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Original Research

Influence of Seed Rate and Row Spacing on Growth, Yield and Yield Components of Fenugreek (*Trigonella foenum-graecum* L.) in Abay Chomen district, Western Ethiopia

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Abstract

A field experiment was carried out in Abay Chomen District, Western Ethiopia during the rainy season in 2021, to determine the effects of seed rate and row spacing on growth, yield, and yield components of fenugreek. It was executed in randomized complete block design, factorial arrangement by using 'Ebisa' variety and four seed rate (15, 18, 22, and 24kgha-1) and three inter-rows spacing (20, 25, and 30 cm) in three replications. The variance analysis indicated intra-row spacing had a highly significant effect on most of yield and its components. The interaction effects of seed rates and row spacing were highly significant ($p < 0.01$) for the yield and its component characters. Days to 50% flowering, number of branches per plant, number of pods per plant, seed per pod, pod length, harvest index and seed yield were found to be significantly increased with the increase of row spacing and seed rate to 25 cm rows spacing and 22 kg per hectare seed rate, whereas plant height and thousand seed weight were found to be significantly decreased. Extending the row spacing beyond 25 cm rows and seed rate of 22 kg per hectare resulted in a significant decrease in a number of pods per plant, seed per pod, pod length, seed yield, biomass yield, and harvest index. It suggests that the appropriate seed rate and row spacing for maximum seed yield under the present study were 22 kg per hectare and 25 cm.

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INTRODUCTION

Fenugreek (*Trigonella foenum-graecum* L.) is an annual herb that belongs to the family Fabaceae (Engles *et al*., 1991). It is believed to be native to the Mediterranean region, but now, it is widely cultivated in Ethiopia and other parts of the world. It is a multipurpose spice crop; every part of the plant is being used as a leafy vegetable, fodder, and condiment (Ahmad *et al*., 2005). Fenugreek is one of the oldest known medicinal plants that have been documented in ancient herbal publications, religious scriptures, travel records, and anecdotes dating back in human history (Bayram, 2010).

Fenugreek leaves and seeds are consumed in different countries around the world for different purposes such as medicinal uses (anti-diabetic, lowering blood sugar and cholesterol levels, anti-cancer, anti-microbial, *etc.*), making food (stew with rice in Iran, flavor cheese in Switzerland, syrup and bitter rum in Germany, mixed seed powder with flour for making flat bread in Egypt) and roasted grain as coffee-substitute (in Africa) (Bommi *et al*., 2010). In India, it has been used as part of traditional medicine practices (Deora *et al*., 2009).

It is commonly used to supplement low protein foods such as maize, rice, wheat, sorghum, and "tef" because of its high protein c ontent (32-36%) (Tiwari et al., 2016). Fenugreek is grown as an intercrop with sorghum in the eastern Hararghe Zone (Jemal *et al*., 1998). According to Asfaw *et al.* (1981), fenugreek c an be found in nearly every market in Ethiopia and has been cultiv ated in Ethiopia since ancient times for use as a food, spice, and medicine.

According to the CSA (2021) estimates of Ethiopia, fenugreek cultivation covered about 32,507.42 hectares of agricultural land with over 28,925.21 tons of fenugreek seed per year, which makes fenugreek the sixth most produced highland pulses in the country. Fenugreek is grown on a wide range of soils but flourishes on well-drained loams or sandy loams. Fenugreek is also adapted to dry lands including slightly alkaline soils or marginal lands (Deora, *et al*., 2009). The production and distribution of fenugreek in Ethiopia are nearly similar to those of other cool-season food legumes (DZARC, 2004). There is a large genetic diversity of the crop in Ethiopia (Feysal, 2006).

The Oromia region is ideal for fenugreek production in Ethiopia. In the region, among the total land area of 2,549,031.00 hectares planted by pulses, fenugreek covered 2,449.00 hectares, which is 0.06% of the production area covered by all pulses grown in the region in 2015/16 cropping season (CSA, 2021). According to CSA (2021), in the 2014/15 Ethiopian main cropping season, the productivity of fenugreek in the country was 0.996 tons ha^{-1}, which is too low compared to its potential yield of 1.8 tons ha^{-1} (Gill *et al*., 2005).

One of the principal production constraints of fenugreek is maintaining the optimum plant population per unit area, which depends on the best possible seed rate and spacing. It is, therefore, necessary to improve fenugreek productivity and production through different seed rate management and row spaces rewarding to farmers and to satisfy the demand for fenugreek both in the local and international markets. Even if, fenugreek has wide adaptability concerning soil and climatic conditions, there is limited scope of cultivation area and lack of systematic research work on fenugreek particularly concerning yield and production.

Generally, the yield in fenugreek is low because of poor agronomic practices including seed rate and row spacing. To increase the yield and productivity of this important seed spice cum leafy vegetable, optimum seed rate and spacing are the most important factors. Not only for maximizing productivity but also for securing the highest net returns from a unit area, maintaining optimum plant population per unit area, which depends on the best possible seed rate and spacing, is very essential. However, very little research work has been carried out on spacing and population management practices along with optimum seed rate and spacing. So considerable scope of increasing the productivity of this commercial crop by adopting the experiment was planned to evaluate the influence of seed rate and row space on growth, yield, and yield components of fenugreek and to recommend optimum seed rate and row space for the study area.

MATERIALS AND METHODS

Description of the study site

The study was conducted in the Oromia regional state, Horro Guduru Wollega Zone, Abay Chomen District Genji Haro kebele on a farmer field during the 2019 cropping season. It is located about 275 km away from Addis Ababa to the Western part of the country and about 49 km to the zonal capital, Shambu. The district is located at the geographic coordinates of 10°59' 33'' North latitude and 32°28' 66'' East longitude. The altitude is 2354 m a sl and the slope remains at 8%. The area is characterized by an unimodal rainfall pattern and with a rainfall period from May to October. The average rainfall is 1329 mm and the minimum and maximum air temperature of the area is 21^0c and 30^0c, respectively

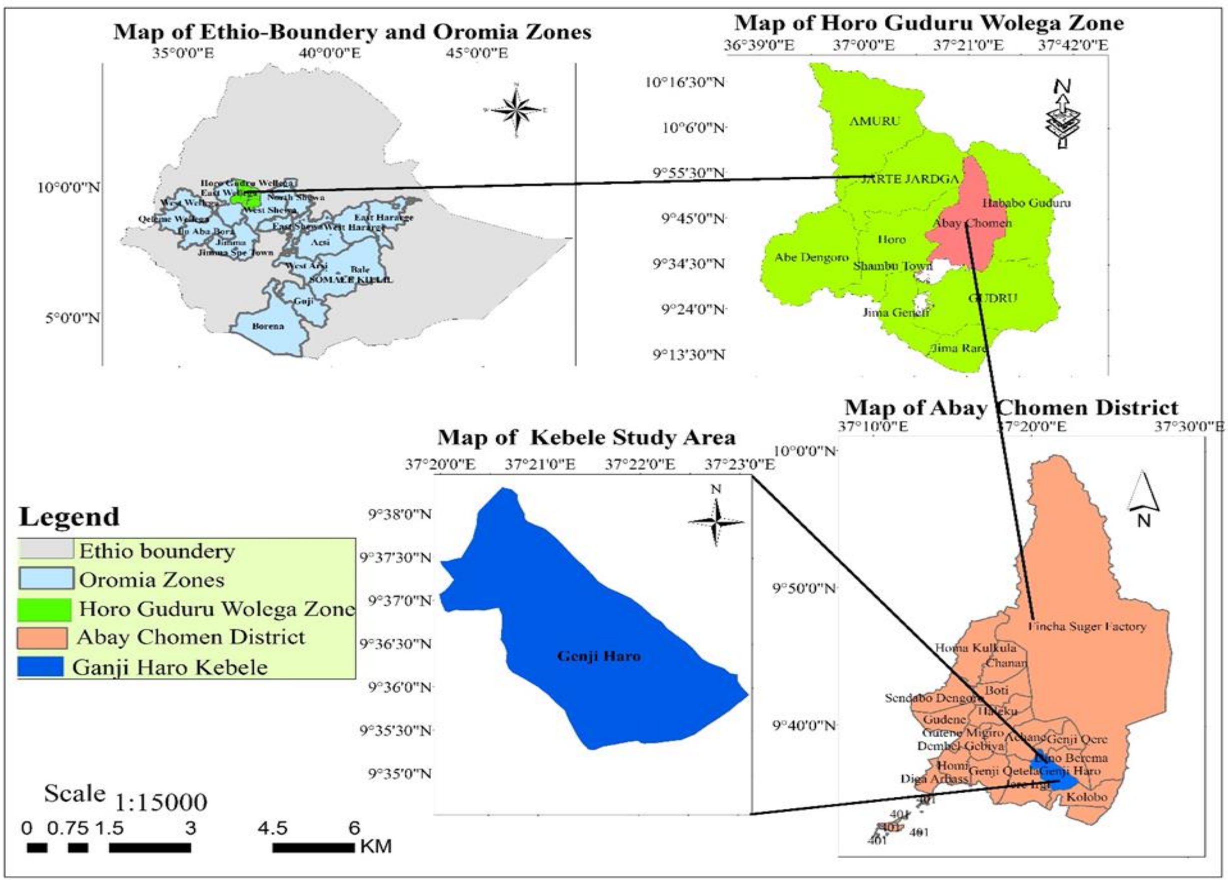

Fig 1. Map of the study area

Experimental Design and Treatment

Two factors, seed rate (15, 18, 22, and 24 kgha^{-1}) and inter-row spacing (20, 25, and 30 cm) with constant intra-row (10 cm) were used. The experiment involved 4 by 3 factorial experiment arranged in randomized complete block design three replications. Twelve treatment combinations were evaluated making a total of thirty-six experimental unit.

Application of 100 kg NPS ha^{-1}NPS was done by banding around the fenugreek seed at sowing time). Fenugreek seed was sown into rows on the prepared fine seedbed on August 20, 2021. All weeds were removed by hand as required after emergence. Harvesting was performed at maturity and the plants were then threshed and separated into seed and straw to make the seeds ready for data analysis. The fenugreek variety: Ebisa which was released by Sinana Agricultural Research Center in 2012/13, was adaptable to the agro-ecology of the study area and more productive than other varieties was used for the experiment. It has medium plant size with a deep yellow seed color and basal branching growth habit. On average this variety needs 51 days to flowering and 129 days to physiological maturity.

Data collection

Growth, yield, and yield component parameters were collected as scheduled including days to flowering, number of branches plant, number of pods plant^{1,} number of seeds pod per plant, pod length, harvest index, and seed yield.

Data analysis

The responses for each factor level have a normal population distribution. All the measured parameters were subjected to analysis of variance (ANOVA) using the General Linear Model (GLM) (SAS, 2012). The Least Significant Difference (LSD) test at a 5% probability level was used for mean comparison when the ANOVA showed significant differences.

RESULTS AND DISCUSSION

Days to 50% emergence

The effect of seed rates and row spacing on fenugreek was non-significantly ($p > 0.05$) affected day to 50% emergence. This uniform day of emergency may be due to the use of one variety.

Days to 50% flowering

Days to flowering were highly significantly ($p < 0.01$) affected by the main effect, while the interaction effects were not significant. Fewer seed rates (15 kg ha^{-1} and 18 kg ha^{-1} seed rate showed early flowering which required 57.44 and 61.67 days than more seed rates, beyond 25 kg ha^{-1} which flowered on 63.74 and 66.44 days after sowing respectively. The days taken to 50% flowering in fenugreek increased significantly with the decrease in the seed rate and delayed with more seed rates might be because denser plants per unit area which had made for nutritional competition than less seed rating. In line with this result, Kumar *et al*. (2018) reported the earliest flowering from the lowest seed rate of 16 kg ha^{-1} and advanced in 50 percent plants by 6.41 days in fenugreek.

Flowering is a very important physiological process in the development of the fenugreek crop and has a profound effect on the final yield that can be obtained. Too longest days to 50% flowering (64.25) were recorded at narrow (20 cm) row spacing, while the shortest (60.50) were recorded at wider (30 cm) row spacing (Table 1). Furthermore, narrower spacing had less light interception compared to the wider row spacing, resulting in a greater number of days to flowering of fenugreek. Opposite of this result, Sharma (2000) found the earliest flowering at closer spacing (20 cm) of coriander as compared to wider spacing of 30 and 40 cm.

Plant height

The analysis of variance showed that the main effect of seed rate and row spacing had a highly significant ($p < 0.01$) effect on plant height of fenugreek. However, the interaction effect of seed rate and row spacing did not significantly affect the plant height of fenugreek. The result indicated that the maximum plant height was recorded from seed rate 24 kg ha^{-1} 63.93 cm, whereas, the shortest plant heights were recorded for seed rate 18 kg ha^{-1} 51.65 cm (Table 1). Results depicted from Table 1, the highest plant height (58.77 cm) was recorded for the Ebisa variety at a row spacing of 20 cm followed by 57.13 cm a row spacing of 25 cm and the shortest plant height was recorded row spacing of 30 cm. Narrowest row spacing resulted in the highest plant height than the wider spacing. This might be due to increasing light, air, and space demand for narrow-spaced plant populations which resulted in an increase of height in search of light. Also, at the early stage of growth, there is a high rate of growth regulating hormone production which fastens the cell division, growth, and height of the plant.

However, cell division decreases as the plant grows and further height increment stops and goes to maturity. In addition to this, when row spacing increased, the plant height decreased showing that spacing can be inversely related to plant height for variety. Similar results were reported by Nandal *et al*. (2007). observed that seed rate had a positive effect on the height of fenugreek plants. Roussis *et al.* (2017) indicated that the tallest plant at a high seed rate of 60 kg ha^{1}. The results obtained in this study also in line with the findings of Singh *et al*. (2013). Kumar *et al*. (2018) also showed that the tallest plants (61.14 cm) with the highest plant density of 320,000 plants ha^{-1} and the lowest plant height of 52.55 cm in the lowest plant density of 125,000 plants ha^{-1} of green bean. Likewise, Singh *et al*. (2013) reported that the denser plant population increased the plant height of faba bean due to competition among plants.

Days to 90% physiological maturity

The seed rates and row spacing effect of fenugreek were non-significant ($p > 0.05$) affecting day to 90% physiological maturity. This uniform day of physiological maturity may be due to the same variety used.

Table 1. Main effect of a day of 50% flowering, plant height, and biological yield as affected by spacing and seed rate.

Treatments	**Parameters**		
Seed rate (Kg/ha)	DY50%F	PH	BY
SR1	57.44[d]	51.65[d]	2296[d]
SR2	61.67[c]	54.41[c]	2537[c]
SR3	63.74[b]	58.85[b]	2920[b]
SR4	66.44[a]	63.93[a]	3528[a]
LSD (5%)	0.872	1.299	165.235
Row spacing (cm)			
R1	64.25[a]	58.77[a]	2486[c]
R2	62.25[b]	57.13[b]	2767[b]
R3	60.50[c]	55.74[c]	3208[a]
LS D (5%)	0.755	1.125	143.098
CV (%)	1.2	2.3	8.5

Where By- biological yield, PH- pl ant height, DyF- days to flowering, SR1-15kgha^{-1}seed rate, SR2-18kgha^{-1}seed rate, SR3- 22kgha^{-1}seed rate, SR4-24kgha^{-1}seed rate and R1-20cm row spacing, R2-25cm row spacing and R3-30cm row spacing respectively

Thousand Seed weight

The two-way interaction effect of seed rate and row spacing was significantly ($p \leq 0.05$) affected 1000 seed weight. Thousand seed weight reflects the ability of the genotypes to partition their dry matter into seed. Small seeds develop rapidly, once the reproductive phase starts, and produce less dry matter in their seed. In this study, the largest seed weight (6.86 g) was recorded from the interaction of 22 kg ha^{-1} and 20 cm row spacing whereas the smallest seed weight (1.600 g) was recorded from the interaction of 24 kg ha^{-1} seed rate and 20 cm row spacing (Table 2). This might be due to enough growth resource availability under wider row spacing which converted biological yield to economic yield and stored in seed yield. In addition, in wider spaced plants, the improved supply of assimilates to be stored in the seed, hence, the weight of thousand seeds increased. Where the seed was sown densely the variety had smaller seed than the seed sown moderately and less. Higher 1000 seed weight was recorded for lower plant populations of row spacing, than denser plant populations with narrow row spacing. The found results are similar to the findings of Gowda *et al*. (2006) who obtained the maximum test weight (11.71 g) with a seed rate of 15 kg ha^{-1} and minimum (10.91 g) with a seed rate of 25 kg ha^{-1}. In addition, the result of this study was in line with the result obtained by Disasa (2009) who reported that the highest hundred seed weight of 27.47 g at the lowest plant population of 133, 333 plants ha^{-1} and the lowest 24.99 g at the highest plant population of 333,333 plants ha^{-1} of common bean. Similarly, Amany (2014) reported that the increase of planting density from 25 to 33 plant m^{-2} increased plant height while decreasing the number of branches plant^{-1}, number of pods plant^{-1}, number of seeds plant^{-1}, 100 seed weight, and seed yield plant^{-1}. Moreover, Khalil *et al*., (2011), Kurubetta et *al.* (2009), and Matthews *et al*. (2008) reported that 100 seed weight of faba bean was negatively related with plant density that means low faba bean plant density produced heavier grains compared with high density, which produced lighter grain. In contrast to this result, Tunçtürk *et al*. (2011) obtained a non-significant effect of plant density on the hundred seed weight of bean. In fenugreek, as the highest test weight was obtained from crop geometry (30 cm x 10 cm), the lowest values were obtained from 5 cm x 10 cm as reported by Nandal *et al*. (2007).

Number of pod plant^{-1}

The result of ANOVA showed that the two-way interaction effect of seed rate and row spacing was highly significant ($p < 0.01$) effect on the number of pods per plant (Table 2). The highest number of pod plant^{-1} (10.8) was recorded from the interaction of 22kg ha^{-1} seed rate and 25 cm row spacing while the smallest number (6.83) was recorded from the interaction of 22 kg ha^{-1} seed rate and 20 cm row spacing (Table 2). This might be due to a higher number of branches plant^{-1} at wider row plant spacing as a higher number of branches benefits to more sites for flower development, which is attributed to a prolific pod production. This result was in conformity with the study of Tiwari *et al*. (2016) who observed that significantly higher number of pods per plant with row spacing of 30 cm x 10 cm than the rest other spacing except plant spacing of 25 cm x 10 cm which was reported at par with plant spacing 30 cm x 10 cm. Similarly, Sharma *et al*. (2008) observed the seed rates of 30 and 45 kg ha^{-1}, gave significantly highest number of pods per plant (19.7) and (17.4), respectively compared with a seed rate of 60 kg ha^{-1}. In fenugreek, pod number plant^{-1} increased with increasing row spacing. The maximum number of pods plant^{-1} was obtained when fenugreek was sown at a wider spacing; while the lowest pods plant^{-1} was obtained from the narrow row spacing.

Pod length

The result of ANOVA indicated that the interaction effect of seed rate and row spacing was highly significantly ($p < 0.01$) affected the pod length. In the result, the longest pod length (11.9 cm) was obtained from the interaction effects of 22 kg ha^{-1} seed rates and 25 cm row spacing whereas, the shortest pod length (5.73 cm) was recorded from the interaction of 24 kg ha^{-1} seed rates and 20 cm row spacing (Table 2). The narrowest row spacing and higher seed rate resulted in the lowest pod length than the wider spacing and moderate seed rating. This might be due to decreasing light, air, and space demand for narrow-spaced plant populations which resulted in a decrease in length in search of light. Also, at an early stage of growth, there is a high rate of growth regulating hormone production which fastens the cell division, growth, and length of the pod. But cell division decreases as the plant grows and further length increment stops and goes to maturity. In line with this finding of Kumar *et al.* (2018) opposing the result of the present study. A fenugreek seed rate of 16 kg/ha when sown at a row spacing of 40 cm showed a significantly better result. In addition to this conformity fenugreek Jamal *et al*. (2010) recorded that the crop geometry 30x10 cm gave a significant increase in pod length (11.28 cm) as compared with the 22.5 cm x 13.3 cm (10.24 cm) and opposed to this finding Brar *et al*. (2005) conducted a field trial to record the effect of sowing date and row spacing (22.5 and 30 cm) on the cv. ML-50, observed the fenugreek seed sown at the closer spacing resulted in significantly higher pod length.

Number of seeds pod^{-1}

The two-way interaction result showed a highly significant ($p < 0.01$) effect on a number of seeds per pod. A maximum number of seeds plant-^{1} (11.9) was achieved from a 22 kg ha^{-1} seed rate and row space of 25 cm while the minimum number of seeds plant-^{1} (3.75) was recorded from the interaction of 24 kg $^{-1}$ seed rate and 20 cm row spacing (Table 2). The reduction in a number of seeds plant-^{1} in high plant density could be explained by the canopy development at the early stages of this treatment which was insufficient to maximize light interception. Consequently, plants may compete against each other, and the performance of individual plants becomes poor. While, at low planting density, each plant performance was good due to less competition for resources such as water and light. In fenugreek, Sharma *et al*. (2008) and Gendy (2013) observed the seed rates of 30 and 45 kg ha^{-1}, which gave significantly highest number of pods per plant (19.7) and (17.4), respectively as compared with a seed rate of 60 kg ha^{-1}. Plant density had an effect in which wide row spacing gave the highest seed number; however, the lowest seed number was obtained from narrow row spacing. The results of the present study were also confirmed by the findings of Sharma (2000) who obtained the maximum number of seeds per pod under wider row spacing.

Biological yield

The main effect of seed rate and row spacing were highly significant (*$p < 0.01$*) and affected the aboveground dry biomass of the fenugreek variety while the interaction effect was non-significant. The highest dry biomass weight was 35.28tonha^{-1} which was recorded from the seed rate 24 Kg ha^{-1} and 29.2tonha^{-1} from the 22 Kg ha^{-1} seed rate. On the other hand, the lowest mean dry biomass was recorded from a seed rate of 18 Kg ha^{-1} with a dry biomass of 22.97tonha^{-1} (Table 2). The reason for the increased biological yield with the highest seed rate and widest row spacing might be due to the presence of optimum plant population at optimum spacing, which brought improvement in vegetative growth. The finding conforms to previous reports of Brar *et al*. (1993) who reported the seed rate significantly affected the biological yield.

Harvest index

The two-way interaction results were showed that highly significantly ($p < 0.01$) different on the harvest index per plot and per hectare, increased with the increase in seed rate and row space. Regarding the harvest index, the maximum present of harvest index (38.97) was obtained from the interaction of 22 kg ha^{-1} seed rate and 25 cm row spacing whereas, the minimum (12.46%) value for harvesting index was obtained from the interaction of 18 kg^{-1} used seed rate and 20 cm row spacing (Table 2). The data indicated significant variation among different seed rates and row spaces with respect to harvest index. The increase in harvest index might be attributed to increased seed yield with the increase in seed rate and row spacing. A balance between the productive parts of plants and reserves, which form economic yield, is essential to get a higher yield from a crop. A considerable increase in the yield of economic parts is usually dependent on an increase in total dry matter produced by the crop. The lower harvest index with a seed rate of 18 kg ha^{-1} and row spacing of 20 cm might be due to an increase in vegetative growth resulting in higher biological yield per hectare. However, the results of the present study are contradictory to those of Tiwari *et a*l. (2016) who observed that different spatial arrangements showed a non-significant effect on the harvest index of fenugreek. The beneficial effect of seed rate on fenugreek concerning harvest index is in accordance with the findings of Dessa (2009) who noticed that the seed rate significantly influenced the harvest index.

Seed Yield

The two-way interaction results were showed highly significantly ($p < 0.01$) different in the seed yield ha^{-1}. The maximum seed yield per ha-^{1} (1139 kg ha^{-1}) was obtained from the interaction effects of 22kg ha^{-1} seed rate, and row space of 25 cm. Whereas, the minimum (232.46 kg ha^{-1}) seed yield was recorded from the interaction of 18 kg ha^{-1} seed rate and 20 cm row spacing (Table 2). The observed data indicated that there was a significant variation among different seed rates and row spaces with respect to seed yield per ha^{-1}. The value for seed yield per ha-^{1} varied from 1139.0 kg ha^{-1} to 232.2 kg ha$^{-1.}$ The seed yield per ha^{-1} improved considerably with the increase in seed rates and row spacing. The increase in seed yield per plot and hectare might be due to optimum plant population at optimum seed rate which improved vegetative growth and proper utilization of light and other nutrients at wider spacing providing better germination and proper seed size and weight as compared to lower seed rate and higher seed weight. The present result supports the findings of Meena *et al*. (2003) and Nandal *et al*. (2007) who noticed the sowing of fenugreek crop at wider spacing i.e. 30 and 40 cm, significantly increased the seed yield over sowing at narrow spacing, i.e. 20 cm. Tuncturk (2011) reported the highest seed yield (777.0-785.0 kg ha^{-1}) was obtained from 30 cm row spacing. The results also showed that the sowing of fenugreek seeds at the row spacing of 30 cm increased the yield over the sowing at a spacing of 20 cm.

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

Seed rate (Kg/ha)	Row spacing	Yield Parameters					
		NPP	NSPP	PL	TSW	HI	SY
SR1 (18 kg/ha)	R1(20cm)	7.633bcd	9.633bc	7.733^{bc}	4.600^{c}	12.46^{f}	232.46 ^{f}
SR1 (18 kg/ha)	R2(25cm)	8.433bc	10.233b	8.633^{b}	3.63d^{e}	19.26^{de}	435d^{e}
SR1 (18 kg ha)	R3(30cm)	9.200^{b}	7.767e	8.400^{b}	2.700^{fg}	20.04^{de}	557.2^{cd}
SR2 (20 kg/ha)	R1(20cm)	7.800^{bcd}	7.800^{e}	6.667^{cd}	5.833^{b}	16.75^{ef}	390.6^{e}
SR2 (20 kg/ha)	R2(25cm)	8.700^{bc}	8.933^{cd}	8.267^{b}	3.900^{cd}	18.51^{de}	462.8^{de}
SR2 (20 kg ha)	R3(30cm)	9.033^{b}	9.333^{bcd}	8.900^{b}	2.933^{ef}	20.21 ^{de}	562.8^{cd}
SR3 (22kg/ha)	R1(20cm)	6.833^{de}	6.867^{f}	6.600^{cd}	6.867^{a}	20.04^{de}	662.8^{c}
SR3(22kg/ha)	R2(25cm)	10.900^{a}	11.900^{a}	11.800^{a}	4.367^{c}	38.97a	1139.0^{a}
SR3 (22kg/ha)	R3(30cm)	8.967^{bc}	8.633^{de}	8.833^{b}	3.267^{de}	29.63^{b}	946.1^{b}
SR4 (24 kg/ha)	R1(20cm)	5.600^{e}	3.733^{h}	5.733^{d}	1.600^{h}	28.64^{b}	901.7^{b}
SR4 (24 kg/ha)	R2(25cm)	6.467^{de}	4.667^{g}	6.367^{cd}	2.100^{gh}	29.68^{b}	996.1^{b}
SR4 (24 kg/ha)	R3(30cm)	7.400^{cd}	5.467^{g}	6.833^{cd}	2.567fg	21.81^{cd}	884.6^{b}
Mean		6.489	4.623	6.311	2.089	26.71	927.467
LSD (5%)		1.436	0.877	0.352	0.6700	4.415	127.179
CV (%)		10.5	6.5	9.84	10.7	11.1	11.0

Where NPP-no of pod per plant, NSPP No of seed per pod, Pl- plant height, TSW- 1000 seed weight, HI harvesting index, SY- seed yield, SR1-15kgha^{-1}seed rate, SR2-18kgha^{-1}seed rate, SR3- 22kgha^{-1}seed rate, SR4-24kgha^{-1}seed rate and R1-20cm row spacing, R2-25cm row spacing and R3-30cm row spacing respectively

CONCLUSION

In this study the effects of seed rate and row spacing on growth, yield and yield components of fenugreek (*Trigonella foenum-graecum* L.) in Abay Chomen district, Western Ethiopia were reported. The findings showed that inter-row spacing, and seed rates had a significant influence on the phenology, growth, yield and yield components of fenugreek. Among the row space and seed rate, 22kgha^{-1} seed rate and 25 cm inter-row space were found to be high yielders in the experiment. However, as this result was done for one season and location; the experiment has to be repeated over locations and seasons to reach a more reliable conclusion and recommendation.

Data Availability Statement

The corresponding author can provide the raw data that was gathered and used to support the study's conclusions upon reasonable request.

Conflict of Interest

The authors declare that there is no conflict of interest.

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