**Effect of Sowing Date and Seed Rate on Faba Bean (Vicia faba L.,) Growth, Yield and Components of Yield at Sinana, Highland Conditions of Bale, Southeastern Ethiopia**

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**Abstract.** The experiment was conducted during 2011-2013 Bonal/Meher cropping seasons for three consecutive years to study the direct influence of sowing date, seed rate and their interactions on faba bean. The experiment was laid out in split-plot with randomized complete block design (RCBD) in three replications. Four seed rates (175, 200, 225 and 250 kg/ha) were used as main plot and four sowing dates, which begun on the onset of the rain shower and with two week sowing date intervals to the rest three sowing dates were used as a subplot. The results of the three years data revealed that sowing date significantly affected all the tested parameters except 1000 seed weight. Seed yield was declined by 5, 23.3 and 67% from first to the fourth sowing dates respectively. On the other hand, seed rate had no significant effect on all parameters except for plant height. The interaction effect between sowing date and seed rate showed all the tested parameters were significantly affected. The data indicated that the highest plant height, number of pods plant⁻¹, number of seeds pod⁻¹, seed yield hectare⁻¹ and 1000 seed weight were obtained at 250 kg/ha with third sowing, 200 kg/ha with first to third sowing, 250 kg/ha with second sowing, 250 kg/ha with first sowing and 175 kg/ha with third sowing date while the minimum value was obtained at fourth sowing date with consecutive seed rates. However, the partial budget analysis showed 175 kg/ha seed rates with early planting gave the highest marginal rate of return (MRR) and it was economical to produce faba bean in highlands of Bale. But, another seed rate experiment will be needed in the future with seed rates of less than 175 kg/ha for conclusive recommendations.

**Keywords:** Faba bean (Vicia faba L.), seed rate, sowing date

1. **INTRODUCTION**

Legumes are very important both ecologically and agriculturally: because they are responsible for a substantial part of the global flux of nitrogen from atmospheric N2 to fixed forms such as ammonia, nitrate and organic nitrogen. Atmospheric N2 fixed symbiotically by the association between rhizobium species and legumes represents a renewable source of nitrogen for agriculture. Legume crops are not only used as improving soil fertility through biological nitrogen fixation but also major food for human diet especially for Ethiopians. It also constitutes an important component in cropping systems due to their role in improving soil fertility through biological nitrogen fixation and serve as effective break crop for weed and diseases.

Faba bean (vicia faba L.) is the fourth most important pulse crops in the world (Talal, 2006). It is one of the most important legume crops worldwide; because it is nitrogen fixing leguminous plant, offering high quality protein, capable of returning atmospheric nitrogen to the soil (Amin, 1988). Faba bean is used as human food in developing countries and as animal feed, mainly for pigs, horses, poultry and pigeons in industrialized countries (Talal, 2006). It has been considered as a meat extender or substitute and as a skim-milk substitute. In Ethiopia among the pulse crops grown; the greatest area of land was allocated to faba bean (CSA, 2012). However, the national yield per hectare of this crop was very low. The main reasons for the low yield of this crop were attributed to several factors such as, poor soil fertility, low use of inputs, weed, depth of sowing, inadequate soil moisture and limited use of modern agronomic or cultural practices (poor appropriate time of planting and plant density) were the most critical (Hebblethwaite et al., 1983; Asfaw et al., 1994). However, high yield of the crop was realized when those yield limiting factors are solved with the optimum management. Thus, sowing date and seeding rate are one of the most important cultural practices which affect the productivity of faba bean.
Sowing date is an important factor which significantly affects the timing and duration of vegetative and reproductive stages consequently yield its components and seed quality (Refay, 2001 and Turk and Tawaha, 2002). Since, environmental factors i.e., temperature and light differ due to sowing dates. There are number of studies which indicated that sowing date had significant yield limiting factor on faba bean. Thus, Talal and Ghalib (2006) reported that early planting (end of November) resulted in a significant yield advantage (157%), more shoot and root growth, more number of nodules and higher nodule dry weight over the late sowing date (end of January). They concluded that much of this advantage resulted from the extended period of vegetative growth which resulted in the improvement of several agronomical characters. Another experiment from Jordan indicated that early planting in November resulted in a substantially yield increase which was more than double that produced when planting in January (Haddad and Thalji, 1988). Similarly, El-Metwally et al. (2013) showed that sowing date at 25th October recorded the highest values of growth characters and pigment content (total chlorophyll). While, the greatest values of yield and its components were resulted from the sowing date 25th November. However, in Ethiopia the Optimum sowing date for faba bean crop differed with location, cultivar, and availability of soil moisture due to agricultural crops production in the country totally depends on start of rainfall shower. But, sowing dates from mid June to early July have been recommended for most faba bean growing areas. Since, Late-sown crops suffered from frost and earlier ones from root rot and chocolate spot diseases (IAR 1975; Amare 1985, 1990).

On the other hand, crop density or seeding rate significantly influences yield and yield components due to competition for limited resources in the field especially, for light, water and nutrients. In this regard, results obtained from different areas which describe yield response to plant population alteration in different cultivation systems are highly variable. Plant population studies carried out for 3 years (1970-72) at Holota research center using the local landraces showed that broadcasting 250 kg/ha on Nitosols and drilling 350 kg/ha seed on cambered vertisols gave the highest yields (IAR, 1975; Amare, 1985). Similar result from Kulumsa research center also showed the best seed yields were obtained from 375kg/ha seed rate (CADU, 1969b,1969c; Amare, 1985). Moreover experiments conducted by Sinana state farm, Bale zone which conducted for 3 years (1989-91) in meher cropping season indicated that the highest seed yield of 2.78t/ha was obtained from a seeding rate of 275kg/ha which resulted in yield advantages of 532 and 516kg/ha over seeding rates of 125 and 300kg/ha, respectively (BADE, 1989-91). On the other hand, in Spain, Caballero (1987) found that increasing plant population from 10 to 50 plants m⁻² increased seed yield from 4.59 to 5.23 tons ha⁻¹. In Egypt, Leilah and El-Deeb (1990) reported that higher seed yields were obtained when 36 or 60 kg nitrogen ha⁻¹ was applied to a density of 33 plants m⁻². Generally, as described from the different findings, it was concluded that plant population and sowing date had a profound significant effect on faba bean growth, yield, and yield components. However, on study areas there was no detail information with regard to the combined effect of seed rate and sowing date on faba bean yield and yield traits. Therefore, this study was aimed to investigate the direct influence of sowing date and seed rate on faba bean growth, yield and yield traits and develop recommendations for faba bean production under highland conditions of Bale, Southeastern Ethiopia.

2. MATERIALS AND METHODS

2.1. Experimental Site

This study was conducted under rain-fed conditions of Sinana Agricultural Research Center, on-station during the “bona” season August-December of 2011-2013 which is the main cropping season. Sinana is located at a distance of about 463 km from Addis Ababa, Capital of Ethiopia in the South-Eastern direction in the highlands of Bale Zone, South-eastern Oromia, and 33 km East of Robe town, the capital of the Bale Zone. It is located at 7°57'N latitude and 40°10'E longitude, at an elevation of 2400 meters above sea level. The soil of the area was dominated by Cambisol. Rainfall data recorded at Sinana weather stations indicated that the rainfall was normally distributed during the experimental years. The area received an annual rainfall of 1142 mm during the cropping seasons (Figure 1). The mean maximum and minimum temperatures of the area during the growing season were 20.44°C and 9.82°C, respectively. The highest mean amount of rainfall was received in 2012 cropping season in which the highest amount (325.5 mm) and (338.6 mm) was obtained in August and September respectively.

2.2. Experimental Design and Procedure

The experiment was conducted to determine the direct influence of sowing date, seed rate and their interactions on faba bean for three years (2011, 2012 and 2013 main cropping seasons) on Sinana agricultural research center on-station. The experiment was laid out in split plot with randomized complete block design. Four seed rates (175, 200, 225
and 250 kg/ha) was used as a main plot and four sowing dates, which begun on the onset of the rain shower and with two week sowing date intervals to the rest three sowing dates were used as a subplot with three replications. For this finding an improved faba bean cultivar (Shallo) which released from Sinana agricultural research center was used. The size of the subplot was 4 m x 3 m and the distance between subplot and blocks (rep) were 1 m and 1.5 m respectively. All the recommended packages for faba bean production (two times hand weeding at 25-30 and 40-45 days after emergency, single application of 100kg/ha DAP fertilizer along with seeds etc) were applied for each treatment. Seedbed preparation was conducted using oxen plough based on farmer’s practices.

2.3. Data Collection

Agronomic parameters collected included plant height (average of five plants), number of pods per plant and number of seeds per pod (average of five plants), seed yield per hectare, thousand seed weight of faba bean and seed price and labor person-day were collected to investigate the economic profitability of the treatments. To estimate seed yield of faba bean, sample size of 6 m$^2$ was harvested from each plot in December. After threshing, the harvested materials, seeds were cleaned, weighed and adjusted to 10% moisture level. The total seed yields recorded on plot basis were converted to kg/ha for statistical analysis.

2.4. Statistical Analysis

The crop data were subjected to analysis of variance using the General Linear Model Procedure of SAS statistical package version 9.1 (SAS Institute, 2002). Data were not combined over the year due to heterogeneity. The total variability for each trait was quantified using pooled analysis of variance over years. The least significant difference (LSD) test at 5% level of significance was used to compare the means.

2.5. Economic Analysis

As farmers attempt 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% (i.e. for management and plot size differences, to reflect the difference between the experimental yield and the yield that farmers could expect from the same treatment). Farm-get prices of faba bean seed Ethiopian Birr (ETB 9.0 kg$^{-1}$) of the average of one month from the time of crop harvesting and labor valued at ETB 25 per person per day were used for variable cost determination.

3. RESULTS AND DISCUSSIONS

3.1. Plant height

As indicated in Table 1, the main effect of sowing date showed that there is no significant difference between first, second and third sowing dates on plant height in 2011. On the other hand, significant variation was observed between fourth sowing date and the rest sowing dates. For the 2013 cropping season sowing data had showed non-significant variation on plant height. The data revealed plant height decreased from first sowing date to the fourth in 2011 and increasing trend up to third sowing date and decline at fourth in 2012. The average of the three years data revealed that non-significant variation of plant height was observed between first, second and third sowing dates. However, significant variations were observed between the fourth sowing date and the other three sowing dates in which the least score (130.1cm) was observed at fourth sowing date. This result was in agreement with those reported by Metwally et al. (2013) who concluded that no significant variations were observed between 25 October, 10 November and 25 November while significant variation between 10 December and the rest three sowing dates.
The main effect of seed rate Table 1 revealed that significant variation of plant height was observed in 2011 and 2012 growing seasons whereas, no significant variation observed in 2013. It was observed that the highest plant height (119 cm and 143.9 cm) was recorded at seed rate of 250 kg/ha while the lowest height (109.8 cm and 132.2 cm) was observed at 175 and 200 kg/ha seed rate respectively in 2011 and 2012 growing seasons. The mean of the three years data showed that seed rate had significant main effect on plant height in which the highest plant height (138.3 cm) and the lowest (132.5 cm) was observed at 250 and 200 kg/ha respectively. This increase in plant height may be attributed to the high on plant –to-plant competition in the higher density treatments. Ali and El-Shaikh 2008, demonstrated that narrow spacing, in their works, lead to a reduction of light intensity, which encouraged IAA concentration in stem tissues. Such increase in IAA concentration may reflect in cell enlargement and, hence, plant height. The result of interaction effect of seed rate and sowing date showed that plant height was significantly influenced by the parameters for the three years. The highest plant height (130, 160 and 161cm) was observed at 250 kg/ha with second and third sowing date in 2011 and 2012 and 200 kg/ha with first sowing date in 2013 respectively (Table 3). Moreover, the average of the three years data revealed that plant height was significantly influenced by the interaction of both parameters. Accordingly, the highest plant height (142.1cm) was recorded at 250 kg/ha seed rate with third sowing date while the lowest scored (128.6 and 128.8 cm) observed at 200 and 175 kg/ha with fourth sowing date respectively. Overall, from the result it was observed that the highest plant height was recorded at the highest seed rate with early planting dates while minimum score was observed at late sowing date (fourth sowing date) for each seed rates compared with the other sowing dates. This might be due to early planting resulted in extended period of vegetative growth which resulted in the improvement of the several agronomic characters. Moreover, higher seed rate caused more population competition for sunlight which resulted in high plant height and low number of pod per plant and seed per pod.

3.2. Number of Pods per Plant

As it was presented in Table 1 the number of pods per plant was significantly (P≤0.05) influenced by sowing date across the three years. The data revealed that across the three years first to third sowing dates were non-significantly influenced the number of pods per plant while it was significantly influenced at fourth sowing date. The maximum score was observed from first to third sowing date while lowest score was recorded at fourth. Similarly the mean of the three year data also revealed that number of pods per plant was only affected at fourth sowing date at which minimum score was observed. Early planted crop more efficiently utilized the nutrient, water and radiation for longer duration that resulted in more pods compared with late planted crop (Tay, 1992). On the other hand, number of pods per plant was influenced by seed rate only for 2011 growing season. The maximum number of pods per plant was recorded at 200 to 250 kg/ha while the minimum was observed at 175 kg/ha. The average of the three years data revealed that seed rate had no significant effect on number of pods per plant. However, Shad et al. (2011) observed that maximum number of pods per plant were recorded at lowest plant population whereas, the lowest at the highest plant population.

Number of pods per plant was significantly (P ≤ 0.05) influenced by the interaction between sowing date and seed rate for 2011 and 2012 cropping seasons while non-significant for 2013. The result showed that the highest number of pods per (11.9, 11.6 and 11.7) was observed at 200 kg/ha with first sowing, 250 kg/ha with second and third sowing dates respectively in 2011 thought it was at par with most treatments. For 2012 cropping seasons the highest (26.9 and 27.1) at 175 and 200 kg/ha with first and second sowing date while the lowest was observed at fourth sowing date for successive seed rates. Similarly, the mean of the three years data showed significant variation on number of pods per plant in which the highest (17.2, 16.6 and 16.8) was recorded at 175 with first sowing, 200 kg/ha with first to third sowing while the lowest was recorded at fourth sowing date for successive seed rates (Table 3).

3.3. Number of Seeds per pod

Analysis of variance revealed that significant variations were observed for number of seeds per pod due to sowing date in 2011 whereas, non-significant for the other two years. The 2011 cropping season data showed no significant variation was observed between first to second sowing dates while it showed variation between fourth and the rest three sowing dates. Similarly the average of the three years revealed insignificant variation between first to third sowing dates while significant variation observed at fourth sowing at which the lowest value (2.5) was recorded. Grenz et al. (2005) and Badran and Ahmad (2010) obtained similar results. The main effect of seed rate Table 1 revealed that significant variation of number seeds per pod was observed only in 2011 growing seasons. It was observed that the highest number of seeds per pod (3.0) was observed at a seed
rate of 175 kg/ha and the lowest score (1.2) was recorded at a rate of 250 kg/ha. However, the mean of
the three years data showed seed rate had no main
effect on number of seeds per pod. These results
confirm what was reported by Rifaee et al. (2004)
who reported that plant population did not affect the
number of seeds per pod.

The interaction effect of seed rate and sowing date
depicted in Table 3 showed that it was significant
across the three years as well as for the mean of the
three years. The mean of the three years data showed
that the highest number of seeds per pod (3.4) was
recorded at 250 kg/ha with second sowing dates while
the lowest was observed at fourth sowing dates for
each successive seed rates.

3.4. Seed Yield (kg/ha)

As presented in Table 2 the main effect of sowing date
was significant on seed yield (kg/ha) throughout the
three years. The data revealed that seed yield was
consequently decreased from the first sowing date to
the fourth in 2011 and 2013 growing season. However,
the results of 2012 growing season showed that seed yield was increased from first sowing date to
the third sowing date and then it declined at the fourth
sowing date. The result also showed seed yield was
decreased by 20.2%, 50.9%, 87.7% and 14.3%, 53.2%
and 86.9% from first sowing data to the fourth sowing
date respectively in 2011 and 2013 growing season.
Contrary to the two years data, the 2012 growing
season indicated that seed yield was increased by
12.8% and 17.0% from first sowing date to the third
sowing date and then declined by 46.6% at fourth
sowing date. The main factors which contribute for an
increase of yield from first to third sowing dates in
2012 growing season was the amount and uniform
distribution of rainfall. Thus, the amount of rainfall
during 2012 was very high and uniform up to the end
of the crop growth stage than 2011 and 2013 growing
seasons. Generally, the three years mean seed yield
data revealed that seed yield was declined by 5%,
23.3% and 67% from first sowing date to the fourth
sowing date respectively. The high yield from early
planted crop might be due to the fact that early planted
crop had longer period for vegetative growth and
better utilization of water and nutrients. Moreover late
sown crops produced less pods plant$^{-1}$ and hence
resulted in low yield. Moreover, the reduction in yield
in late planted crop may be due to poor growth,
shorter grain filling duration and maturity period, less
number of fruiting nodes and pods plant$^{-1}$ and minimum grains pod$^{-1}$ (Berhe, 1998 and Sahile et al.,
2008). On the other hand, analysis of variance showed
non-significant statistical differences due to seed rate
for seeds yield (kg/ha) were observed for each of the
three years as well as for the mean of the three years.
The result found in this study is consistent with
Abdel-Rahman et al. (2002) who found statistically
non-significant effect of seeding rate on lentil grain
yield.

The result of interaction effect between sowing
date and seed rate indicated that significantly affected
seed yield kg/haear each years and for the
mean of the three years (Table 4). It was observed that
the highest seed yield was obtained at first sowing
date with each successive seed rates for the 2011 and
2013 growing seasons while the lowest value was
obtained at fourth sowing date with successive seed
rates. In contrary to the 2011 and 2013 growing
seasons, the 2012 growing season showed maximum
seed yield was obtained at third sowing dates with 175
kg/ha seed rate (Table 4). The average of the three
years data also revealed that sowing date and seed rate
significantly affected seed yield. Thus, the maximum
seed yield (2865 kg/ha) was obtained from 250 kg/ha
at first sowing date whereas the lowest value was
recorded at fourth sowing date for each successive
seed rates. In agreement with these result Shad et al.
(2011) suggested that maximum yield was recorded at
thick plant density with early sowing while minimum
seed yield was recorded at thin plant density with late
sowing.

3.5. Thousand Seed Weight (g)

As presented in Table 2 the main effect of sowing date
was significant on thousand seed weight throughout
the three years growing seasons except for 2012
growing season in which it was non-significant. The
result of 2011 and 2013 growing season data showed
that thousand seed weight was gradually declined
from the first sowing date to the forth sowing date for
both years exception at third sowing date in 2013
growing season which showed an increment. This
might be due to early planted crop efficiently utilized
the nutrient, water and radiation for longer duration
that resulted in heavier grains compared with late
planted crop (Tay, 1992). However, the average of the
three years data indicated that thousand seed weight
was not significantly influenced by sowing dates.
Table 1: Effect of Seed rate and sowing date on plant height, number of pods per plant and seeds per pod of faba bean at Sinana 2011-2013 Bona cropping Season

<table>
<thead>
<tr>
<th>Treatments Sowing Date</th>
<th>2011 PH (cm)</th>
<th>NPP (kg/ha)</th>
<th>SPP (g)</th>
<th>2012 PH (cm)</th>
<th>NPP (kg/ha)</th>
<th>SPP (g)</th>
<th>2013 PH (cm)</th>
<th>NPP (kg/ha)</th>
<th>SPP (g)</th>
<th>Mean PH (cm)</th>
<th>NPP (kg/ha)</th>
<th>SPP (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>121.6a</td>
<td>10.4a</td>
<td>3.0a</td>
<td>133.3b</td>
<td>22.7b</td>
<td>2.3</td>
<td>156.1</td>
<td>14.7b</td>
<td>3.9</td>
<td>137.0a</td>
<td>15.9a</td>
<td>3.0a</td>
</tr>
<tr>
<td>2</td>
<td>121.5a</td>
<td>9.7a</td>
<td>3.2a</td>
<td>136.5a</td>
<td>22.7a</td>
<td>2.5</td>
<td>151.3</td>
<td>14.0ab</td>
<td>4.0</td>
<td>136.7a</td>
<td>15.5a</td>
<td>3.2a</td>
</tr>
<tr>
<td>3</td>
<td>111.5a</td>
<td>10.1a</td>
<td>2.8a</td>
<td>147.4a</td>
<td>20.8ab</td>
<td>2.4</td>
<td>151.2</td>
<td>13.9ab</td>
<td>4.0</td>
<td>136.5a</td>
<td>14.9a</td>
<td>3.1a</td>
</tr>
<tr>
<td>4</td>
<td>98.6b</td>
<td>5.1b</td>
<td>1.2b</td>
<td>139.4b</td>
<td>15.3b</td>
<td>2.4</td>
<td>152.3</td>
<td>12.8b</td>
<td>3.8</td>
<td>130.1b</td>
<td>11.1b</td>
<td>2.5b</td>
</tr>
<tr>
<td>Mean</td>
<td>113.3</td>
<td>8.8</td>
<td>2.5</td>
<td>139.1</td>
<td>20.4</td>
<td>2.4</td>
<td>152.7</td>
<td>13.8</td>
<td>3.9</td>
<td>135.1</td>
<td>14.35</td>
<td>2.95</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Sowing Date</th>
<th>LSD</th>
<th>CV</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11.62</td>
<td>1.67</td>
</tr>
<tr>
<td>2</td>
<td>9.5</td>
<td>27.3</td>
</tr>
<tr>
<td>3</td>
<td>6.1</td>
<td>14.4</td>
</tr>
<tr>
<td>4</td>
<td>ns</td>
<td>ns</td>
</tr>
</tbody>
</table>

Table 2: Effect of Seed rate and sowing date on thousand seed weight and seed and biomass yield of faba bean at Sinana

<table>
<thead>
<tr>
<th>Treatments Sowing Date</th>
<th>2011 SY (kg/ha)</th>
<th>TSW (g)</th>
<th>2012 SY (kg/ha)</th>
<th>TSW (g)</th>
<th>2013 SY (kg/ha)</th>
<th>TSW (g)</th>
<th>Mean SY (kg/ha)</th>
<th>TSW (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2839a</td>
<td>490.0a</td>
<td>3109b</td>
<td>487</td>
<td>1939b</td>
<td>556.8a</td>
<td>2629a</td>
<td>511.2</td>
</tr>
<tr>
<td>2</td>
<td>2265b</td>
<td>456.9b</td>
<td>3566b</td>
<td>494</td>
<td>1661b</td>
<td>553.8b</td>
<td>2497b</td>
<td>501.6</td>
</tr>
<tr>
<td>3</td>
<td>1393b</td>
<td>489.0b</td>
<td>3745b</td>
<td>499</td>
<td>908b</td>
<td>605.2b</td>
<td>2015b</td>
<td>530.4</td>
</tr>
<tr>
<td>4</td>
<td>350c</td>
<td>438.3c</td>
<td>2001c</td>
<td>636</td>
<td>253c</td>
<td>525.9c</td>
<td>868c</td>
<td>533.6</td>
</tr>
<tr>
<td>Mean</td>
<td>1711.7</td>
<td>468.55</td>
<td>3105.2</td>
<td>529</td>
<td>1190.2</td>
<td>559.9</td>
<td>2002.2</td>
<td>79.2</td>
</tr>
</tbody>
</table>

| LSD | 543.8 | 35.42 | 371.2 | 286 | 285.1 | 19.39 | 235.7 | 79.6 |
| CV  | 37.7  | 9.0   | 6.0   | ns  | 28.4  | 4.1   | 33.9  | ns  |

<table>
<thead>
<tr>
<th>Seed Rate (kg/ha)</th>
<th>175</th>
<th>200</th>
<th>225</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1679</td>
<td>477.7</td>
<td>3070</td>
<td>499</td>
</tr>
<tr>
<td>2</td>
<td>1557</td>
<td>458.0</td>
<td>3023</td>
<td>488</td>
</tr>
<tr>
<td>3</td>
<td>1716</td>
<td>467.7</td>
<td>3103</td>
<td>646</td>
</tr>
<tr>
<td>4</td>
<td>1894</td>
<td>470.7</td>
<td>3225</td>
<td>482</td>
</tr>
<tr>
<td>Mean</td>
<td>1711.5</td>
<td>468.52</td>
<td>3105.3</td>
<td>529</td>
</tr>
</tbody>
</table>

| LSD | 494.0 | 34.1 | 889.3 | 231 | 289.7 | 20.60 | 344.4 | 95.2 |
| CV  | ns    | ns   | ns    | ns  | ns    | ns    | ns    | ns   |

1=Planted at onset of rain shower, 2=Planted after two week of rain shower, 3=Planted after a month of rain shower 4=Planted after a month and two weeks of rain shower, SY=Seed yield, TSW=Thousand seed weight, BY=Biomass yield, LSD=Least significant difference, CV=Coefficient of variation.

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Similarly, seed rate had shown non-significantly influenced thousand seed weight for each years as well as for the mean of the three years. However, (Jasinska and Kotecki, 1995) established that heavier grains obtained from think density compared with thick density which produced lighter grains.

Result of analysis of variance revealed that interaction between sowing date and seed rate significantly affected the thousand seed weight across each year and the mean of the years. The mean of the three years data showed that the highest value (535.1g) was recorded at 175 kg/ha with third sowing date whereas, lowest value (472.6g) was observed at 225 kg/ha with fourth sowing date though it was at par with fourth sowing dates for each successive seed rates (Table 4).

### Table 3: Interaction Effect of Seed rate and sowing date on yield and yield components of faba bean at Sinana

<table>
<thead>
<tr>
<th>Treatment SD x SR</th>
<th>2011 PH (cm)</th>
<th>NPP</th>
<th>SPP</th>
<th>2012 PH (cm)</th>
<th>NPP</th>
<th>SPP</th>
<th>2013 PH (cm)</th>
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<th>SPP</th>
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<td>130.0±d</td>
<td>12.5±2d</td>
<td>2.6±d</td>
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</table>

Mean 113.2  8.8  2.5  139.3  20.3  2.38  152.7  13.8  3.9  135.06  14.33  2.9  

LSD 21.23  3.74  1.12  13.07  8.49  0.38  12.43  3.54  0.46  9.42  3.32  0.414  

CV 11.2  25.5  26.2  5.6  25.0  9.6  4.88  ns  7.1  7.5  24.1  19.9  

1=Planted at onset of rain shower, 2=Planted after two week of rain shower, 3=Planted after a month of rain shower 4=Plant after a month and two weeks of rain shower,
Wakweya et al.
Effect of Sowing Date and Seed Rate on Faba Bean (*Vicia faba* L. var.) Growth, Yield and Components of Yield at Sinana, Highland Conditions of Bale, Southeastern Ethiopia

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)

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Adjusted yield 10% (kg/ha)</th>
<th>GB (BIRR/ha)</th>
<th>Costs that vary (BIRR/ha)</th>
<th>Seed</th>
<th>Labor</th>
<th>TVC (BIRR/ha)</th>
<th>NB (BIRR/ha)</th>
<th>MRR (%)</th>
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<tr>
<td>1 x 175 kg/ha</td>
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<td>1575</td>
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<td>1 x 200 kg/ha</td>
<td>2253.6</td>
<td>2100</td>
<td>1800</td>
<td>150</td>
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<td>18182</td>
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<td>2625</td>
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<td>2025</td>
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<td>2025</td>
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<td>4 x 200 kg/ha</td>
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<td>375</td>
<td>3000</td>
<td>4994.7</td>
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</tbody>
</table>

1= Onset of rain shower, 2= Planted after two week of rain shower, 3 = Planted after one month of rain shower, 4 = Planted after one month and two week of rain shower, GB = Gross Benefit, TVC = Total variable cost, NB = Net Benefit, MRR (%).

4. CONCLUSION

The present study demonstrated that sowing date from first (onset of rainfall) to a third sowing date (a month) had no statistical significant effect on yield components and yield contributing factors. Moreover, during low rainfall year and few amount at the end of crop growth stage, there is chance to plant faba bean up to two weeks after onset of rainfall without significant yield loss. However, if there is enough and uniform rainfall distribution up to the end of the crop growth stage there is a chance of planting up to a month after start of rain shower without significant yield loss. On the other hand, seed rate alone had no significant effect on all tested parameters except for plant height. Overall findings showed that, 250 kg/ha seed rate at onset of rain shower showed maximum seed yield than the other seed rates without significant statistical variation between first and second sowing dates for successive seed rates. However, the partial budget analysis result revealed that the highest marginal rate of return was obtained from 175 kg/ha seed rate at early planting and showed economical for this study. But, another seed rate experiment would be needed in the future with seed rates of less than 175 kg/ha for conclusive recommendations.

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Tay UJ (1992). Seeding date effects on faba bean yields in two agro ecological areas of Southern Chile. FABIS Newsletter, 30: 26-28.

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