Research Journal of Agriculture and Environmental Management Vol. 5(3), pp. 086-094, April, 2016
Available online at http://www.apexjournal.org
ISSN 2315-8719© 2016 Apex Journal International

Full Length Research

Effect of sowing method and seed rate on the growth, yield and yield components of faba bean (*Vicia faba* L.) under highland conditions of Bale, Southeastern Ethiopia

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Accepted 25 April, 2016; Published 29 April, 2016

Faba bean (*Vicia faba* L.) is one of the main crops grown in Southeastern Ethiopia. Broadcasting is the dominant planting method of faba bean production in the study area. An experiment was conducted on the effect of sowing method and seed rate on the growth, yield and yield components of faba bean at Sinana agricultural research center during 2013-2014 'Bona/meher' cropping seasons. Two faba bean cultivars (Shallo and Gebelcho), Two sowing methods (Broadcast and row planting), Five seed rates (125, 150, 175, 200 and 225 kg/ha) were laid out in split-spilt plot with randomized complete block design (RCBD) in three replications. SAS, computer software was used to compute the analysis of variance. The results revealed that cultivars significantly affected seed and biomass yield, harvest index and 1000 seed weight. Gebelcho cultivar surpasses shallo. Similarly sowing method also significantly affected plant height, pods plant^{-1}, biomass and seed yield. The seed yield gained by row sowing method was 20.2% higher than broadcast sowing method. Seed rates had significantly affected all the tested parameters except number of pods plant^{-1} and seed yield. On the other hand, the interaction effect between cultivars and sowing methods showed it was significantly affected all the tested traits. Similarly interaction between cultivar and seed rate had significantly affected all the tested parameters except number of pods plant^{-1} and seeds pod^{-1}. Interaction between sowing method and seed rates were significantly affected all the studied parameters but not harvest index. The interaction between cultivar, sowing method and seed rates were also significantly affected all the tested parameters. Thus, for small seeded cultivars like Shallo use of 125 kg/ha seed rate was economical to use. On the other hand, Gebelcho in row sowing method at 200 and 225 kg/ha gave the first and the second highest mean seed yield (kg/ha). However, the partial budget analysis result showed that Gebelcho cultivar planted in row sowing method with 150 and 200 kg/ha seed rates gave the first and second highest marginal rate of return (MRR) respectively and it was economical to produce faba bean.

Key words: Faba bean (*Vicia faba* L.), cultivar, sowing method, seed rate.

INTRODUCTION

Ethiopia is second to China in faba bean production area but forth in productivity per unit area after Egypt, Sudan and China in the world (Sitou and Mywish, 2011). In Ethiopia, among the high land legume crops, faba bean is the first important stable food grain and mainly grown under rain fed conditions. In Bale Zone, the crop is also the leading pulse crop grown in large areas by farmers (Tilahun et al., 2000). It is one of the commonest and cheapest source of protein (20-25%) especially for the poor who cannot afford animal protein (Schatz and Endres, 2009), generating a considerable household income for the farming community; improve soil fertility through biological N fixation (Schatz and Endres, 2009) and it is a valuable low-input break crops in cereal based

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crop production system (Amare and Adamu, 1993). Despite its manifold merits, however, the production and the productivity of the crop is far below the potential, due to a number of yield limiting and reducing factors. Among the many yield limiting factors in faba bean production under farmers practice; plant density and planting method are important (Mehdi et al., 2010). High yields are realized with optimum plant population and planting method. However, due to lack of holistic recommendations on sowing method and plant population of faba bean cultivars, plant populations on farmers' field appear lower or higher than the optimum. As a result, very low yield was obtained.

Plant density is an important agent that affects yield and yield components of legumes. Since, if the plant population is too high, plants compete with each other for resources and low yield was realized. On the other hand, if the population is too low, more growing space was wasted and it lowering yield. In line with these facts Kakiuchi and Kobata (2004) found that lower plant density increased the pod number per plant whereas; the higher plant density decreased the parameter. Similarly, several authors (Khalil et al., 1993; Abdel-Aziz et al., 1999) reported that plant height increased with increasing population density up to 33.3 plant/m^2 or 44.4plant/m^2 (El-Douby et al., 1996). Moreover, Mehdi et al. (2010) also reported that plant density had shining influences on plant height, biological and seed yield (kg/ha) where the parameters increased by increasing plant densities.

On the other hand, planting method has a significant effect on resource utilization like water, nitrogen and phosphorus economy, energy savings and soil compaction (Trodson *et al.* 1989). Moreover, absorption of photosynthetically active radiations has also been found to be influenced by planting methods (Lal et al., 1991). In the study area of Bale highlands, Ethiopia faba bean is planted through broadcasting method. However, row planting method in general has many advantageous in contrast to broadcasting. Since, one of the major constraints of broadcasting method in faba bean production in the field is weed management which requires higher labor**,** requires higher seed rate and results in lower plant population (Umed *et al.* 2009). Keeping in view the importance of seed rate and sowing method this study was designed to determine the best sowing method and seed rate for the two selected cultivars, Shallo and Gebelcho for ultimate faba bean production.

MATERIALS AND METHODS

The experiment was conducted at Sinana, on-Station in Bale highlands in the South-east of Ethiopia, for two years (2013-2014) under rain-fed conditions during the "*bona*" season August-December which is the main cropping season. Bale highland is characterized by bimodal rainfall patterns or two separate crop growing seasons namely, "*bona"* extends from August to December and "*ganna"* from March to July. Sinana is located at 7°7'N longitude and 40°10'E latitude, at an elevation of 2400 m.a.s.l. The soil of the area is dominated by Cambisol. The mean monthly rainfall data was shown in Figure 1. The mean annual total rain fall during the cropping season (August to December) is 416.3 mm, ranging between 309.3 and 523.4 mm and the average annual temperature are ranging from 5 to 23°C. The highest rain fall was observed in October for both years.

Moreover, as shown in Figure 1 monthly rain fall were more or less good uniform distribution during 2013 cropping season as compared to 2014 cropping season. Some of the selected soil physico-chemical properties of the experimental site are shown in Table 1. The soil of the experimental site was dominantly clay in texture. The experiment was laid out in split-spilt plot with randomized complete block design (RCBD) in three replications. Two released faba bean cultivars (shallo and Gebelcho) were used and assigned to the main plots and the two sowing methods (broadcast and row planting) were assigned to the sub-plot. The five seed rates (125, 150, 175, 200 and 225 kg/ha) were used as sub-sub plots. The size of each sub-sub plot was 4 × 1.6 m (6.4 m^2) and the distance between each plot and block were 0.6 and 1.5 m apart respectively. The distance between rows for row planting plots were 0.4 m. At planting all field activities and other crop management practices were done with standard production practices or as per recommendation of the area. All the relevant data's including plant height, number of pods $plant^{-1}$, number of seeds pod^{-1}, biomass and seed yield (kg/ha), harvest index and thousand seed weight (gram), were collected from the net plot size and subjected to analysis of variance using SAS 9.1 computer software. Comparisons between treatment means were made using Least Significant difference (LSD) test at 0.05 probability level. To evaluate the economic benefits of shift in practice, partial budget analysis was done to identify the rewarding treatments. Yields from on-farm experimental plots were adjusted down ward by 10% to reflect the difference between the experimental yield and the yield that farmers could expect from the same treatment. Field seed price (9.0 Birr kg^{-1}seed) of the average of one month from the time of crop harvesting and labor for planting, weeding and harvesting were valued at Birr 30 per person per day were used for variable cost determination.

RESULTS AND DISCUSSION

Effect of varieties

The influence of variety on the yield and yield component of faba bean (*vicia faba* L.) was presented in (Table 2).

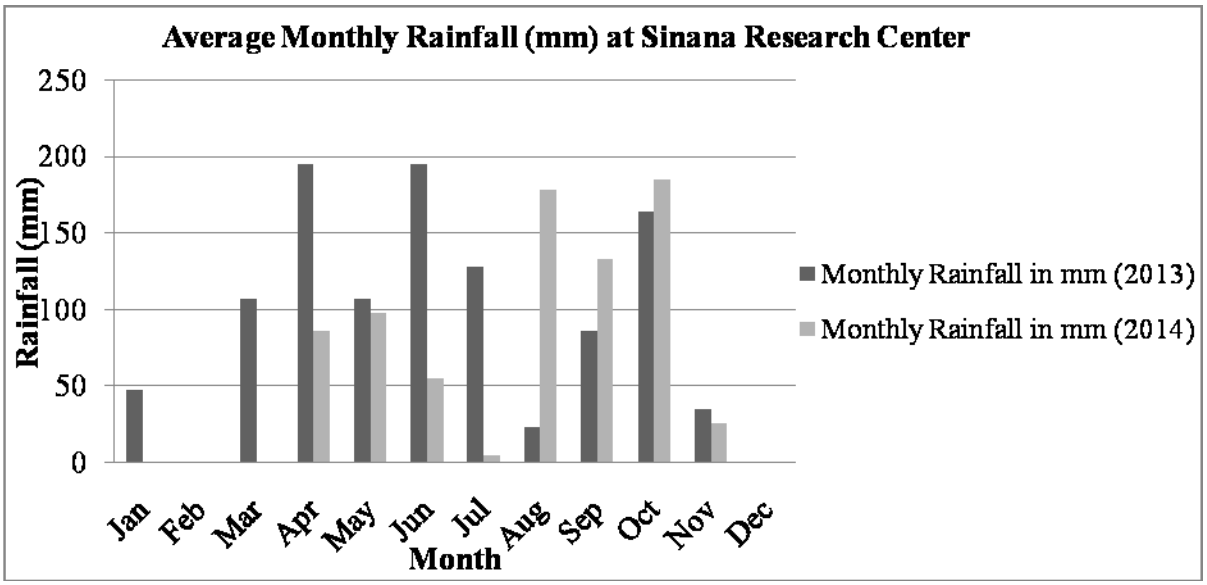

Figure 1. Monthly rain fall (mm) during the experimental years (2013-2014) at Sinana Agricultural Research Center.

Table 1. Selected physico-chemical properties of the experimental soil before planting in the Study areas (Sinana and Agarfa).

Physical properties					Chemical properties					
	(%)								(cmol.(+) kg soil^{-1})	
Soil depth (cm)	Sand	Silt	Clay	Textural class	pH in water (1:2.5)	OC (%)	Total N (%)	Available P (ppm) (Olsen)	CEC	K^+
0-20	22	22	56	Clay	7.7	2.18	0.16	6.8	49.24	2.19

OC, N, P, CEC, K, Cmol kg soil,$^{-1}$ Organic Carbon, Nitrogen, Phosphorus, Cation exchange capacity, Potassium, Centimole per kilogram of soil respectively.

The combined data of the two years demonstrated that variety had no significant effect on plant height, pods plant^{-1} and seeds pod^{-1} (Table 2). Conformity with this finding Mehdi et al. (2010) reported that plant height and seeds pod^{-1} was not affected by cultivars. However, varietal differences in pods number plant^{-1} and plant height were previously reported by Khalil *et al.* (1993) and Abdalla et al. (2000). On the other hand, biomass and seed yield (kg/ha), harvest index and thousand seed weight were significantly ($P<0.05$) influenced by varieties. Results of analysis of variance revealed that Gebelcho variety produced significant high biomass yield (17.6%), seed yield (20.4%), harvest index (4.25%) and thousand seed weight (27%) compared with Shallo. This might be due to the genetic makeup difference of the varieties. Since, Gebelcho variety recorded the highest thousand seed weight which in turn contributes for high biomass yield, seed yield and harvest index. Similar results are in agreement with those obtained by Osman et al. (2010) and Bakry et al. (2011) they reported that significant differences among faba bean varieties on biomass and seed yield, harvest index and thousand seed weight was recorded.

Effect of sowing method

Sowing method has a significant integral effect on resource utilization like water and nutrients, absorption of photosynthetically active radiations. Current result revealed that sowing method had significant influence on plant height, number of pod plant^{-1}, biomass and seed yield (kg/ha). According to Table 2 the highest plant height (164.3 cm), pods plant^{-1} (22.4) and biomass and seed yield (11272.1 and 5297.9 kg/ha) were recorded by row planting method as compared to broadcast planting. The yield gained from the row planting method was 20.2% higher than the broadcasting method. The response of these traits to the sowing method may be due to the efficient resource utilization of the plant when planted in row as compared with the other method. These results are in line with those reported by (Collins and Fowler. 1992). On the other hand, seeds pod^{-1}, harvest index and thousand seed weight were not influenced by sowing method. These results are in contrary with that obtained by Jayanta (2007) who concluded that line sown crop always showed better performance than that of broadcast sown crop.

Table 2. Main effects of variety, sowing method and seed rate on plant height, number of pods plant^{-1}, seeds pod^{-1}, biomass and seed yield (kg /ha), harvest index and 1000 seed weight (g) of faba bean at Sinana (2013-2014).

Treatments	PH	PPP	SPP	BY (kg/ha)	SY (kg/ha)	HI	TSW (g)
Varieties							
Shallo	163.3	21.1	2.7	9247.4^{b}	4222.3^{b}	0.45^{b}	544.0^{b}
Gebelcho	162.0	20.4	2.6	11222.7^{a}	5303.3^{a}	0.47^{a}	746.3^{a}
LSD (5%)	NS	NS	NS	513.24	325.51	0.014	11.69
Sowing Method							
Broadcast	160.8^{b}	19.0^{b}	2.6	9197.9^{b}	4227.8^{b}	0.46	646.5
Row	164.3^{a}	22.4^{a}	2.7	11272.1^{a}	5297.9^{a}	0.47	643.8
LSD **(**5%)	2.26	2.03	NS	2094.2	325.51	NS	NS
Seed Rate (kg/ha)							
125	157.4^{d}	21.0	2.7^{a}	9635.4^{b}	4596.4	0.47^{a}	656.9^{a}
150	160.5^{c}	20.4	2.6^{b}	10172.5^{ab}	4731.9	0.46^{ab}	649.0^{ab}
175	163.0^{bc}	20.7	2.7^{a}	10491.5^{a}	4916.0	0.46^{ab}	645.0^{ab}
200	164.8^{b}	21.0	2.7^{a}	10348.3^{ab}	4792.1	0.46^{ab}	640.2^{ab}
225	167.6^{a}	20.7	2.6^{b}	10527.3^{a}	4777.9	0.45^{b}	634.7^{b}
CV (%)	2.65	17.87	10.34	13.84	18.86	8.15	6.00
LSD (5%)	2.47	NS	0.16	811.5	NS	0.02	18.48

CV= Coefficient of variation, LSD =Least significant difference, PH=Plant height, PPP=Number of pods plant^{-1}, SPP = Number of seeds plant^{-1}, TSW = Thousand seed weight.

Effect of seed rate

The main effects of seed rate confirmed that it had significant influence on all studied parameters except for number of pods plant^{-1} and seed yield (kg/ha) Table (2). The result revealed that plant height and above ground biomass yield was increased as plant density increased. The highest plant height (167.6 cm) and biomass yield (105, 27.3 kg/ha) was observed at the highest seed rate of 225 kg/ha. While the lowest value (157 cm) and (9635.4 kg/ha) was recorded at 125 kg/ha seed rate. Similarly, the highest number of seeds pod^{-1} (2.7) were observed at 125, 175 and 200 kg/ha seed rates and the lowest value (2.6) at 150 and 225 kg/ha. Several faba bean investigators reported the dense planting resulted in decreases for seeds pod^{-1}, seeds plant^{-1} and pods plant^{-1}(Hassan and Hafiz, 1998, Mokhtar, 2001 and Dahmardeh et al., 2010). On the other hand, similar to current finding Dahmardeh et al. (2010) reported that plant height and biomass yield was increased as plant density increased. The increase in plant height could be justified on the bases of increase in the number of plant per unit area coupled with high plant to plant competition. Similarly, biomass yield was justified by number of plant per unit area. However, Shahein et al. (1995) reported that plant height was not affected by increasing plant density.

The result also showed that harvest index and 1000 seed weight were showed decreasing as plant density increased from the lowest to the highest for both traits. This might be due to the fact that as plant density per unit area increased there is more plant to plant competition which results in low nutrient partitioning into seeds as compared to straw; as a result there was low seed yield with low seed weights. This low seed weight was a main cause for low thousand seed weight and harvest index. This result was similar with the findings of (Hassan and Hafiz, 1998 and Mokhtar, 2001) they reported dense planting resulted in decrease for those traits. Similarly, even though seed yield (kg/ha) was insignificant, it showed increasing trend from 125 to 175 kg/ha and then declined. This might be due to severe plant to plant competition beyond certain level of plant populations. Connecting with this Saxena and Stewart (1983) reported the lowest seed yield was obtained from the highest dense planting (33 plant/m^{2}).

Effect of Interaction between varieties and sowing method

Analysis of variance showed that interaction effect of variety and sowing method significantly affect ($P<0.05$) all the studied parameters. The result revealed that both varieties performed better when they are planted in row sowing method as compared to broadcast method. The highest plant height (165.6 cm) and number of pod plant^{-1} (22.5 and 22.2) were obtained from shallo and Gebelcho

cultivars in row sowing method respectively. Similarly, the maximum biomass yield (12474 kg/ha) and seed yield (5921.6 kg/ha) were obtained from Gebelcho in row planting whereas the lowest value was recorded in broadcast sowing method for both cultivars. On the other hand, concerning harvest index and 1000 seed weight, significant variations were only observed between varieties not for sowing method.

Effect of interaction between varieties and seed rates

The average of the two years data revealed that variety x seed rate interactions for plant height, biomass and seed yield (kg/ha), harvest index and 1000 seed weight were statistically significant while pods plant^{-1} and seeds pod^{-1} were not influence (Table 2). The interactions between variety x seed rate indicated that seeding rates did not showed significant influences on biomass and seed yield (kg/ha), harvest index and 1000 seed weight for both varieties. However, these parameters were affected only by varieties. On the other hand, plant height was affected by seed rates for both varieties in which the highest plant height (168.4, 165 and166.7 cm) was recorded at shallo with 225 and 200 kg/ha and Gebelcho with 225 kg/ha and the lowest value (156.2 cm and 158.5 cm) was observed at lowest seed rates for Gebelcho and Shallo respectively. Generally, maximum biomass and seed (kg/ha) were produced by Gebelcho variety with increasing trend under each plant density. Similarly, highest harvest and 1000 seed weight were also recorded by the same variety with decreasing trends under successive plant densities. In agreement with current result Leilah et al. (1988) and Dahmardeh et al. (2010) have recorded that there was significant variation between plant density and varieties in which the highest biomass and seed yield (kg/ha) were obtained from variety at highest plant density. Furthermore, they also observed that number of pods plant^{-1}, seeds pod^{-1} and plant height were insignificantly affected. However, the higher plant height for both varieties under high plant density was supported by Derya (2013) who indicated that denser plant population of pea increased plant height due to competition among plants.

Effect of interaction between sowing method and seed rates

Combined data presented in Table 3 showed that the interaction between sowing method and seed rate had significant effect on all studied characters except harvest index. In line with this Hayatullah et al. (2000) noted that wheat sowing method x seed rate interactions were significantly influenced only tiller per plant and biomass yield (kg/ha). ANOVA results of the broadcast sowing x seed rate in Table 3 showed that it had significantly influenced plant height and 1000 seed weight. It revealed that plant height was gradually increased as plant density increased whereas the reverse was true for 1000 seed weight. On the other hand, though broadcast sowing x seed rate was non-significant biomass and seed yield (kg/ha) were gradually increased by increasing seed rates from 125 to 175 kg/ha and then started to decline. This might be due to high number of plants per unit area caused high plant to plant competition. Similarly, row planting x seed rate interaction effect was insignificant for all tested characters except for biomass yield (kg/ha) which indicated gradual increment from the lowest seed rate to the highest. This is also might be due to the increase in number of plants per unit area. Similarly, though seed yield (kg/ha) was not significantly.

Influenced by row planting × seed rate, it increased from the 125 to 200 kg/ha. In the general data in Table 3 demonstrated that the highest values were recorded for all traits at row sowing methods exception for 1000 seed weight which recorded at both methods. The reason why high values recorded for each trait at row planting method might be due to efficient resource utilization and partitioning into reproductive organs (grains) by the plant. These results were similar of finding reported by Hayatullah et al. (2000) who concluded that row sowing method surpassed the broadcast sowing method.

Effect of interaction between varieties, sowing method and seed rates

It is evident from the combined analysis of variance across two years indicated in Table 4 that the interaction between varieties, sowing method and seed rate had significant ($P<0.05$) effect on all tested characters. Based on the statistical results, it was detected that the highest plant height (171.4 cm) and number of pods per plant (24.3) were obtained from Shallo cultivar in row planting at 225 kg/ha and number of seeds per pod (2.8) from shallo in row planting at 125, 175 and 225 kg/ha and Gebelcho cultivar in row planting at 200 kg/ha (Table 4). Concerning the 1000 seed weight the highest value (778.9 g) was recorded by Gebelcho cultivar in broadcast sowing method at lowest seed rate though it was statistically at par with most treatments in which Gebelcho planted either in row or broadcast method while the lowest score (531.9 g) was recorded by Shallo in broadcast sowing method at 225 kg/ha seed rate. It was also observed that 1000 seed weight values were declined as plant density increased for both cultivars for both sowing methods. Harvest index value was not affected by sowing method and seed rates for both cultivars whereas it was affected by cultivars in which the highest value was recorded by Gebelcho and the lowest by shallo. On the other hand, the data also revealed that maximum biomass yield (13307.3 kg/ha) was recorded by Gebelcho cultivar grown in row sowing method with

Table 3. Interaction effects of variety by sowing method, variety by seed rate and seed rate by sowing method on plant height, number of pods plant^{-1}, seeds pod^{-1}, biomass and seed yield (kg /ha), harvest index and 1000 seed weight (g) of faba bean at Sinana 2013-2014.

Treatments		PHT	PPP	SPP	BY (kg/ha)	SY (kg/ha)	HI (%)	TSW (g)
Variety	**Sowing method**							
Shallo	Broadcast	160.9^{c}	19.7^{b}	2.6	8424.5^{c}	3770.5^{c}	0.44^{b}	547.1^{b}
	Row	165.6^{a}	22.5^{a}	2.7	10070.3^{b}	4674.2^{b}	0.46^{ab}	540.8^{b}
Gebelcho	Broadcast	160.7^{c}	18.5^{b}	2.6	9971.4^{b}	4685.0^{b}	0.47^{a}	745.9^{a}
	Row	163.3^{b}	22.2^{a}	2.6	12474.0^{a}	5921.6^{a}	0.47^{a}	746.8^{a}
LSD (5%)		2.21	1.90	NS	725.83	460.34	0.02	16.53
Variety	**Seed rate (kg/ha)**							
Shallo	125	158.5^{ef}	21.6	2.7	8710.9^{c}	4104.8^{c}	0.47^{ab}	555.8^{b}
	150	161.0^{ed}	20.6	2.7	9082.0^{c}	4151.8^{c}	0.45^{abc}	543.3^{b}
	175	163.2^{cd}	21.4	2.7	9726.6^{bc}	4421.2^{bc}	0.45^{abc}	544.2^{b}
	200	165.0^{abc}	21.0	2.7	9362.0^{c}	4268.3^{c}	0.45^{abc}	544.2^{b}
	225	168.4^{a}	21.3	2.6	9355.5^{c}	4165.6^{c}	0.44^{c}	533.4^{b}
Gebelcho	125	156.2^{f}	20.0	2.7	10559.9^{ab}	5087.9^{ab}	0.48^{a}	759.0^{a}
	150	160.0^{ed}	20.1	2.6	11263.0^{a}	5311.9^{a}	0.48^{a}	754.7^{a}
	175	162.7^{cd}	20.0	2.6	11256.5^{a}	5410.7^{a}	0.47^{ab}	745.8^{a}
	200	164.6^{bc}	21.0	2.6	11334.6^{a}	5315.9^{a}	0.47^{ab}	736.2^{a}
	225	166.7^{ab}	20.3	2.5	11699.2^{a}	5390.2^{a}	0.46^{abc}	736.0^{a}
LSD (5%)		3.49	NS	NS	1147.6	727.85	0.03	26.14
Sowing Method	**Seed Rate (kg/ha)**							
Broadcast	125	155.1^{g}	20.8^{a-d}	2.7^{a}	8665.4^{d}	4131.2^{c}	0.47	674.0^{a}
	150	159.1^{f}	19.1^{bcd}	2.6^{ab}	9381.5^{d}	4265.9^{c}	0.45	646.8^{b}
	175	161.0^{ef}	19.4^{bcd}	2.7^{a}	9602.9^{cd}	4393.7^{bc}	0.45	641.3^{b}
	200	163.0^{cde}	18.4^{cd}	2.6^{ab}	9088.5^{d}	4113.7^{c}	0.45	633.6^{b}
	225	165.8^{bc}	17.8^{d}	2.5^{b}	9251.3^{d}	4234.4^{c}	0.46	636.9^{ab}
Row	125	159.6^{ef}	21.2^{abc}	2.7^{a}	10605.5^{bc}	5061.5^{ab}	0.47	639.8^{cd}
	150	161.9^{def}	21.6^{ab}	2.7^{a}	10963.5^{ab}	5197.8^{a}	0.47	651.2^{abc}
	175	164.9^{bcd}	22.1^{ab}	2.7^{a}	11380.2^{ab}	5438.3^{a}	0.48	648.7^{abc}
	200	166.6^{ab}	23.5^{a}	2.7^{a}	11608.1^{ab}	5470.6^{a}	0.47	641.6^{bcd}
	225	169.4^{a}	23.5^{a}	2.7^{a}	11803.4^{a}	5321.4^{a}	0.45	644.9^{a-d}
CV (%)		3.96	27.59	12.45	13.90	19.25	6.07	6.25
LSD (5%)		3.49	3.00	0.22	1147.6	727.85	NS	26.14

CV= Coefficient of variation, LSD =Least significant difference, PH=Plant height, PPP=Number of pods plant^{-1}, SPP = Number of seeds plant^{-1}, TSW = Thousand seed weight.

the maximum seed rate though, it was statistically at par with most of the treatments in which the same cultivar grown in row sowing while the minimum biomass yield (7877.6 kg/ha) was observed by Shallo cultivar in broadcast sowing at 125 kg/ha. Similarly, the seed yield data also indicated that maximum seed yield (6151 kg/ha) was obtained from Gebelcho in row sowing at 200 kg/ha while the minimum (3718 kg/ha) was recorded by Shallo grown in broadcast at 125 kg/ha (Table 4). It was observed that for both parameters row sowing method was surpassed the broadcast method for both cultivars. This implies that sowing method was the crucial element to boost production and productivity of the crop. Agreement with those result Hayatullah et al. (2000) reported that row sowing method surpassed the broadcast method. According to partial budget analysis as indicated in Table 5, the first and the second marginal rate of return (MRR) were obtained from Gebelcho cultivar sown in row sowing method with 150 and 200 kg/ha seed rates respectively.

Conclusion

The present study demonstrated that Gebelcho cultivar recorded more seed yield (20.4%) higher than shallo. The main sources for the yield difference between the two cultivars were 1000 seed weight which was recorded by

Table 4. Interaction effect of variety, sowing method and seed rate on plant height, number of pods plant^{-1}, seeds pod^{-1}, biomass and seed yield (kg /ha) and 1000 seed weight (g) of faba bean cultivars at Sinana (2013-2014).

Treatments			PH (cm)	PPP	SPP	BY (kg/ha)	SY (kg/ha)	HI (%)	TSW (g)
Variety	**Sowing method**	**Seed rate (kg/ha)**							
Shallo	Broadcast	125	155.3^{g}	21.7^{a-f}	2.7^{abc}	7877.6^{h}	3718.6^{f}	0.47^{ab}	569.1^{c}
		150	159.4^{efg}	19.7^{c-f}	2.7^{abc}	8502.6^{fgh}	3769.5^{ef}	0.44^{ab}	547.1^{cd}
		175	161.2^{c-f}	20.5^{a-f}	2.7^{abc}	8906.2^{e-h}	3854.2^{ef}	0.42^{b}	548.2^{cd}
		200	162.9^{b-e}	18.9^{c-f}	2.7^{abc}	8424.5^{gh}	3746.5^{ef}	0.43^{ab}	539.4^{cd}
		225	165.5^{bcd}	17.8^{f}	2.4^{c}	8411.5^{gh}	3763.5^{ef}	0.44^{ab}	531.9^{d}
	Row	125	161.7^{c-f}	21.4^{a-f}	2.8^{a}	9544.3^{d-g}	4491.0^{def}	0.47^{ab}	540.5^{cd}
		150	162.2^{b-e}	21.5^{a-f}	2.7^{abc}	9661.5^{d-g}	4534.2^{def}	0.46^{ab}	539.4^{cd}
		175	165.3^{bcd}	22.3^{a-e}	2.8^{a}	10546.9^{cd}	4988.2^{bcd}	0.47^{ab}	540.1^{cd}
		200	167.2^{ab}	23.1^{abc}	2.7^{abc}	10299.5^{cde}	4790.2^{cde}	0.46^{ab}	549.0^{cd}
		225	171.4^{a}	24.3^{a}	2.8^{a}	10299.5^{cde}	4567.6^{def}	0.44^{ab}	534.9^{cd}
Gebelcho	Broadcast	125	154.9^{g}	19.9^{b-f}	2.7^{abc}	9453.1^{d-h}	4543.8^{def}	0.48^{a}	778.9^{a}
		150	158.8^{efg}	18.5^{def}	2.5^{bc}	10260.4^{cde}	4762.3^{c-f}	0.46^{ab}	746.4^{ab}
		175	160.9^{def}	18.2^{ef}	2.7^{abc}	10299.5^{cde}	4933.1^{bcd}	0.48^{a}	734.4^{b}
		200	163.1^{b-e}	18.0^{f}	2.5^{bc}	9752.6^{d-g}	4480.8^{def}	0.46^{ab}	727.8^{b}
		225	166.0^{bc}	17.9^{f}	2.5^{bc}	10091.1^{c-f}	4705.2^{c-f}	0.47^{ab}	742.0^{ab}
	Row	125	157.5^{fg}	20.9^{a-f}	2.7^{abc}	11666.7^{bc}	5632.1^{abc}	0.48^{a}	739.0^{b}
		150	161.2^{c-f}	21.8^{a-f}	2.6^{abc}	12265.6^{ab}	5861.5^{ab}	0.48^{a}	763.0^{ab}
		175	164.5^{bcd}	21.8^{a-f}	2.6^{ac}	12213.5^{ab}	5888.4^{ab}	0.48^{a}	757.2^{ab}
		200	166.0^{bc}	23.9^{ab}	2.8^{a}	12916.7^{ab}	6151.0^{a}	0.47^{ab}	744.7^{ab}
		225	167.5^{ab}	22.7^{a-d}	2.5^{bc}	13307.3^{a}	6075.2^{a}	0.45^{ab}	730.1^{b}
CV (%)			3.83	20.56	10.65	13.84	18.86	8.15	5.0
LSD (0.05)			4.94	4.25	0.31	1630	1050.1	0.05	36.97

CV= Coefficient of variation, LSD =Least significant difference, PH=Plant height, PPP=Number of pods plant^{-1}, SPP = Number of seeds plant^{-1}, TSW = Thousand seed weight.

Gebelcho. The experiment also revealed that the highest yield and yield components especially seed yield (20.2%) was obtained from row sowing method as compared to broadcast method. Moreover, both cultivars gave maximum values for all traits when they planted in row sowing method. On the other hand, seed rate alone had no significant effect on seed yield. Furthermore, the sowing method x seed rate interaction effect revealed that biomass and seed yield increased from lowest seed rate up to 175 kg/ha seed rate in broadcast sowing method while it rise up to the maximum seed rate in row sowing method. On other hand, for small seeded cultivars like Shallo use of 125 kg/ha seed rate was economical to use and Gebelcho in row sowing method at 200 kg/ha seed rate followed by the same cultivar in similar sowing method at 225 kg/ha seed rate gave the first and the second highest mean seed yield (kg/ha). But, the partial budget analysis result revealed that the first and the second highest net benefit or the highest marginal rate of return was obtained from Gebelcho (large seded) in row sowing method at 150 kg/ha and 200 kg/ha seed rates respectively and it was economical to produce faba bean in Bale highlands but it should be testing under small scale farmers' conditions.

Table 5. Partial budget and dominance analyses of sowing method and seed rates of faba bean cultivars at Sinana, average of two years (2013-2014).

Treatments	Adjusted seed yield 10% (kg/ha)	GB (Birr/ha)	Costs that vary (Birr/ha)				
			Seed	Labor	TVC (Birr/ha)	NB (Birr/ha)	MRR (%)
V1* R* 125kg/ha	4041.90	36377.10	1125	1170	2295.00	34082.10	
V2 * R* 125kg/ha	5068.89	45620.01	1125	1170	2295.00	43325.01	
V1* R* 150kg/ha	4080.78	36727.02	1350	1170	2520.00	34207.02	Dominated
V2* R* 150kg/ha	5275.35	47478.15	1350	1170	2520.00	44958.15	725.84
V1* BC *125kg/ha	3346.74	30120.66	1125	1620	2745.00	27375.66	D
V2* BC* 125kg/ha	4089.42	36804.78	1125	1620	2745.00	34059.78	D
V1* R* 175kg/ha	4489.38	40404.42	1575	1170	2745.00	37659.42	D
V2*R*175kg/ha	5299.56	47696.04	1575	1170	2745.00	44951.04	D
V1*BC*150kh/ha	3392.55	30532.95	1350	1620	2970.00	27562.95	D
V2*BC*150kh/ha	4286.07	38574.63	1350	1620	2970.00	35604.63	D
V1*R*200kg/ha	4311.18	38800.62	1800	1170	2970.00	35830.62	D
V2*R*200kg/ha	5535.90	49823.10	1800	1170	2970.00	46853.10	421.10
V1*BC*175kg/ha	3468.78	31219.02	1575	1620	3195.00	28024.02	D
V1*R*225kg/ha	4110.84	36997.56	2025	1170	3195.00	33802.56	D
V2*BC*175kg/ha	4439.79	39958.11	1575	1620	3195.00	36763.11	D
V2*R*225kg/ha	5467.68	49209.12	2025	1170	3195.00	46014.12	D
V1*BC*200kg/ha	3371.85	30346.65	1800	1620	3420.00	26926.65	D
V2*BC*200kg/ha	4032.72	36294.48	1800	1620	3420.00	32874.48	D
V1*BC*225kg/ha	3387.15	30484.35	2025	1620	3645.00	26839.35	D
V2*BC*225kg/ha	4234.68	38112.12	2025	1620	3645.00	34467.12	D

GB=Gross benefit, TVC=Total variable cost, NB=Net benefit, MRR=Marginal rate of return.

ACKNOWLEDGMENT

The authors would like to thank Mr. Tadele Tadesse head of Pulse and Oil crops research case team who follow up and coach the study. The authers also would like to thank Mr. Amanuel Tekalign, Gebeyehu Wondimu, Kemal Muktar, Muhidin A/Qadir, Hailu Reta, Negash Mohamed, Bekele Zenebe, Birhanu Bareka, Zara Kedir and Sundusa Abda of Sinana Agricultural Research Center (SARC) pulse and oil crops research case team members for managing the trail, data collecting and compiling. We would like to thank SARC administrative staff for facilitating all the necessary resources. Finally we also would like to thank Oromia agricultural research institute for financing this study.

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