site geographical situated at latitude of $14^0$22.87' north and longitude of 038^0 48.101' east with altitude of 1395masl, and the mean annual rainfall ranged from 400mm to 600mm with The average temperature in summer is 27°C and in winter is 36°C in addition to this high evaporation rate with moderately to high relative humidity.

Experimental Design:

The experiment was conducted in 2014 a main cropping season at Merblekhe district at central zone of Tigray, Ethiopia, substation of Axum agricultural Research center. The experimental design was laid out in split plot design with three replications and with a plot size of 5 rows by 3 meters length. The main plot was spacing whereas, subplot were the seed rate with level of (30cm, 40cm and 50cm) and (5, 10, 15, 20, 25 and 30kg/ha) respectively. The standard variety called Taddes was used as experiment material. All the remained agronomic practice such as land preparation, sowing/planting, fertilizer rate and application, weeding was applied per the recommendation.

Plant Sampling and Measurements:

Data were collected on plant height and measured from the ground to the tip of the plant, number of productive tiller plant raised from the base of the main plant and produced yield, length of fingers, biomass yield the total ground and grain yield. The central rows of the plants were used for collection of data mainly on plant height, number of productive tiller and length of finger. Number of finger was counted per a single plant head. The data was taken from 5 randomly selected plants and the average value was compute for all except biomass and grain yield. The

net 3 rows were harvested at fully maturing, the biomass yield and grain yield weight with different plot size. The net areas for individual spacing were as follow:for spacing of 0.3m the areas was 2.7meter square, 0.4m was 3.6meter square and 0.5m also 4.5 meter square, whereas, the length of the plot was equal (3 meters) for all spacing. The plots were harvested by hand sickle and threshed using man power. (You need to references)

Statistical Analysis:

Analysis of variance was performed using the 2 way ANOVA procedure of SAS Statistical Software Version 9.1.3[10].The data collected was subjected to analysis of variance (ANOVA) to test treatment effects for significance using the F-test; the significant means were separated using LSD at alpha level 0.5%.

RESULTS AND DISCUSSION

Analysis of variance for 2 factors split plot design (Table 1) revealed significant difference ($P \leq 0.01$) on the interaction effects of spacing and seed rate the means of plant height, number of productive tillers and biomass yield whereas, a significant difference($P \leq 0.05$) of grain yield. However, there are no significance differences at number of fingers and their lengths at ($P \leq 0.05$). Since, in the parameters which showed significance difference had an interaction effect between the spacing and seed rate; it was not important evaluating the main effect of these factors. The interaction of spacing and seed rate for the respond variable showed that over cross interaction, therefore, it become difficult to select the main factors independently. Then it needs to answer which level of spacing at what level of seed rate had higher respond on the tested variable.

1. Interaction effects of spacing and seed rate on growth traits

The number of productive tillers showed that there is a significances difference in the interaction effects of the spacing and seed rate. The highest numbers of productive tillers were counted from the interaction effect of 40cm spacing and 30kg/ha of seed rate (5.5) followed by the

combination of 50cm spacing and 30kg/ha seed rate (4.89). The lowest number of productive tiller counted from the combination of the factors of 50cm spacing and seed rate of 5kg/ha (1.82).The interaction of the higher seed rate and intermediate inter row spacing gained the higher number of productive tillers. This might be due to the area is moisture stressed; the more plant population can maintained the moisture level under the soil. Therefore, at the base of the plant the tiller can raise.

Table 1. The mean square values, R square, coefficient of variance and grand means of the plant height, number of fingers, number of productive tillers, length of finger, biomass yield and grain yield of finger millet

Source of variation	Df	MS for the interaction(sp*sd)	R square	CV	Grand mean(kg/ha)
Plant height (cm)	10	45.288**	0.554	4.674	93.66
Number of fingers (#)	10	0.3140829ns	0.4807	7.81	6.36
Number of productive tiller (#)	10	1.4563**	0.7235	18.98	3.65
Length of fingers(cm)	10	0.38532996ns	0.4527	9.66	4.85
Biomass yield(kg/ha)	10	12664076.6**	0.586	23.53	8520.23
Grain yield(kg/ha)	10	426355.406*	0.5565	30.48	1333.86

Note: *, **Significant at $p < 0.05$ and $p < 0.01$, respectively and 'ns' indicate non-significant

Inversely, the low seed rate and the wider intra row spacing gained the low number of productive tillers. Thus, the wider space between the plants under moisture stressed area is exposed to sunlight. This leads to unfavorable condition to raise tiller on base of the plant.

In agreement with the present study, tiller numbers per m^2 increased with use of closer spacing giving higher plant densities[11]. Thus, more population per plot increases the tillering capacity. However, some author reported disagreement to the present finding the wider spacing the higher productive tiller[12]. Whereas, the lower seed rate produced the higher tillers against to the present finding on the similar crop[13].

Table 2. The mean interaction effects of spacing and seed rate for the number of productive tillers (number)

Number of productive tillers of finger millet(number)							
Seed rate(kg/ha)							
Spacing(cm)	**5**	**10**	**15**	**20**	**25**	**30**	**Average**
30	3.33	2.78	2.5	3.66	3	3.66	3.155
40	2.88	4.61	3.89	4.33	2.72	5.5	3.988
50	1.82	4.72	3.77	3.99	3.51	4.89	3.783
Average	2.676	4.036	3.386	3.993	3.11	4.683	3.64

Note: Least significance difference between the spacing and seed rate=1.147

The longest plant height was measured from the interaction mean effect of 50cm spacing and 20kg/ha seed rate (101.4cm).However, the intermediate height which is the shortest from the measured treatments was 82.76cm. Even though there is a significance differences among the treatments or interaction of effect of spacing and seed rate effect on plant height, the longest plant height does not directly correlated with biomass yield and grain yield. (Table 3) showed that there is no numerical such big differences between the interactions mean effect on plant height. As seed rate increases from 3kg/ha to 9kg/ha the plant height is correspondingly decrease[13].Moreover, the wider the intra row spacing the longer the plant height[14-15].

Table 3. Mean interaction effect of the spacing and seed rate for plant height and the grand mean of finger millet

Plant height(cm)							
Seed rate(kg/ha)							
Spacing(cm)	**5**	**10**	**15**	**20**	**25**	**30**	**Average**
30	93.93	96.13	92.2	92.33	91.6	82.76	91.491
40	93.93	98.8	92.6	94.2	93.8	95.26	94.765
50	98	91.13	97.33	101.4	89.53	91.06	94.741
Average	95.286	95.353	94.043	95.976	91.643	89.693	93.666

Note: Least significance difference of spacing and seed rate=7.251

2. Interaction effects of spacing and seed rate on yield and yield components

The maximum biomass yield recorded from the interaction of the 30cm spacing and 15kg/ha seed rate was (12889kg/ha) and for the interaction of 30cm spacing and 10kg/ha was 11358kg/ha. Whereas, the minimum biomass yield recorded from the combination of 30cm spacing by 30kg/ha of 5504kg/ha. The grand mean of the two factors (spacing and seed rate) was 8520kg/ha. The optimum seed rate and inter row spacing was the 30cmx15kg/ha (Table 4).

Table 4. The mean interaction effect of biomass yield on finger millet

Biomass yield(kg/ha)							
Seed rate(kg/ha)							
Spacing(cm)	**5**	**10**	**15**	**20**	**25**	**30**	**Average**
30	6796	11358	12889	10617	7469	5504	9105.5
40	7467	10000	6556	7222	9667	8889	8300.167
50	9272	8889	9333	9185	6037	6215	8155.167
Average	7845	10082.33	9592.667	9008	7724.333	6869.333	8520.278

Note: **Least significance difference between the interaction spacing and seed rate=3320**

The higher grain yield was recorded from the interaction effect of 30cm spacing with 15 kg/ha (2214.4 kg/ha) followed by combination of 50cm by 10 kg/ha 1844.7kg/ha. However, the lowest grain yield was measured from the combination of 40cm by 20 kg/ha 732kg/ha (Table 5). This revealed that the optimum spacing and seed rate for the production and productivity of finger millet is 30cm inter row spacing and 15kg/ha seed rate for the study areas and similar agro-ecologies.

The narrow spacing was increase the yield; by optimizing the space and covering the root by canopy of inter row plants for the moisture stress land. The optimum seed rate uses effectively the available nutrients, moisture and sunlight. Therefore, the lower and higher seed rate not increase the grain yield of finger millet. Since, the lower seed rate needs high moisture to recover while the higher seed rate also required plenty of rain fall to minimize the competition between the populations per the plot. The effect of the levels from both factors affected the grain yield

was interdependently. In agreement to this finding[14] reported the higher grain yield obtained from the intra row spacing of 30 cm.

However[9], disagreed with present finding (45cm by 10kg/ha).Whereas[16], report that 15 kg/ha seed rate with 40cm the higher grain yield. Similarity and difference of the present finding with previous research might be due to for the similarity, the optimum seed rate is 15kg/ha whereas, for the difference on the inter row spacing also, depending on the growing weather condition. Therefore, the recommendation of the appropriate inters row spacing and seed rate per the study location and similar agro-ecology will be important.

Table 5. The mean interaction effect of spacing and seed rate on grain yield

Grain yield(kg/ha)							
Seed rate(kg/ha)							
Spacing(cm)	**5**	**10**	**15**	**20**	**25**	**30**	**Average**
30	1102	1574.8	2214.4	1582	1209.1	1150.9	1472.2
40	918.1	1286	1166.1	732	1303.1	1805.2	1201.75
50	1485.9	1844.7	1510.7	992.5	811.8	1320.1	1327.617
Average	1168.667	1568.5	1630.4	1102.167	1108	1425.4	1333.856

Note: **Least significance difference between the interaction effect of spacing and seed rate=673.41**

CONCLUSIONS

The present study revealed that, there is interaction effect between the spacing and seed rate on the traits like plant height, number of productive tiller, biomass and grain yield. The appropriate inter row and seed rate for the production of finger millet at the study area was 30cm spacing by 15 kg/ha of seed rate gives the higher grain yield and biomass yield. However, the longest plant height and more number of productive tiller obtained from the interaction effect of 50 cm spacing with 20kg/ha of seed rate, 40cm with 30 kg/ha of seed rate respectively. Therefore, to increase the production and productivity of finger millet in merblekhe district and similar agro ecology, the appropriate inter row and seed rate is the interaction of 30cm with 15kg/ha.

CONFLICT OF INTEREST

No conflict of interest

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